PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS'

FIELD CLUB

VOLUME XVII.

Part I, 1910. Part II, 1911. Part III, 1912

GLOUCESTER: 1910-1912

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PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB

(SESSION 1909—10.)

EDITED BY THE HONORARY SECRETARY

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*The Supplement to Vol. IX., is 'The Origin of the Cotteswold Field Club, and an Epitome of the Proceedings from its formation to May, 1877,' by W. C. Lucy, F.G.S.

†The Supplement to Vol. XIV., is the 'Contents of Proceedings,' Vols. I.—XIV. 1847—1903. To Members, 2/6; to the Public, 3/6.

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Vol. II. lacks the plate of Cirencester High Cross.

Copies of Vol. III., imperfect as regards plates of Crosses, will be sold at one-third reduction.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

PRESIDENT

REV. WALTER BUTT, M.A., J.P.

HONORARY SECRETARY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

Vol. XVII. Part I.

1910

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PRINTED BY JOHN BELLOWS

GLOUCESTER

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* Signifies those who have contributed Papers printed in the "Proceedings" of the Club.

(Any corrections in this List should be notified to the Hon. Secretary.)

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	£ s d	£ s d
Balance from last Account		17 7 2
Interest on Deposit Account	0 15 8	
Subscriptions, 1908, 2 at 15/-	1 10 0	
" 1909, 95 at 15/-	71 5 0	
" " 2 at 10/-	1 0 0	
Entrance Fees	11 0 0	
Sale of Proceedings	8 10 5	
Archæological Society—Rent of Room	8 0 0	
Secretary—over from Excursions	0 7 10	
		102 8 11
		£119 16 1

T. S. ELLIS, *Hon. Treasurer.*

Gloucester, 2nd April, 1910.

N.B.—By an error on the part of the Editor, for which he desires to express regret, the last statement was made to appear as though it was for the whole of the year 1908, whereas it was only for the period, from April 8th to December 31st. Also, the words "current account" should have been omitted.

THE YEAR ENDING DECEMBER 31st, 1909.

EXPENDITURE

	£ s d	
Secretary's Expenses, including Entertainment of Guests, Proceedings, etc.	10 10 6	
Ditto, Library Expenses	0 15 6	
Dr. Callaway and Mr Gray, Expenses arranging Malvern Excursion	0 14 0	
Librarian—Expenses	1 12 8	
Treasurer—Expenses	0 18 0	
Bellows—Rent	12 0 0	
Custodian, etc.	1 5 1	
Municipal Schools—Rent	2 2 0	
Custodian	0 17 0	
Pitcher—Lantern	0 18 0	
Coffee House Co.—Refreshments	5 10 0	
Bellows—Printing	43 4 11	
Norman, Sawyer & Co., Printing	10 0 3	
Stroud "Journal" Blocks and Reprints	0 17 9	
Hayward—Printing Cards of Meetings	0 7 0	
Burrows—Loan of Blocks	0 18 0	
Artists' Illustrators—Blocks	0 13 11	
Cornish—Book for Library	1 5 5	
Dovey—Ballot Box	1 7 6	
Riddelsdell—"Flora" Expenses	1 3 6	
		97 1 0
BALANCE		22 15 1
		£119 16 1

Audited by me and found to be correct,
H. KNOWLES.

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to promote the preservation of all antiquities and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club not being a Field Meeting; one black ball in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (see Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Elected Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot), but the President shall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in the early part of each year, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Executive Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

Adopted at the Annual Meeting of the Members at Cheltenham, April 27th, 1896; and revised at the Annual Meeting at Gloucester, April 9th, 1907.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

AT THE

ANNUAL GENERAL MEETING

APRIL 12th, 1910

THE REV. WALTER BUTT, M.A., J.P.

IN THE CHAIR

The Minutes of the last Annual Meeting were read and confirmed.

The Hon. Treasurer presented his Financial Report, which was approved, and showed that the Club was in a satisfactory financial position.

Mr J. H. Hume-Rothery, M.A., B.Sc., was elected a Member of the Club.

The President then delivered his

ANNUAL ADDRESS.

This dealt with the losses and additions to the membership of the Club; the literary output of the Members; and the progress made in connection with the Flora of Gloucestershire.[1]

Mr Butt then left the Chair.

The Hon. Secretary then called upon the Rev. H. H. Winwood to propose the President for the coming year.

Mr Winwood thanked the President for his address and efficient services, and then proposed as his successor Mr W. Crooke, B.A., F.A.I. This was seconded by Mr C. Bowly, who referred to the retiring President's interest in botany, and thought that he had shown considerable qualification for the office he had so well filled. The meeting warmly approved of Mr Crooke's nomination, after which Mr Crooke returned thanks for the honour conferred on him. He said that most of his life had been spent abroad, and such knowledge as he possessed had been mainly acquired abroad. This made him somewhat diffident in accepting a position of so much responsibility, but having been trusted by Members of the Club, he would do all in his power to maintain its high traditions during his term of office.

The Vice-Presidents, Elected Members of Council, the Hon. Treasurer, Hon. Librarian, Hon. Secretary and Hon. Assistant-Secretary were re-elected.

1 See Appendix.

It was decided to hold Field Meetings as follows:—Yate District, May 10th; Charlton Common, May 28th; Northleach District, June 7th; Cranham, July 2nd; Northampton, July 12th to 14th; and Forest of Dean, Sept. 13th.

Before the Members passed into the tea-room, Dr McAldowie again referred to the theory of Sir Norman Lockyer's, which he had discussed at the last Meeting, and its application to the Cotteswold Hills. He again drew attention to maps, upon which many lines had been scored, with a view of proving that the ancient camps and tumuli were constructed with due regard to sun-worship and the sacrifice of human beings which it involved. No discussion took place, it being felt that Dr McAldowie had embarked upon a wide subject, which would require careful thought and investigation before the Members could be expected to commit themselves to accepting a theory which certainly plays havoc with some of the opinions held by those who have written on these ancient hill structures.

ORDINARY WINTER MEETINGS

TUESDAY, November 16th, 1909

REV. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read and confirmed.

The President announced that the Rev, H. J. Riddelsdell had sent him a list of the plants found during the Builth-Wells excursion of the Club. It was a very long list, and included some records new to the district. Mr Riddelsdell had recorded these in the *Journal of Botany* for September, 1909, where there appeared the following note:—"New County Records.—During the Cotteswold Club's Meeting at Builth, July 13th to 15th, the following 'new county records' (taking Top. Bot. and 1905 supplement as the standard) were established: For Breconshire (v.—c. 42), *Sedum purpureum*, Tauch., *Campanula latifolia*, L., *Polygala oxyptera*, Reichb., *Valeriana dioica*, L., *Lobelia Dortmanna*, L., *Carex contigua*, Hoppe, and *Carex inflata*, Huds."

The Rev. A. R. Winnington-Ingram exhibited portions of a wasps' nest that had peculiar peg-like processes connecting the successive layers of cells.

Mr T. S. Ellis exhibited a relief-model of the Severn Basin and the West Midlands.

Mr L. Richardson exhibited two specimens of grasshoppers sent him by Mr G. W. S. Brewer, F.G.S., of Nailsworth. Mr Brewer wrote:—"I am forwarding herewith two specimens of the grasshopper which I believe is known as the Green Grasshopper (*Locusta viridissima*). The specimens were taken in September 7th to 14th—one at a part of Nailsworth known as Newmarket, the other at Forest Green, in a garden. Another specimen was shown to me on September 16th, having been captured in a bedroom. I also heard a few days later another specimen 'singing' in the corner of a field near where the second specimen was taken. I am unable to say whether the insect is at all uncommon, but I do not recollect capturing any specimen before." It was suggested that they should be sent to Mr H. J. Elwes, F.R.S., with a request for information.

[Mr James Edwards, F.E.S., secretary to Mr Elwes, who examined the specimens, replied (*in litt.* Nov. 18th, 1909): "the Great Green Grasshopper is not, in my experience, common in this county; it is usually regarded as a coast insect, and, as such, is recorded as occurring from Cromer to Land's End, and also from Rhossilly in Glamorgan. I used to get it occasionally in the Norwich district, and the Rev. J. G. Wood took it near Oxford."]

Mr Richardson also read a letter from Francis Druce (of 65 Cadogan-square, London), in which Mr Druce said he had found the grass of Parnassus (*Parnassia palustris*) in flower by the River Dickler, at Hyde Mill, near Stow-on-the-Wold. Mr Druce also sent photographs of a tree that had been struck by lightning about 4.15 p.m. on September 17th, 1909. The tree is situated about 150 yards south-west of Stow Station.

The following communications were made:—

1. "Some Glacial Features in Wales and the Cotteswold Hills." By *L. Richardson.*[1]

2. "Some New Cotteswold Brachiopoda." By *L. Richardson.*

A discussion followed, in which the President, Mr J. N. Hobbs, Mr W. R. Carles, Dr E. W. Prevost, and Mr T. S. Ellis took part.

Tuesday, December 14th, 1909

Rev. Walter Butt, M.A., President, in the Chair.

The Minutes of the last Meeting were read and confirmed.

The President (Mr Butt) exhibited some specimens of calcareous tufa from Sedbury Cliff, near Chepstow. The tufa is formed by water containing the bicarbonate of lime evaporating and depositing the insoluble carbonate of lime round moss and twigs. Quite large masses are thus formed at Sedbury, the water deriving its carbonate of lime from the Lower-Lias limestones that cap the cliff.

The Rev. H. H. Winwood exhibited some curiously-shaped pieces of arenaceous Great-Oolite limestone, which he had obtained from a tumulus which had been recently opened on Lansdown, Bath.

Mr W. Moyle Rogers had exhibited for him *Sagina nodosa*, a sandwort found by him on Minchinhampton Common. This is a new record for the West of England.

Mr Charles Upton sent for exhibition specimens of the extremely rare *Scirpus holoschœum* from Braunton Burrows, North Devon, along with photographs to show its habitat.

The President also brought from his herbarium several specimens of mounted *Scirpi*, some being quite small, and all being different from the much rarer plant sent by Mr Upton. So rare is it, that, as the President pointed out, no other habitat is known in our country than Braunton Burrows, and as it is a distinctly Mediterranean plant, the wonder is that it should be found growing in quantities at this particular spot in North Devon. It is catalogued as an indigenous plant, and four excellent photographs supplied by Mr Upton, show how thoroughly it has established itself upon the wind-swept sand dunes.

Prof. J. R. Ainsworth-Davis, M.A., F.C.P., Principal of the Royal Agricultural College, Cirencester; Mr A. J. Cullis, Mr J. S. Daniels, Mr J. F. Hooper, Mr H. H. Knight, M.A., Mr F. T. Pearce, and Mr W. R. Price were elected Members of the Club.

The following communications were made:—

1. "Notes on a White-Lias Section at Saltford, near Bath." By *The Rev. H. H. Winwood, M.A., F.G.S.* [2]

2. "On the Winding Course of the River Wye." By *T. S. Ellis.*

In the discussion the President and Hon. Secretary spoke.

[1] See pp. 33-43. [2] Pp. 45-48.

TUESDAY, January 18th, 1910

REV. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read and confirmed.

Mr Charles Bailey, M.Sc., F.L.S., was elected a Member of the Club.

The following communications were made:—

1. "SOME OBSERVATIONS ON BIRD LIFE." By *The Rev. Marcus C. Rickards, M.A., F.L.S.*
2. "NOTE ON AN ANTLER OF A RED DEER FROM THE GRAVELS AT STANLEY DOWNTON, NEAR STROUD." By *Charles Upton.*[1]
3. "GEOLOGICAL INFORMATION OBTAINED DURING THE CONSTRUCTION OF THE HATHERLEY AND ARLE SEWERS, CHELTENHAM." By *L. Richardson.*[2]

TUESDAY, February 15th, 1910

REV. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read and confirmed.

Mr Herbert Haigh was elected a Member of the Club.

The following paper was read:—

"FIELD NOTES ON CERTAIN PRE-HISTORIC REMAINS, NEAR CHELTENHAM." By *A. M. McAldowie, M.D., F.R.S.E.*

The paper was illustrated with maps and lantern-views.

In the discussion which followed, the President and Messrs John Sawyer, E. Northam Witchell, and W. Crooke, F.A.I. took part.

1 See pp. 51-52. 2 Pp. 53-56.

THE RIVER WYE FROM TIDENHAM CLIFF

(*E. Ballard, Chepstow, photo.*)

EXCURSIONS

EXCURSION TO NUNEATON

TUESDAY, May 18th, 1909

Director: L. RICHARDSON

(*Report by* L. RICHARDSON, *with Notes by* C. CALLAWAY, M.A., D.Sc.)

The first Field Meeting for the Session 1909-10 was held at Nuneaton. Those present were:—The Rev. Walter Butt (*President*), Mr T. S. Ellis (*Hon. Treasurer*), Mr L. Richardson (*Hon. Secretary*), Messrs F. H. Bretherton, G. M. Currie, F. J. Cullis, F.G.S., J. N. Hobbs, F. T. Pearce, W. Thompson. Lieut.-Col. J. C. Duke, Surgeon-Major I. Newton, Mr A. R. Horwood, and the Rev. R. Spurrell, Vicar of Hartshill.

At Nuneaton Station, which was reached at 12 o'clock, brakes were awaiting the party, and the drive was at once commenced for Chapel End. Here, in an old railway-cutting, an excellent section was seen showing the

FIG. 1.—View of railway-cutting at Chapel End, showing the Lower Coal-Measures resting unconformably on the Cambrian Shales.

(*W. Thompson, photo.*)

gritty and conglomeratic beds of the Lower Coal Measures, resting markedly unconformably upon the Cambrian (Oldbury) Shales (text-fig. 1), which have been "bent back and folded by the soil-creep down the hill-slope."[1] Passing under the arch, towards the abandoned works, the Members saw a diorite dyke intrusive in the shales, and, in the field hard by the works, were other openings in the shales. Rejoining the brakes, the drive was continued to Oldbury, and on the way there, on the south side of the road, the very furrowed country, where parallel diorite dykes prevail amid the shales, was pointed out. This effect of the rocks upon the scenery was further emphasized in the short walk over the fields to Raspberry Knob, and the presence of the diorite dykes was finally displayed in the huge Mancetter Quarries close to the Oldbury Reservoir which feeds the Coventry Canal.

"The rock type presented by the Nuneaton Diorites," writes Prof. W. W. Watts (Proc. Geol. Assoc,, vol. xx., pt. 9, 1898, pp. 395-396), "is a widely disseminated one. Whenever Stockingford Shales have been penetrated by deep borings, they are found to be pierced by sills of this rock. A similar rock is intrusive in the Archæan rocks of the Lickey, in the Shineton Shales of the Wrekin, in the rocks of the Longmynd itself, and its northern continuation at Bayston Hill, near Shrewsbury, and they are known to pierce the Cambrian rocks in other localities. Similar rocks are intrusive in the Cambrian Quartzites and Limestone of Inchnadamff, and a hornblende-picrite, like that of Chilvers Coton, occurs among the Bray Head rocks at Greystone, in Ireland. In none of these localities are the rocks known to penetrate any formation of later than Cambrian age."

The scenery of the district around the reservoir is very picturesque, and the marvellous carpet of blue squills—usually called "wild hyacinths"—came in for particular attention.

At Hartshill, the home of Michael Drayton was pointed out (Plate II., fig. 2). Michael Drayton was a contemporary of Shakespeare. Professor Morley, writing of Drayton, says:—"In his long poem of England many-ways-happy (Polyolbion), he lovingly described his native Warwickshire and the wooded region called, therefore, Arden, north-west of the Tame, near his own birthplace, which is on the Anker, celebrated in his verse, a stream flowing from above Nuneaton to Tamworth. The fullness with which he dwelt in this part of his poem on the hunting of the hart, was probably suggested by the fact that his birthplace was named from it." From the ridge a distant view was obtained of Bosworth battlefield, and Henry Richmond's march prior to his sharp but decisive struggle with Richard Crookback was indicated by Mr Spurrell. Nor was it lost sight of that the party had penetrated into the country of George Eliot, the famous novelist, and that a drive of a very few miles would have taken them to her birthplace. At Hartshill there is a survival of cottage silk-weaving, and the occupant of one tenement permitted an inspection of her loom and accessories. The village is not far from Coventry, where there is a considerable concentration of the silk industry. In Hartshill also there is a Quakers' meeting-house, and George Fox, the founder of the sect, was born at Fenny Drayton, not many miles away.

Hartshill Castle, now a picturesque ruin, is on the site of an ancient British village. The village is mentioned in Domesday Book, "and in 1125, together with Ansley, was given by Ranulf, the powerful Earl of Chester, to his kinsman, who took the surname of 'de Hardredeshull' from the place, and built a castle, the massive wall of which, enclosing a spacious square, and pierced all round with loopholes cut in large square stones, still stands.

1 For an account of the Geology of the district, see C. Lapworth, Proc. Geol. Assoc., vol. xx., pt. 9 (1898), pp. 313-416: *ibid.*, pt. 10, pp. 417-421: Trans. Leicester Lit. and Phil. Soc., vol. v., pt. 6 (1899), pp. 306-308.

Fig. 1.—MICHAEL DRAYTON: THE HARTSHILL POET
Born at Hartshill, 1563

Fig. 2.—BIRTHPLACE OF MICHAEL DRAYTON

(*Copyright photos of the "Midland Counties Tribune."*)

From the outside these loopholes present the appearance of a narrow cruciform slit, but inwardly the aperture widens, so that the garrison within could command a wider range on either hand.

The walls are about three feet in thickness, and are built of rough, undressed stone, embedded in firm cement; but the loopholes and buttresses which flank the angles are of wrought freestone. The entrance to the square is by a narrow postern, through which two men could hardly ride abreast, and the castle was built for defence as well as for attack.

One of the Earls of Chester married the granddaughter of the immortal Lady Godiva, and the castle was an important outpost of his for offence and defence against his mortal enemy, Lord Marmion, of Tamworth Castle. Other Lords of Hartshill have figured in such memorable battles as those of Bannockburn and Evesham." [1]

Leaving Hartshill village, Mr Abell's quarry was visited. Here in the large quarry were seen the quartzite beds that are so largely worked for road-metal, and in the deep approach-cutting their junction with the underlying Pre-Cambrians. Remarkable as it may appear, it is not easy to indicate precisely the line of demarcation between the Cambrian Quartzites and the Caldecote rocks. The bottom beds of the Quartzite contain many derived fragments of the underlying rocks. The Caldecote rocks consist chiefly of quartz-felspar tuffs as at the "Blue Hole," weathered in their upper portion into huge spheroidal blocks, and here, as there, pierced by a noticeable dyke of porphyritic basalt (see north-eastern end of section, fig. 1).

The next quarry visited was Mr Trye's. Since the Geologists' Association was there in 1898, it has been more than doubled. On the north side of the tunnel under the road, and in the south side of the cutting, intrusive in the quartzites, is the bed of diorite that has segregated on cooling into clots and acid veins. Professor Lapworth calls this type of diorite "anchorite."

SECTION ACROSS THE CENTRAL PART OF THE NUNEATON RIDGE.—*C. Lapworth.*

f 6 Keuper Marls.
d 5 Coal Measures.
a 4 Black Stockingford (Oldbury) Shales.
a 3 Purple Stockingford (Purley) Shales.
a 2 *Hyolithus*-Beds.
a 1 Cambrian Quartzite.
A Caldecote Volcanic Rocks.
Black rocks—Diorite Dykes.
F.F. Faults.

In the drive from Trye's Quarry to that near the windmill, the Members were again rewarded by the sun shining brilliantly on the scene, and the wonderful view of the valley of the Anker was seen with appreciative eyes, the visitors being as interested in the prospect of the Bosworth battlefield, with Crown-hill at Stoke Golding, where Richmond was crowned after victory, as they were with the nearer view of the spirelet of Fenny Drayton, with its memories of George Fox, the first Quaker.

At the windmill the members alighted. The quarry in the fork of the road was pointed out as being in the Middle or Tuttle Hill Quartzite, and then the path between the windmill and the Windmill-Hill Quarry was followed down to the celebrated "Blue Hole." The rocks seen here were similar to those seen in the entrance cutting to Mr Abell's quarry—dark quartz-felspar tuffs pierced by the noticeable pale-coloured porphyritic basalt.

1 "The George Eliot Country" (price 6d, The Abbey Press, Nuneaton), p. 29.

A visit to the Windmill-Hill Quarry, Mr Boon's, completed the day's work.

The remarks on the geology made during the day may be thus summarised :—

The oldest known rocks have been termed "Archæan." Of them, three divisions can be made: first and lowermost, the Malvernian (crystalline); second, the Uriconian (volcanic); and third, the Longmyndian (predominantly sedimentaries). Here and there doubtless the volcanic episode was prolonged into Longmyndian times, but the products of volcanic activity are the most obvious in the inter-Malvernian-Longmyndian or Uriconian period.

Archæan rocks appear at the surface in six places in England, namely, (1) in the Lizard district of Cornwall, (2) the Malvern Hills, (3) the Longmynds, (4) the Lickey Hills, (5) the Nuneaton-Atherstone Ridge, and in (6) Charnwood Forest.

The Cotteswold Club had paid visits to the districts numbered 2, 3, 4 and 6, but not to those numbered 1 and 5. The object of the Nuneaton excursion, therefore, was to visit the latter—number 5.

A section across the Nuneaton-Atherstone ridge at about half-way between these two places reveals, at the south-eastern end, Triassic beds faulted against pre-eminently volcanic rocks (see fig. 1).

These latter are succeeded unconformably to the west by the highly-inclined quartzites of Cambrian age, that in turn give place to the shales of the same system (all invaded by sills and dykes of diorite,[1] with occasional contemporaneous flows), and overlaid at Chapel End by the less-inclined gritty beds of the Lower Coal-Measures of the East Warwickshire Coalfield.

The depressed Triassic rocks on the eastern side of the fault-line give rise to an undulating lowland; the Cambrian Quartzite to a marked but quarried ridge; the Cambrian Shales, with associated igneous rocks, to a tract of parallel valley and irregular ridging; while the less-inclined Carboniferous rocks slope regularly down and originate the features that one expects to meet with in a well-formed coal-basin.

It is only of recent years that the stratigraphic facts detailed above have been discovered. Sir Andrew Ramsay saw in the Cambrian Quartzites a well-developed Millstone-Grit, and in the black shales of the upper portion of the Cambrian the unproductive beds of the Coal-Measures, thereby not following the more correct conclusions of his predecessor in the same field of work, the Rev. James Yates, who in 1829 correctly paralleled the Nuneaton volcanic and quartzite beds with the Wrekin and Caradoc series of central Shropshire. Prof. C. Lapworth and the late W. J. Harrison, however, worked out the succession in the Nuneaton district, proving the Pre-Cambrian age of the volcanics now called the Caldecote series, and the Cambrian age of the succeeding quartzites and overlying shales. Their work has been accepted by the Geological Survey, and satisfies the very pleasing test, that its results are in harmony with those obtained elsewhere, and this emphasizes the simplicity of an at first sight highly complicated succession of beds.

A fault forms the eastern boundary to the ridge. It might be thought that its displacement was great, but the fact that in the quarry close to the railway station the red marls (Keuper) are seen resting upon the weathered surface of the Quartzite necessitates a more moderate view being taken. The Quartzite ridge of Nuneaton-Atherstone is one of several that represent the higher portions of the old Mercian Highlands—uplands of Archæan and Palæozoic rocks that long formed the high ground in our Midland Counties, until they were obliterated under the thick deposits of Triassic date. So at

1 As it occurs in sills and dykes, this "diorite" is not "diorite," in the true sense of the word, being a hypabyssal, instead of a plutonic, rock. For dyke-rocks, Rosenbusch uses the term "Lamprophyres," and those that are mainly composed of plagioclase and hornblende are called "camptonites." A camptonite is thus the hypabyssal equivalent of the plutonic rock, diorite.

the present time subaërial denudation, by its differential action, is removing the cloak of Triassic sediment that has for long hidden a sculptured upland of an early age.

From the high ground at Camp Hill there are extensive views over a considerable part of the East Warwickshire Coalfield, which is marked by innumerable chimneys; over the low ground where Bosworth Field was fought; of the distant eminence of Bardon Hill—the highest point (850 feet) of Charnwood Forest; and the great valley of the Trent.

The rocks composing this ridge have a prevalent south-westerly dip. Therefore the oldest are found immediately to the west of the fault-line already referred to, and are known as the Caldecote Series—pre-Cambrian rocks. They comprise sheets of volcanic breccia, tuffs, and grits, with a few intrusive dykes of basic rock.

In the "Blue Hole," on the slope of Caldecote Hill, the Caldecote rocks are exposed, and the predominant type is a dense bluish quartz-felspar-tuff, which has been pierced by a very distinctive porphyritic basalt with numerous plagioclase-felspar phenocrysts and blebs of quartz. In places, so fine are the intrusions of this rock amid the tuff, that specimens of a very interesting "mixture-rock" can be obtained. A precisely similar rock-association is seen in the entrance-cutting to Abell's Quarry, a little over a mile to the north-west of the "Blue Hole." Here the top-portion of the quartz-felspar tuff has been weathered, apparently in pre-Cambrian times, into great spheroids, one of which is six or seven feet across.

Between the Caldecote rocks and the succeeding quartzites there is no marked unconformity, but the noticeable difference between the lithic structure of the two, combined with the presence of derived fragments of the Caldecote rocks in the basement-beds of the quartzites, show how really great must be the break.

In this Nuneaton-Atherstone area the Cambrian rocks admit of the same dual division that characterizes the system throughout our English Midlands—bedded quartzites of a pale pinkish colour at the base, shales above.

In this area, certain shale-bands amid the quartzites have allowed of still further subdivision, while, piercing shales and quartzites alike, are noticeable masses of diorite.

Dr C. Callaway, who was unable to be present, sent the following paper, which was communicated by the Hon. Secretary:—

Previous to the eighth decade of the last century, the only rocks in the Midlands which had received the name of Cambrian were the Charnwood mass and the Longmynd series. These are now admitted to be pre-Cambrian. True Cambrian strata in the Midlands were first identified in Shropshire at Shineton, south of Shrewsbury. In certain shales exposed on a brook near the Severn I found, in the early seventies, a fauna, chiefly trilobites, of Upper Cambrian age. In the same area there was a well-known formation of similar shales, containing Ordovician fossils, and known as the Harnage Shales. The two formations were often brought together by faults, and being so similar in composition, had been lumped together as Caradoc (Upper Ordovician, then called Lower Silurian). Strata underlying the Shineton Shales rested upon the igneous rocks of the Wrekin, and were supposed to be of "Lower Silurian" age. The lowest of these beds was a quartzite, the crystalline structure of which was thought to be due to the metamorphic action of the Wrekin mass, which was regarded as intrusive, and later than the rocks on its flanks.

While I was at work on the newly discovered Cambrian strata, Mr Allport, of Birmingham, ascertained that the Wrekin rocks were not intrusive, but older than the flanking beds, and consisted of volcanic ashes and lava-flows, whose age he left undetermined. It was therefore obvious that they could not have metamorphosed the adjacent strata. What was the age of these two formations? My discovery of the Shineton fossils enabled me to answer the question.

Working downwards in the succession in the direction of the Wrekin, I found below the Shineton Shales a green sandstone containing Cambrian fossils, and below these strata lay the quartzite, which therefore could not be younger than Cambrian. This quartzite rested upon Allport's volcanic series, and it rested at a discordant angle. It was therefore clear that the volcanic rocks must be pre-Cambrian. I gave them the name "Uriconian," from the Roman city Uriconium, which lies at the base of the Wrekin. The succession thus determined proved to be the key to the Cambrian and pre-Cambrian succession in the central Midlands. This area was worked out by Professor Lapworth and others, with whose researches I have never interfered, scientific etiquette demanding that each geological bishop should confine himself to his own diocese.

The succession at Nuneaton is closely similar to the order made out in Shropshire. A shale with Cambrian fossils is underlain by arenaceous beds with a quartzite at the base. This quartzite rests unconformably upon the Caldecote volcanic rocks, which are therefore of pre-Cambrian age. It would scarcely be rash to call them "Uriconian," but in the absence of fossils we cannot determine the point with certainty.

Subdivision of the Cambrian Beds in the Nuneaton-Atherston Area :—

CAMBRIAN	Stockingford Shales	Olenian	a.	Merevale or *Dictyonema*-Shales. Thin bedded greenish-grey shales (best seen in an old quarry 200 yards West of Merevale Abbey).
			b.	Oldbury Shales (Black Shales of Malvern and Lower Dolgelly Beds of North Wales). Mudstone with carbonaceous bands, but less felspathic than the underlying Purley Shales. (Chapel End and quarry at Oldbury reservoir).
		Paradoxidian	c.	Purley Shales. Purple mudstones with bands of pale green shales; very felspathic. (Purley Lane).
	Hartshill Quartzite	Olenellian	a.	Camp Hill Quartzite. (Comley and Hollybush Sandstone) with associated *Hyolithus* - Limestones and Shales, stained red with iron and manganese.
			b.	Shale-band.
			c.	Tuttle-Hill Quartzite (Quarry in fork of roads north of Camp Hill Farm, and opposite Midland Railway Station).
			d.	Two shale-bands with a relatively thin median layer of quartzite.
			e.	Park-Hill Quartzite with derived fragments of the underlying Caldecote rocks in the basal layer.
				Unconformity.
Pre-Cambrian (? Uriconian)				Volcanic breccia, grits and quartz-felspar tuffs, with intrusive dykes of porphyritic basalt.

HALF-DAY EXCURSION TO NAILSWORTH, AVENING AND MINCHINHAMPTON

SATURDAY, June 5th, 1909

Directors: A. E. SMITH, E. NORTHAM WITCHELL and E. T. PARIS

(*Report by* L. RICHARDSON and W. THOMPSON)

The Members arrived at Nailsworth Station at 2.38 p.m. Those present included: Mr W. R. Carles (*Vice-President*), Messrs F. H. Bretherton, A. Cockshott, S. J. Coley, F. J. Cullis, G. M. Currie, Charles Curtis, J. M. Collett, J. M. Dixon, O. H. Fowler, G. W. Hedley, J. N. Hobbs, M. H. Medland, G. P. Milnes, H. E. Norris, J. W. Skinner, Vincent A. Smith, A. J. Stephens, Col. E. C. Dowse, Surgeon-Major I. Newton, Dep. Surg.-Gen. G. A. Watson, E. T. Paris (*Hon. Assistant-Secretary*), etc.

The deepest part of the Nailsworth Valley is in the blue Upper Lias clay, which was exposed when the new church was built, and is frequently laid bare when drainage works are in process of construction. Here and there, as at Dunkirk Mills, about half-a-mile out of Nailsworth on the Woodchester Road,[1] are hollows in the clay-floor, in which occur gravel and occasional peat-beds, in one of which the remains of beaver have been found. Above the Upper-Lias clays are the Upper-Lias or Cotteswold Sands capped with the Cephalopod-Bed, which has been exposed in Mr A. E. Smith's garden.[2] To the Cephalopod-Bed succeeds the Inferior Oolite—in this neighbourhood comprising the subdivisions, *Scissum*-Beds, Lower Limestone, Pea-Grit, Lower Freestone, *Bradfordensis*-Beds, Upper *Trigonia*-Grit, *Clypeus*-Grit, and White Oolite.

Considerable portions of Nailsworth are built upon terrace-like gravel-beds, and from a clayey bed in the gravel exposed in the pit on the Bath Road, fresh-water shells have been collected.[3]

Leaving Nailsworth Station, the Members drove along the Avening Road, seeing near Longfords Lake, the section of Pea-Grit beds from which Edwin Witchell obtained so many specimens of *Nerinææ* new to science, and the old quarries where the Lower Freestone has been mined.

At Avening, the Church was visited under the guidance of Mr A. E. Smith (text-figure 1).[4] The village is situated mainly upon the Fullers' Earth, and the Great Oolite has been quarried in the bank to the south.

Crossing the valley, the Members ascended the hill, and saw the top-portion of the Great Oolite in a quarry in a field by the road-side, with a most interesting *Rhynchonella*-Bed, correlative with that at Tiltups End (about a mile-and-a-half to the south of Nailsworth) above.[5] This *Rhynchonella*-Bed, which is a marly clay, in which *Rhynchonella obsoleta* abounds, also contains *Chlamys vagans*, *Nerinæa* sp., and *Ostrea* sp.

At the entrance to Gatcombe Park, Major Ricardo met the party, and conducted them to the long tumulus,[6] which is visible from the road. The tumulus was opened in 1870 by Canon Lysons, but the portion that is of

1 J. Lycett, "The Cotteswold Hills" (1857), p. 116.
2 Proc. Cotteswold Nat. F. C., vol. xiii., pt. 1 (1899), p. 9.
3 *Idem*, p. 9.
4 *Vide idem* p. 10.
5 *Idem*, vol. xvi., pt. 1 (1907), pp. 39, 40.
6 *Idem*, vol. v., pt. 3 for 1870 (1871), pp. 279, 280.

most interest now, namely, the small chamber that can be entered by an inconspicuous opening on the north side, was not discovered until the following year—1871.

FIG. 1.—Avening Church
(*C. Upton, photo.*)

A few hundred yards to the north of the tumulus, but on the other side of the road, is the "Long Stone" (text-figure 2). The portion above ground measures about 7 feet. "There were formerly two other similar stones near; one of them has entirely disappeared, and the other—a much smaller one—is incorporated in the wall dividing the field from the road. The hollow immediately to the southward of 'The Long Stone' is known as 'Woful Dane's Bottom,' and there is reason to believe that at this spot was fought a great battle between the Saxons and the Danes in the year A.D. 837."[1]

Time only permitted of a brief inspection of Minchinhampton Church, with its monument to Bradley, the celebrated Astronomer-Royal, and the party proceeded on to the Common, where Mr Northam Witchell communicated the substance of his paper, read to the Club some eleven years back, on the Danish, British, and Roman camps of the locality.[2] He added

1 See C. Upton in "The Stroud Valley Illustrated," 2nd ed., p. 85.
2 Proc. Cotteswold Nat. F. C., vol. xiii., pt. 1 (1899), pp. 53—56.

that, since reading his paper, he had found in the Roman camp "pieces of tesseræ and fragments of Samian ware, which are evidence of Roman occupation. Roman soldiers were in the habit of playing pitch and toss with tesseræ when on guard, and pieces were frequently found in Roman camps. The late John Bellows was of opinion that the deep trench was Roman, and considered that the form of the entrance was characteristic of Roman work."

FIG, 2.—The Long Stone, near Minchinhampton
(*C. Upton, photo.*)

On returning to Nailsworth, the party were entertained to tea at "The Hollies" by Mr and Mrs Smith, and evinced great interest in Mr Smith's fine collection of wild flowers and fossils. Before leaving, a very hearty vote of thanks was accorded Mr and Mrs Smith for their generous hospitality.

EXCURSION TO CHEPSTOW

TUESDAY, June 15th, 1909

Directors: THE PRESIDENT (Rev. WALTER BUTT), The Rev. H. J. RIDDELSDELL, Dr SHOOLBRED, and L. RICHARDSON

(*Report by* L. RICHARDSON and W. THOMPSON)

Those present at the Meeting were: Rev. Walter Butt (*President*), Rev. H. H. Winwood, F.G.S., Mr Charles Upton (*Vice-Presidents*), Mr J. G. Phillips (*Hon. Librarian*), Mr T. S. Ellis (*Hon. Treasurer*), Mr L. Richardson, F.R.S.E. (*Hon. Secretary*), Mr E. Talbot Paris (*Hon. Assistant Secretary*), Col. E. C. Dowse, Lieut.-Col. J. C. Duke, Dep. Surg.-Gen. G. A. Watson, Rev. R. Hyett-Warner, Rev. H. J. Riddelsdell, Dr Shoolbred, and Messrs Bretherton, J. M. Collett, F.C.S., S. J. Coley, A. Cockshott, W. Crooke, F.A.I., F. J. Cullis, F.G.S., G. M. Currie, J. M. Dixon, O. H. Fowler, J. H. Garrett, F.L.S., J. W. Gray, F.G.S., F. Hannam-Clark, G. W. Hedley, F.C.S., J. N. Hobbs, A. E. Hudd, F.S.A., G. W. Keeling, H. H. Knight, John H. Jones, W. Margetson, H. E. Norris, G. Phillips, E. W. Prevost, F.R.S.E., W. P. Price, E. C. Sewell, J. W. Skinner, Vincent A. Smith, A. J. Stephens, J. A. Smithin, and W. Thompson.

OFFA'S DYKE

On arriving at Chepstow (Plate III., fig. 1), the Members were met by Mr Butt, and having taken their places in two brakes and a waggonette, were driven over the bridge which divides Monmouthshire from Gloucestershire, where was seen an excellent example of an anticline in the Carboniferous limestone.[1] Offa's Dyke was passed through on the southern side of Sedbury Park, and about this famous earth-mound the President had something to say. He said that according to Sir John Maclean, the oldest monument in England of which the date is known is Hadrian's Wall, 121 A.D. The next was Offa's Dyke, 779 A.D. Offa reigned in Mercia from 755 to 794. There were older boundary ditches in Wilts and elsewhere, but their dates were unknown. This dyke was said to stretch from the Severn to the estuary of the Dee. They were told that it was not a fortification, but a bank with a ditch on each side. When perfect it was about 40 feet at the base, and 18 feet 4 inches in height. Mr Butt said that apparently on his own land what was called Offa's Dyke was something else. Ormerod, who lived at Sedbury Park, said that Llancaut was joined by a narrow neck of land to Tidenham, across which works ranged from cliff to cliff, consisting of two parallel mounds, formed of fragments of limestone, with the convex side of the curve and the ditch towards Mercia. It might be either British or an entrenchment of Danish pirates. Ormerod inclined to the former. Sir John Wintour intended to fortify and make good these entrenchments in 1644, but was defeated and driven over the river. It was remarkable that they had here Buttington Wood, with the precipice and the dyke resting on the Severn, and precisely the same combination at Buttington, near Welshpool, in Montgomeryshire. They knew that Offa was more than once interrupted in the construction of his dyke by the incursions of the Britons, and it is doubtful if it was ever completed. As far as his own personal observation went, it could hardly be possible that it ever formed a continuous mound from here to Chester. One writer said that its condition very much resembled an unfinished modern railway. One saw portions of the line completed, others in course of construction, and elsewhere on the line of route the ground was untouched. One could to-day find no trace of the dyke in or about Tutshill. It was really lost sight of from a point almost opposite the end of the Norman walls of Chepstow till it reappears close to Mr Yockney's house on the road leading to Lancaut from the main-road, running from Tutshill to the Chase and St Briavels. Sir John Maclean, who traced the course of the dyke throughout Gloucestershire, asserts that it has invariably occupied a site removed from the river Wye about a quarter or half mile, of which it in all cases commands a view. This was not so on his (the speaker's) place—if the mound is Offa's Dyke—for the end comes absolutely up to the edge of the cliff. [W.T.]

THE GEOLOGY OF SEDBURY CLIFF

At Sedbury Cliff, Mr Richardson gave a short lecture on the geology of the country around Chepstow.[2] He said that, as they were aware, two great subdivisions had been made of the great mass of fossiliferous rock that lies above the Archæan, namely, the Palæozoic and Neozoic. Each of these had been subdivided, the upper three systems of the Palæozoic Group being the Devonian, Carboniferous, and Permian, and the lower three of the Neozoic, the Triassic, Jurassic, and Cretacic. In late Carboniferous times the Palæozoic rocks were crumpled, and in the Chepstow district underwent denudation, which produced hill and valley, until late Triassic or Keuper times. Then it sank, and the waters of the Keuper inland sea slowly crept

1 L.R., Proc. Cotteswold Nat. F. C., vol. xv., pt. 1 (1904), pp. 17, 18, and Pl. I.
2 L.R., Trans. Woolhope Nat. F. C., vol. for 1903, pp. 178-184.

Fig. 1.—CHEPSTOW CASTLE AND TOWN AND RIVER WYE

(*E. Ballard, Chepstow, photo.*)

Fig. 2.—SEDBURY CLIFF AND SALMON "PUTCHERS,"

(*E. Ballard, Chepstow, photo.*)

westwards, thrusting tongues of water up the valleys, forming creeks that were margined with the pebbly beaches or screes that eventually became cemented together to form the "Dolomitic Conglomerate." Thus while "Dolomitic Conglomerate" was formed along and near the shore, ordinary red marl was laid down further out. The area continued for a time to sink, but at the close of Triassic times there was probably a slight movement of elevation, owing to which certain Rhætic deposits were not laid down in the Chepstow district. At the time of formation of the Rhætic Bone-Bed, however, subsidence set in, and the oncoming Rhætic sea worked up the top-layer of the tea-green marl and enclosed the water-worn nodular-masses in a matrix of sand and fish-remains. The deposit of black shales (*Pteria-contorta*-Beds), pale-green marls and limestones, including the Cotham Marble, followed; but then there was a slight uplift again. This is known to have been the case, because there is no White Lias at Sedbury Cliff (Pl. III. fig. 2), and the representative of the Cotham Marble there occurs generally in the form of a conglomerate adherent to the basal layer of the *Ostrea*-Beds. The *Ostrea*-Beds and the same kind of alternations of Lower-Lias limestones and clays, as at Lavernock Point, near Penarth, complete the section. Pieces of the Bone-Bed were collected, and a fine slab of the *Pleurophorus*-Bed was exhibited. Large pieces of the basal *Ostrea*-Bed limestone were seen with the conglomerate adherent to its under-side, and it was generally agreed that this bed constituted the most interesting feature of the Sedbury Cliff section.[1]

The Severn Salmon "is less abundant than it was in past generations. . . . The chief method of taking the fish is by nets. The fisherman moors his boat across the tide, and fixes his net in such a manner that the bag is carried under the boat by the current; he holds a string attached to the net in his hand, and as soon as he feels a fish he hoists up the net. Another method, which has been practised from the earliest times in the parishes of Tidenham and Woolaston, is that of 'potchers,' or more correctly, 'putchers.' A long stand of baskets is erected below high-water mark, tier over tier; the baskets are long and cone-shaped, and open at the base of the cone. The open end faces the incoming tide, and the fish swimming up the river enter these baskets, and being unable to turn round owing to the narrow dimensions of the potcher, are left high and dry by the receding waters. It need hardly be added that the privilege of erecting potchers has long been limited." ("Gloucestershire," Cambridge County Geographies, 1909, pp. 40, 41).

Driving down to the once oft-frequented "passage" at Beachley, the Members walked to a spot on the promontory opposite to the rock on which are the ruins of St Tecla's Chapel. It was first of all pointed out that the Beachley peninsula is composed of red Keuper Marls, faulted against Carboniferous Limestone—the latter presenting a bold face to the Severn estuary. A few of the Members returned along the shore, and noticed the veins mainly of quartz in the red marls, and the masses of Carboniferous Limestone jutting up in the beach.

Driving back into Chepstow, the Members went to the Beaufort Arms Hotel, where the President entertained them at lunch.

After lunch, Mr W. Crooke proposed, and Mr Vincent A. Smith seconded, that a hearty vote of thanks be accorded to the President for his bounteous hospitality, and referred in eulogistic terms to the energy and enthusiasm with which he had initiated and forwarded the scheme for the preparation of a County Flora.

1 L.R., Quart. Journ. Geol. Soc., vol. lx. (1903), pp. 390-395 and pl. xxiv. See also Dr A. Vaughan, Quart. Journ. Geol. Soc., vol. lx. (1903), pp. 396-402.

AT LLANCAUT

After lunch, the Members drove to a spot near the smallest parish in Gloucestershire—Llancaut. Llancaut, the President said, was derived from Llan Ceuid or Cewydd—Cewydd being the Welsh Rain Saint, who was credited with determining the weather for a period of forty days, like St Swithin (July 15th) and St Medard of France (June 8th). Cewydd's festival is on July 1st.

In the wood, just before coming on the common at Llancaut, quarries in the Millstone Grit were observed, and the occasion caused the remark that detailed zonal work had now demonstrated that the grit was not of precisely the same age in all parts of England. Indeed, far otherwise; for example, the grit facies set in earlier in the Clee Hill area than around Bristol, and here, near Chepstow, the bottom-portion was slightly antecedent in date to the corresponding portion of the Bristol Millstone Grit.[1]

The little unroofed church at Llancaut was viewed, and it was remarked that it formerly possessed a lead font that was now at Sedbury. Lead fonts are not common, and of some twenty-five, Gloucestershire possesses seven or eight. Coming now to the path by the Wye, geologic and scenic features again came in for notice. The place where Mr Price, of Pen Moel, had found some plant-remains (*Sphenopteris*, etc.),[2] in what are commonly called the passage beds from the Old Red (Devonian) to the Carboniferous Systems, was pointed out, and also a ledge—along which the Members were shortly to walk—the cause of which did not appear quite clear to some of the local geologists. Mr Richardson was inclined to regard it as partly natural and partly artificial.

The meanders of the Wye (Plate I.), are ever a subject of debate, and Mr Richardson, following Mr S. S. Buckman,[3] held the view that they had been initiated on a sheet of Neozoic rocks that once covered the limestone, and had been perpetuated when the river arrived at the underlying limestone. The meanders would be developed as time went on, the necks cut through, and the river would straighten itself. He thought that if it had been softer rocks instead of Carboniferous Limestone, the Wye would have been straighter than it is to-day in the section where it crosses the Limestone.

The large quarry which the Members crossed (that worked by Sir John Aird for stone to use in the construction of the Avonmouth Docks), is interesting, as it affords some idea of the way in which plants commence to clothe an absolutely bared space. In botanical language, it is interesting from an ecological point of view, showing the result of about two years' colonization.

On reaching the summit of the winding path which lands the pedestrian in the immediate vicinity of Pen Moel, the party were hospitably received and entertained at tea by Mrs Price. After tea, Mr W. P. Price showed the Members the collections of plants and fossils in the house, including the plant-remains found by his brother in the flaggy shale at the foot of the cliff hard by.

During the day a large number of rare plants were seen under the guidance of the President, Dr Shoolbred, the Rev. H. J. Riddelsdell, and Mr W. P. Price. They included:—*Cornus sanguinea, Pyrus aria, Corylus avellana, Galium aparine, Clematis vitalba, Geranium Robertianum, Geranium molle, Geranium rotundifolium, Mercurialis perennis, Chenopodium Bonus-Henricus, Malva sylvestris, Sambucus nigra, Ulmus campestris, Ulmus glabra, Egopodium podagaria, Rubia peregrina, Teucrium scorodonia, Potentilla argentea, Glechoma*

1 For an account of the Carboniferous Limestone of this area, see Dr A. Vaughan, Quart. Journ. Geol. Soc., vol. lxi. (1905), p. 251.
2 E. A. Newell Arber, Geol. Mag., dec. 5, vol. iv. (1907), pp. 4, 5.
3 Proc. Cotteswold Nat. F. C., vol. xiii., pt. 1 (1899), pp. 25-32.

hederacea, Dipsacus sylvestris, Senecio crucifolius, Populus tremula, Rumex crispus, Rumex acetosa, Rumex pulcher, Lactuca muralis, Spergularia, Ranunculus parvifloris, Ranunculus acris, Smyrnium olusatrum, Plantago coronopus, Atriplex patula, Lepidium campestre, Cochlearia anglica, Allium vineale, Tragopogon parviflorus, Artemesia maritima, Carex ovalis, Festuca rubra, Ballota nigra var. *borealis, Salvia verbenaca, Papaver argemone, Silene maritima, Glaux maritima, Cephalanthera ensifolia, Spiræa filipendula, Melampyrum pratense, Salix saprea, Helminthia echioides, Chrysanthemum leucanthemum, Inula helenium, Geranium sanguineum, Prunus spinosa, Linaria cymbalaria, Lychnis diurna, Apium graveolens.*

Most of the Members left Chepstow by the 5.40 p.m. train.[1]

HALF-DAY EXCURSION TO COLESBORNE, NEAR CHELTENHAM

SATURDAY, July 3rd, 1909

Director: J. H. ELWES, J.P., F.R.S., F.L.S., F.Z.S.

(*Report by* L. RICHARDSON and G. W. HEDLEY, M.A., F.C.S.)

The Members arrived at Colesborne Park—at the kind invitation of Mr J. H. Elwes, F.R.S.—about 3.30 p.m., one party coming by brake from Cheltenham, the other from Cirencester.

Those present were:—The Rev. Walter Butt (*President*), Messrs C. Bowly and W. R. Carles, F.L.S. (*Vice-Presidents*), Mr E. T. Paris (*Hon. Assistant-Secretary*), the Rev. A. R. Winnington-Ingram, Col. E. C. Dowse, Surgeon-Major I. Newton, Dep.-Surg.-Gen. G. A. Watson, Messrs W. Bellows, F. H. Bretherton, A. Cockshott, J. M. Collett, F.C.S., F. J. Cullis, F.G.S., C. Curtis, G. M. Currie, J. W. Gray, F.G.S., G. W. Hedley, F.C.S., J. N. Hobbs, C. R. Hooker, John H. Jones, E. P. Little, M. H. Medland, H. E. Norris, A. E. W. Paine, Vincent A. Smith, W. J. Stanton, A. J. Stephens, and a considerable number of visitors.

Mr Elwes conducted the Members around his gardens and greenhouses, which chiefly contained plants that he had obtained in various parts of the world. They were all strange and unfamiliar, and constituted a wonderful collection, few specimens in which could be obtained from dealers in the usual way.

One of the points that interested the chemists of the party was the difficulty found in rearing oaks and *Arbor vitæ* on the local soil: 60 per cent. of the former and a big majority of the latter died after three or four years from chlorosis—the leaves turned yellow and the roots died. Mr Elwes thought the cause was too much "lime" in the soil, that is, calcium carbonate. It is an important question in relation to afforestation. Such chemists and practical botanist-agriculturists as A. D. Hall, of Rothamstead, and Spencer Pickering, of Woburn, and others, have been consulted, but as yet no solution has been arrived at. There is no sign of wire-worm, but Mr Elwes thought that they might be attacked by some insect such as attacks the vines in France. Possibly there are a variety of causes, and Mr Elwes remarked that it was interesting to note that there were hardly ever failures in oaks when they were planted on red sandstone.

1 The Club is indebted to the generosity of the President for the blocks used in illustrating this excursion, and to Mr E. Ballard, of Chepstow, for allowing his photographs to be reproduced.—ED.

Mr Elwes also exhibited his books on trees and lilies; his butterflies, and stuffed skins of animals that he had shot; while some of the Members went up to the fish-ponds.

After tea at the Park, the Members returned—some to Cheltenham, others to Cirencester, etc.

As regards the geology in the immediate neighbourhood of Colesborne, the bottoms of the valleys are in the Upper Lias. Clay was dug for brick-making at Colesborne,[1] and one of the present writers (L.R.) has in his possession pieces of the ammonites *Harpoceras elegans* (Sow.) and *Hildoceras hildense* (Sow.), which were given him by the late Arthur Spry Helps. They date the clay in which they occurred as *falciferi-bifrontis*.

Above the Upper Lias comes the Inferior Oolite, which forms the valley sides; while here and there, capping the higher hills, are little patches of Fullers' Earth or Great Oolite, or both combined. A fault passes roughly east and west through Colesborne village, and the Pea-Grit of the Inferior Oolite is brought down on a level with the Upper Lias. Typical Pea-Grit, with well-formed pisolites and *Rhynchonella oolitica*, Dav., can be seen above a spring by the brook near the village.

EXCURSION TO BUILTH WELLS AND RHAYADER

TUESDAY-THURSDAY, July 13th-15th, 1909

Directors: The Rev. E. EDMONDES OWEN, B.A., and L. RICHARDSON

(*Report by* L. RICHARDSON)

The long excursion of the Club was held in Mid-Wales on July 13th-15th, the Members present being the Rev. Walter Butt (*President*), Mr L. Richardson, F.R.S. Edin. (*Hon. Secretary*), Mr J. G. Phillips (*Hon. Librarian*), Lieut.-Col. J. C. Duke, Surgeon-Major I. Newton, Colonel E. C. Dowse, Messrs J. M. Collett, F.C.S., F. J. Cullis, F.G.S., G. M. Currie, J. M. Dixon, J. N. Hobbs, and the Rev. C. H. Davies, while the Rev. H. J. Riddelsdell came as a visitor.

The Members assembled at Builth-Wells Station on the Tuesday at 2.25 p.m. Unfortunately, a heavy shower had just commenced, and the first part of the programme was seriously interfered with. In pouring rain the Members viewed the picturesque rapids of the Wye (Pl. IV.) between Builth-Wells and Builth-Road Station, and listened under the shelter of the trees to the remarks of the Hon. Secretary, which, he said, they must regard merely as an introduction to the study of the geology of the district.

The scenery of the neighbourhood of Builth-Wells is extremely pretty, and owes its origin to the differential action of denudation upon somewhat folded and faulted rocks of different powers of resistance.

The hill-mass that is perhaps the first to attract attention upon arrival at Builth-Wells is the Carneddau. It is its ruggedness that compels notice. It is composed of the oldest rocks in the district, which occupy the centre of a dome.

1 E. Hull, "Geology of the Country around Cheltenham" (1857), p. 24.

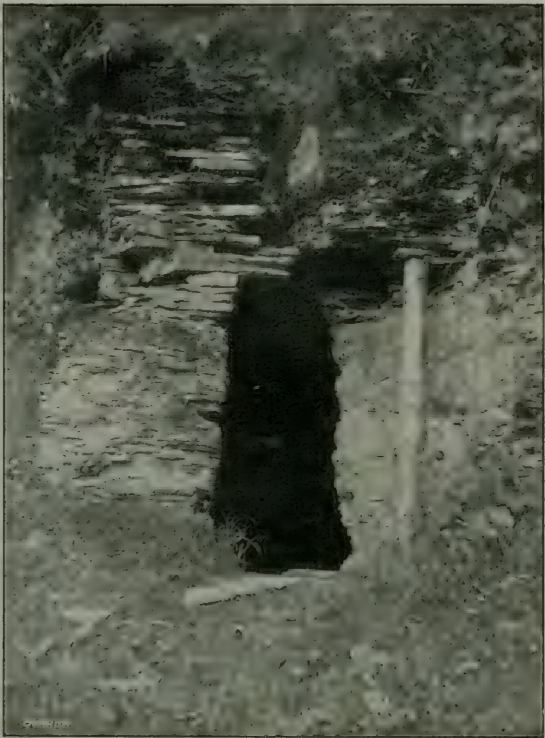


Fig. 1.—LLYWELYN'S CAVE, ABEREDW
(*P. Abery, photo.*)

Fig. 2.—THE WYE AT PARKS COMMON, BUILTH-WELLS
(*P. Abery, photo.*)
(*From Burrow's "Heart of Wales."*)

The principal rocks taking part in the formation of the Carneddau are:[1]

Ordovician

(1) Diabases, which are intrusive in the Upper Llandeilo Shales, but pre-Silurian;
(2) Diabase porphyrites which are readily recognized by their coarsely-crystalline structure;
(3) Rhyolites, which weather very white;
(4) Andesitic ashes, which are extensively worked for road-metal in the quarries north of Llanelwedd, and have yielded sparingly *Orthis calligramma*, Dalm., and a few other fossils; and
(5) Andesites. The quarry by the road-side, just before reaching Gelli Cadwgan, is in this rock, and was opened for obtaining road-metal.

The diabase (1) is well exposed in a quarry by the side of Pencerig Lake, and again in a road-cutting at the back of Pencerig House; while masses of this rock cross the Wye between Builth-Wells and Builth-Road Station, and are the cause of the "Wye Rapids" (Pl. IV., fig. 2).

The Upper Llandeilo Shales are well exposed in a quarry by the road-side near "The Rapids," where numerous specimens of *Ogygia Buchii* (Brongn.) may be collected; in Harper's Quarry, where the numerous specimens of *Ogygia Buchii* (Brongn.), *Trinucleus fimbriatus*, Murchison, *Ampyx nudus* (Murch.), and *Siphonotreta micula*, M'Coy, are beautifully preserved in hard greenish rock; and again at Trecoed.

No Bala or Lower Llandovery rocks appear to be present in the Builth district, and the Upper Llandovery *Pentamerus*-Grit follows the Llandeilo Beds at once.

This Upper Llandovery Grit, of a yellowish colour and not unlike the fine-grained parts of the Upper Llandovery or May Hill Sandstone of May Hill, is to be seen in the bed and south bank of the Wye between "The Rapids" and the railway-bridge, and again at Trecoed.[2] It is more accessible at this latter place, where from four to six feet of it is seen separating the black Llandeilo Shales from the succeeding Wenlock Shales of the *Cyrtograptus-Murchisoni*-Zone. Entering the gate of the field opposite the entrance to Trecoed, the Upper Llandovery Grit will be at once perceived, with some purplish shales (? = the Tarannon Shales) on top; while below are the Llandeilo Shales. They are best exposed in the bed of the stream, but in 1909 there was a considerable heap of shale, rich in specimens of *Ogygia Buchii*, that had been thrown out of an excavation for a well. At the Llanfawr Quarry, Llandrindod Wells, the Llandeilo Shales are magnificently displayed, and nearly every slab that is detached is covered with trilobites (mostly *Ogygia Buchii*) and graptolites.

From their outcrops, marked by the Wye and Trecoed sections, the Upper Llandovery Grit and probable equivalent to the Tarannon Shales, dips down in a westerly direction beneath the Ludlow rocks. When they reappear, the Tarannon Shales are found to have passed into the huge mass of pale shales called the Rhayader Pale Shales, and the Grit into the massive Caban Conglomerates; while below have come in the Gwastaden Group and beds probably referable to the Bala Series. But of this matter more anon (see page 23).

From "The Rapids" the Members drove on towards Trecoed, seeing on the way the tumulus and ancient Cwrt-Llechrhyd intrenchments, and the richly-fossiliferous *Linnarssoni*-Zone Shales by the road-side close to Builth-Road Station, but then, owing to heavy rain, the visits to the Dulas Brook, Coed Mawr, Castle Crab, and Trecoed sections had to be abandoned.

1 See H. Woods, Quart. Journ. Geol. Soc., vol. l. (1894), pp. 566-577.
2 See Proc. Geol. Assoc., vol. xix. (1905), p. 229.

Concerning the Wenlock, it may be as well to state that in this part of Wales it is almost wholly shale, and therefore unlike its equivalent in many other parts, where its upper and lower portions are limestone—the Wenlock and Woolhope Limestones respectively. This absence of limestone from the Wenlock and succeeding Ludlow Stages presented a difficulty to the earlier geological cartographers, who, in the lack of more definite palæontological knowledge, were wont to rely frequently upon lithological characters when mapping the distribution of the rocks. Errors were made; and frequently—owing to no parting mass of limestone—Wenlock and Lower Ludlow beds were mapped as one formation, and correlated with the Wenlock Stage of certain other parts, the so-called "Ludlow" of the geographical maps of the Welsh Borderland being in consequence paralleled with the Upper Ludlow of such typical areas as that of Shropshire. But now, as was anticipated by Prof. Charles Lapworth, by the aid of the lowly graptolite, the geologist is able to read off with ease and certainty the true succession in the monotonous Silurian mudstone of Great Britain, and to effect correlations that were denied to the earlier workers in this particular branch.

The Carneddau formed a land-mass while the Gwastaden and Caban Groups and Upper Llandovery Beds were being deposited, but disappeared beneath the Ludlowian sea. The Carneddau and Gilwern Hills obviously mark an area of crust-weakness, the presence of which is clearly indicated in the present-day geographical distribution of the Wenlock and Ludlow rocks.

South and south-west of Builth-Wells is the furrowed upland called the Mynydd Eppynt, which is capped with the lower beds of the Old Red System, whose higher strata form the jagged Brecon Beacons and the no less awe-inspiring Carmarthen Fan.

It cannot be determined for certain whether or not any post-Devonian rocks were laid down over the Builth district. Certain it is that for untold ages these Palæozoic rocks have been undergoing subaërial denudation.

After tea, the weather improved, and under the guidance of the Rev. Edmondes Owen, of Llanelwedd, the Members made the ascent of the Carneddau.

Mr Owen first pointed out a well-preserved cock-pit, and then, higher up the hill-side, the foundations of a Celtic hut and a kist. Mr Owen indicated a small excavation in front of the entrance to the hut, which had proved the presence of charred wood that had been burnt, and a short distance beyond a well-preserved kist, whose opening he had himself superintended. Mr Owen remarked that the tumulus had been constructed on a roughly-paved area, and was surrounded by a circle of large stones. After Mr Owen had finished speaking, the Hon. Secretary pointed out the geography of the country within view, and made some remarks upon the phases of development at which the river-systems of Central Wales had arrived. Upon this subject he gave a lecture later on in the evening at the hotel.[1] Some of the Members climbed up to the Caer Fawr, from which they saw also another hill-fort, Caer Einon. Caer Fawr and Caer Einon are large bosses of igneous rock that have had their more readily accessible sides protected with works of earth and stones. Caer Einon is the more instructive, the ramparts of stones being very conspicuous, as well as the entrance and the old road leading up to it. To the north of Caer Fawr is a basin-like depression, which is occupied by a small tarn that is fast becoming filled up with vegetation—cotton-grass being very conspicuous. The linguiform depression that runs southwards from this tarn has been caused by the Llandeilo Shales between the igneous masses weathering much more rapidly than their flanking harder rocks.

1 The subject is fully dealt with in a paper in the Geological Magazine for November, 1909.

On Wednesday the Members left Builth at 8.26 a.m., and arrived at Rhayader at 9.2 a.m., the objective being the Cwm Elan Reservoirs that supply Birmingham.

On the drive from Rhayader, the first stop was just above the great Caban Côch Dam.

The Hon. Secretary said it would be unnecessary for him to say more about the geology than that they were now in the heart of a district whose rocks prior to the construction of the reservoirs were practically unknown to geologists. But, fortunately, one of the engineers, Herbert Lapworth, who was engaged upon a section of the water-mains, had applied himself with the skill that characterized his father's (Prof. C. Lapworth) epoch-making researches to the task of unravelling the stratigraphy of the district around Rhayader, and had made three main sub-divisions of the unpromising-looking Silurian rocks—in descending order (i.) the Rhayader Pale Shales, (ii.) the Caban Group, and (iii.) the Gwastaden Group. The determination of the true succession had been complicated by numerous foldings and faultings. Shales, flags, mudstones, grits, and conglomerates composed these groups, and had it not been that a few graptolites had been procured from certain of the shale-beds, the correlation of the deposits would have been difficult in the extreme.

The following table will help to elucidate the remarks on the stratigraphy, and show the relations of the beds in the Rhayader and Builth Wells districts :—

		RHAYADER		BUILTH-WELLS
Silurian				Ludlowian
				Wenlockian
	Valentian	Rhayader Pale Shales, *thinning out to*		Tarannon Shales (a few feet thick)
		Caban Group, 1500 ft: *thinning out to*		U. Llandovery Grit (a few feet thick, & containing *P. oblongus*, resting unconformably upon the
		Gwastadan Group (1800 feet)	Absent from Builth district	
Ordovician		? Bala		
		[Llandeilo]		Llandeilo
		[Arenig]		Arenig

In the cliffs bordering the road at Caban Côch, and in the great quarry close to, no better teaching-specimens of conglomerate could be desired—the white quartz-pebbles standing out in pleasing contrast to their dark matrix.

The scheme of making six reservoirs in the Elan and Claerwen Valleys, and of constructing an aqueduct 73 miles long to Birmingham, was originated by the late James Mansergh, F.R.S , Past President Inst. C.E. At present the three reservoirs on the Elan have been constructed, and the foundations of one dam on the Claerwen, but the others on the Claerwen will not be made until the necessity arises.

From an excellent descriptive book, entitled, "The City of Birmingham Water Department, Elan Supply: A Description of the Works," by E. Anthony Lees, it appears that the total extent of the gathering ground is over 70 square miles. Its minimum elevation is 700 feet O.D., while several of the hills round the rim of the watershed rise to elevations of over 2000 feet. The average yield of the gathering ground has been calculated on the basis of 36 inches per annum, on which basis there is an available yield of 99 million gallons per diem. Of this 27 millions a day go to the Wye as compensation water, and 72 million gallons for supply. The completed scheme provides a total storage capacity of 17,960 million gallons, of which 11,320 million gallons are provided by the works already executed. The aqueduct is designed for carrying 75 million gallons a day, but on the syphon-sections only two pipes out of the six provided for have been as yet inserted. The water is of the usual character of moorland waters. It was soon found that a growth appeared inside the iron conveying-pipes, so filter-beds were provided in order that the water should pass through material composed of crushed local rock. The rate of filtration is about 16 inches per hour. It being also found that the water possessed some slight erosive power when allowed to stand in the lead service pipes overnight, 1½ grains of finely-powdered chalk to the gallon are now introduced to the filters, by means of an overhead electric railway. This gives the necessary hardening to the water.

The filter beds were seen on the right just before arriving at the Caban Côch Dam, the model village being on the left down in the valley.

The Caban Côch Dam is 122 feet in height, 122 feet 6 inches thick at the base, and 566 feet long (measured along its summit line), and can impound 8000 million gallons. The tongue of water to the south is that which occupies the lower reaches of the Claerwen Valley, and now covers the site of the "Nantgwillt"—the house occupied by the poet Shelley in 1812, after his marriage with Harriet Westbrook.

The elegant bridge that crosses the Caban Côch Reservoir, the Careg-ddu Viaduct as it is called, marks a submerged dam. The reason why this submerged dam was constructed was because the point of delivery of the aqueduct at the Birmingham end is 600 feet above O.D., and the compensation water at the Caban Dam is discharged at a level of 720 feet above O.D. This was not high enough to ensure a proper fall, so this submerged dam was made, which rendered it possible to have the bottom level of the aqueduct at 770 feet. The top of the dam is 40 feet below the usual level of the water. This top-layer of water (4585 million gallons) is available for compensation-water as well as supply. The submerged dam divides the lower layer of water in the Caban Reservoir into two portions: that below the submerged dam and between it and the Caban Côch Dam being available for compensation-water only; and that above must always be kept up to its full amount in order to ensure correct charging of the aqueduct. The tower that marks the commencement of the aqueduct is called the Foel Valve Tower. The site of "Cwm Elan," the house where Shelley stayed in July, 1811, was pointed out on the right bank of the Elan, opposite to and a little up-stream of the Foel Valve Tower, but like that of "Nantgwillt," it is now some 40 feet below the top-water-level of the reservoir.

Driving along the well-made road, the scenery was greatly admired, the bare Craig Dol-faenog being particularly grand. Then the Pen-y-gareg Dam came into view, the water passing over its summit being wrought into foam by the projecting stone-blocks, and combining the utilitarian with the picturesque, for this battling of the waters on the projecting stones must aërate them well.

The Pen-y-gareg Dam is 123 feet high, 115 feet 4 inches thick at the base, and has a weir-length of 417 feet 6 inches. The reservoir has a total capacity of 1320 million gallons, and a top-water-level of 124 acres.

After the little path from the foot of the cascade to one of the lateral towers had been climbed, a fine view was obtained of the artificial lake.

The next halt was at the Craig Côch Dam, which is 120 feet high, 104 feet thick at the base, and has a weir-length of 390 feet, and impounds some 2000 million gallons of water. It is traversed by a viaduct.

The scenery of the country around this uppermost (Craig Côch) reservoir is very fine, being wild and desolate. Peat-capped tongues of land project into it, and the infalling streams are often dark with the particles of moorland matter.

After a bridge over the brook that enters the reservoir to the west of the dam had been crossed, a shallow cutting was entered that showed the Rhayader Pale Shales. The section showed very well indeed slaty cleavage, the cleavage-partings being inclined but a little from a right-angle from those of the bedding.

Crossing the Pont-ar-Elan and climbing the steep and bare hillside, the Members halted on the old Aberystwyth Road to look up the upper reaches of the Elan River, which they saw pursuing a braided course at the bottom of a desolate-looking valley.

Crossing Pen Rhiw-wen (1600 feet), whence the Members saw Plinlimmon, where Wye and Severn rise and then diverge, the descent was commenced. The Gwynllyn Cascade was seen and passed, but near Glanllyn the botanists of the party disembarked, to join the others later in the day at Rhayader.

Rhayader was reached at 2.30, the round of some 15 miles being accomplished since 10 a.m. After tea the Members returned to Builth-Wells by the 4.57 p.m. train.

During the evening some of the Members visited Builth Castle, now only a collection of grass-grown mounds, but once a formidable fortress.

On Thursday morning the Members travelled by the 9.35 a.m. train to Aberedw. The object of visiting this locality was to study certain glacial phenomena and the historic spots connected with Llywelyn.

The Hon. Secretary first led the way to a small gravel-pit close to the Wye, and near to where that river is joined by the Edw (text-fig. 1). He

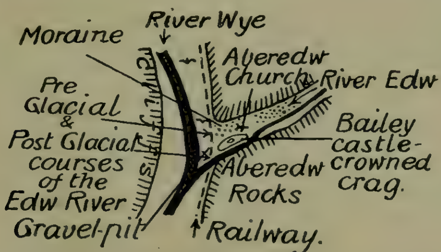


Fig. 1.—Sketch map of the meeting-place of the Edw with the Wye

said that he would shortly tell them why he had brought them to see it. At present all he wanted them to do was to note its aspect and constituents. The gravel was composed of rock-fragments of all sizes, confusedly intermingled, some well-smoothed and rounded, others angular and tabular. The rock-fragments coming under the former category were pieces of the distinctive diabase-porphyrite from the Carneddau, and of Caban Conglomerate, probably from the neighbourhood of Rhayader; those coming under the latter, pieces of Ludlow and Wenlock shaly rock from more local sources. Crossing the railway-line and climbing the steep crag up to the crowning mound, the Members sat down while the Hon. Secretary gave his interpretation of the river-features. He held that in closing Glacial times washed material derived from the lateral moraine of the Wye Glacier and from the terminal moraine of the Edw Glacier blocked up the Aberedw Valley. When the climate became less rigorous, and the snow and ice melted, the Edw found its pre-glacial channel blocked. A lake was therefore formed, which—as its volume became augmented—overflowed, and like most such lakes, found relief by forming an overflow channel between the moraine-dam and the hard rock-bank on the down-stream side. The outflowing water soon commenced cutting into the slaty rocks of the Ludlow, filing its way downwards, and soon grading with the Wye. Having established a passage, the Edw did not attempt to revert to its pre-glacial channel. Now, differential denudation has made its influence felt more on the morainic material than on the hard crag between it and the Aberedw Rocks, with the result that there is seen in a section from south to north (1) the Aberedw Rocks, (2) the deep gorge with the swift-flowing Edw in its bottom, (3) the bailey-castle-crowned crag, (4) the broad meadows on the morainic material, and (5) the hill-slope again composed of solid rock[1] (Plate V.)

It was unanimously agreed that the explanation was in accordance with the facts, and after a few questions had been asked and answered, a discussion ensued on the probable history of the mound upon which they were stood. Lieut.-Col. Duke thought it was a tumulus, and Mr J. M. Dixon a bailey-castle similar to that at Upper Slaughter, near Bourton-on-the-Water, only smaller.

The quaint old church, which is of a very usual Welsh type, having the nave and chancel of the same width, came in for much attention, particularly the old porch.

Next Llywelyn's Cave was visited (Plate IV., fig. 1). It is not easy to find, and when found turns out to be but a small room-like cave cut out of the Ludlow rocks. Its historic associations are such, however, as to add zest to the investigations of Llywelyn's connection with these parts.

It appears that William, son of William de Breos (the son of Philip de Breos, who probably built the first Norman castle at Builth), sided with the Barons against King John, and as a result was deprived of his possessions and attainted. Some, however—including the lordship of Builth—were restored to William's second son, Giles, Bishop of Hereford. On his death it passed to his brother Reginald. Reginald and Llywelyn for some time fought against John, but later Reginald forsook Llywelyn and sided with Henry III. In 1221 Llywelyn besieged Reginald in the Castle at Builth, and was only caused to desist by the arrival of a strong force sent by Henry from Gloucester. Reginald had three daughters—Eleanor, Eva, and Maud, and when in 1230 he was summarily hanged for intriguing with Llywelyn's wife, his Builth and Radnor possessions passed to his third daughter, Maud. This Maud married Roger de Mortimer, but it would seem that ever since the attainder of the first William de Breos the King of England kept Builth Castle in his own hands, and the Mortimers were mere custodians. In 1260 Llywelyn captured the castle by night, and Mortimer was only with difficulty acquitted of connivance. Rhys ap Griffin acted as custodian of the castle for Llywelyn for a while, but was much molested by the Mortimers. When Edward I. came to the throne, Llywelyn partly destroyed Builth Castle and abandoned it. Edward I., however, rebuilt it, and made it, for its size, the strongest in the country.

John Giffard—the same man who had fought with Llywelyn at Lewes on the side of the Barons against Prince Edward, but had afterwards deserted them and joined the King—was placed in command. Soon Llywelyn was engaged in a fierce struggle against Edward I. in North Wales. In order to capture Llywelyn, Giffard pretended to have deserted the King, and invited Llywelyn to Builth. Llywelyn, not suspecting treachery, hastened to Aberedw Castle with only eighteen picked men. There, however, Robert l'Estrange and Edmund and Roger Mortimer made an unsuccessful attempt to surprise and capture Llywelyn that night. He escaped, and is supposed to

1 The glacial features here have been described in detail in the Geological Magazine for November, 1909.

Photo P. B. Abery, Buith Wells.

View of the mouth of the Aberedw Valley and its junction with that of the Wye. From left to right the features are: the wooded hill-side (Aberedw Rocks); post-Glacial gorge of the Edw; the bailey-castle-crowned tump; the level ground formed by the morainic matter filling up the pre-Glacial channel of the Edw; and the slope of the hill-side. The Wye enters the view by the valley on the right and leaves it by that on the left, the hills in the background being on the right (west) bank of the Wye.

have spent some time in or near the cave towards the top of Aberedw Hill. One early morning he arrived at Court Llechryd (near the present Builth Road Station), that was held by a loyal Welsh chieftain. Crossing the river, he proceeded to Builth, and then found the castle closed to him. Giffard's scheme was then apparent, so that, after destroying Builth bridge, he fled to Pont-y-Coed, near Llany's Church. Telling his few men to defend the bridge, he went, probably to rest awhile, in a tithe-barn near Cefn-y-bedd. How long he was there we do not know, evidently long enough for the Mortimers and l'Estrange to cross the Wye at Erwood—(for Llywelyn had destroyed the bridge at Builth)—and to reach Llanynis. Finding the bridge too strongly guarded, they sent a detachment of cavalry, piloted by Helias ap Philip Malwyn, to cross the ford above Cefnllys-gwynne. They succeeded, and at once attacked in the rear the gallant eighteen, probably supported by some loyal Welshmen from the neighbourhood. The battle was uneven, but the fighting was furious. The eighteen fell to a man. Llywelyn, when told of what had happened, declared it impossible. But rushing back to see for himself, he was met by one of Roger l'Estrange's men, Adam, a Welshman from the village of Francton, near Ellesmere, who, mortally wounded, without recognising him. Some time later Adam Francton returned to the spot (now marked by a monument) and identified his wounded victim as Llywelyn. He soon despatched and decapitated him. The headless body was buried at Abbey Cwmhir, and the head, accompanied by a despatch from Roger l'Estrange, was sent to Edward I. at Rhuddlan. He sent it on to London, where, crowned with ivy, it was carried through Cheapside on the point of a lance, and finally placed on the Tower.

The parts of Llywelyn's Castle that remain show that it consisted of a square work of about 40 yards each side, surrounded by a deep dry ditch, and enclosing an area of about one-third of an acre. By a gross act of vandalism, two of the towers and one side of the fortress were destroyed by the railway company in making the line.

After a bread-and-cheese meal at the village inn, and an inspection of the remains of Llywelyn's Castle, now partly destroyed by the railway, the Members departed by the 1.25 p.m. train for Hereford and Gloucester.

During the excursion some good work was done by the botanists, a number of records new to the district being made by the Rev. H. J. Riddelsdell (see pages 57-61).

EXCURSION TO STONESFIELD AND FAWLER

TUESDAY, September 21st, 1909

Director: L. RICHARDSON

(*Report by* L. RICHARDSON)

The last Field Meeting of the Session 1909-10 was held in the Stonesfield district on September 21st, those present being:—The Rev. H. H. Winwood F.G.S. (*Vice-President*), Mr T. S. Ellis (*Hon. Treasurer*), Mr L. Richardson (*Hon. Secretary*), Mr E. T. Paris (*Hon. Assistant Secretary*), Dep. Surg.-Gen. G. A. Watson, Canon Broome Witts, and Messrs F. H. Bretherton, J. M. Collett, F.C.S., J. M. Dixon, O. H. Fowler, J. W. Gray, F.G.S., J. N. Hobbs, F. T. Pearce, J. W. Skinner, W. Stanton, A. W. Stanton, and W. Thompson.

The party arrived at Handborough at 12.27 p.m. Here a brake from Oxford was awaiting them.

The first stop was made at the gravel-pit on the left-hand side of the road in the village, half-way between the Manor House and the Church, in which from 10 to 12 feet of gravel was seen. It is mainly of local origin, but contains a few patches of sand, traces of clay-bands, and a subordinate amount of "Northern Drift" pebbles. Some of the gravel is coated with carbonaceous matter, as at Bourton.[1] Here the Hon. Secretary outlined the work they hoped to accomplish during the day. He said that the district was one the Club had not been to before. They had therefore visited it in order to see in what respects its geology and scenic aspect differed from the geology and scenery of the district further to the west—between the vales of Moreton and the Severn. They had probably observed that the Cotteswold escarpment had been negotiated in the train by means of a fairly steep gradient, a tunnel, and the Chelt "pass" between Charlton Kings and Andoversford. Then followed a steep climb over the broad undulating uplands, *via* Notgrove. The steep western face of the Cotteswolds was mainly due to the thickness of the Inferior Oolite, which, as they knew well, was so finely exposed at Leckhampton Hill. But in this district it was extremely thin, and as they would see shortly at Fawler, its Top-Beds rested directly upon clays belonging to the bottom zones of the Upper Lias. Above the Inferior Oolite comes the Fullers' Earth. Near Stroud it is clay, at least 90 feet thick. At Stonesfield, as a clay deposit, it is scarcely recognisable; but the Great Oolite of Minchinhampton, is well represented at Stonesfield. To the Great Oolite succeed Forest Marble, Cornbrash, and Oxford Clay, and all these occur in the tract to be traversed during the day. Moreover, all these beds, from the Inferior Oolite to the Oxford Clay, and yet younger beds above, once extended much further west than they do now; but untold centuries of denudation, principally by river-work and atmospheric agencies, have evolved and developed that subdued undulating surface which is so pleasing a characteristic of this part of the country.

It is difficult to say, on the evidence at present available, what were the precise conditions that obtained in these parts during the Glacial Epoch. The highest portions of the hills are covered with Northern Drift, or "Plateau Gravel," as it is called in these parts; and although it now occurs in isolated patches, Mr R. I. Pocock thinks that it is the leavings of a time when the district was "overspread by ice in the early Pleistocene period." Since

1 Proc. Geol. Assoc., vol. xviii. (1904), p. 402.

Fig. 1.—"SLATE"-SPLITTING AT STONESFIELD

(*W. Thompson, photo.*)

Fig. 2.—"SLATES" STACKED READY FOR USE

(*W. Thompson, photo.*)

then the river-valleys have become broadened and deepened, and the patches of Northern Drift proportionately more and more widely separated; while four terraces of gravel, at successively lower levels, mark the stages in the lowering of the valleys. The information possessed with regard to the Superficial Deposits may thus be summarized:—[1]

ALLUVIUM.—Recent deposits of fine silt, forming flat meadow lands, liable to floods, alongside the rivers.

RIVER-GRAVELS.—I. *Low Level Gravels.*

(1) 1st Terrace: 5 to 10 feet above flood level, and about 220 feet above sea-level. Occurs in isolated patches. (2) 2nd Terrace: 20 to 30 feet above flood-level. Oxford, and most of the villages of the Upper Thames Valley built upon it. (3) 3rd Terrace: 40 to 50 feet above flood-level. At Wolvercote, the lowest layer is rich in Palæolithic implements of the Chelléen Stage.

N.B.—*All three terraces contain palæolithic implements, and mammoth and other remains.*

II. *High Level Gravel.*

(4) 4th Terrace: 70 to 100 feet above flood-level, and, at the Handboroughs, from 300 to 330 feet above sea-level. No fossil remains yet recorded.

N.B.—The river-gravels "consist of pebbles and small pieces of limestone from the Oolitic uplands, together with a variable quantity of quartzose and flinty material, probably washed out of the Glacial [*or Northern*] *drift.*"

PLATEAU GRAVEL or NORTHERN DRIFT	From 100 feet and upwards above the present level of the river, and of very similar constitution to such Northern Drift in the Lower Severn Valley as caps Sandhurst Hill, near Gloucester. The top of this hill is 283 feet above sea-level.

From Handborough the party proceeded to Stonesfield via Combe. Just before entering Stonesfield, a deep "solution valley"[2] was pointed out, and then the Members proceeded to the banks of the Evenlode, south of the village, where typical *Clypeus*-Grit is clearly exposed. This is one of the prettiest spots in the district, and is of interest both to the geologist and to the student of river-features. Next, the Stonesfield Slate (or better "stone-tile") working was visited. In former years the fissile limestones that occur near the base of the Great Oolite were very extensively worked, but now only one pit is open. The shaft down to the slate-bed is about 30 feet deep, and then the slate is worked by means of a long gallery. The slate-rock is brought to the surface and left to weather for a considerable time, after which it can be readily split (see Pl. VI., figs. 1 and 2). A number of the characteristic fossils were obtained from the slate-workers.

Concerning the rocks between the *Clypeus*-Grit and the Cornbrash in North Oxfordshire, Mr Richardson said that much work had been accomplished of late years on the lower portion by Mr E. A. Walford, F.G.S. His results were most valuable ("On some New Oolitic Strata in North Oxfordshire," Buckingham, 1906), and were worthy of a wider circulation than the form of publication would probably allow.

In descending order, the beds from the Cornbrash to the *Clypeus*-Grit are: the Cornbrash, Forest Marble, Great Oolite proper (with the Stonesfield Slate at the base), Neæran Beds, Chipping Norton Limestone, *Trigonia-signata*-Beds and *Clypeus*-Grit. Of these, the last is of *Truellei* and *Schlœnbachi* hemeræ: the Chipping Norton Limestone of probably *fuscæ;* while *Ammonites subcontractus* has been found in the neighbourhood, and brings the deposit in which it occurred into line with the Weatherstone and Shell-Beds of Minchinhampton, and with the Fullers' Earth Rock of parts of Somerset and Dorset. In these parts of Somerset and Dorset, the deposit

[1] A full description of the gravels of the district, by R. I. Pocock, will be found in the Mem. Geol. Surv., "The Geology of the Country around Oxford" (1908), [price 2s 3d], pp. 81-105.

[2] See paper by the Rev. E. C. Spicer, Quart. Journ. Geol. Soc. vol. lxiv. (1908), pp. 335-342, and pls. xxxviii. and xxxix.

between the "Rock" and the Inferior-Oolite limestone is *all* clay, and is known as the "Lower Fullers' Earth." Therefore the deposits occupying a corresponding stratigraphical position in North Oxfordshire are equivalent to the Lower Fullers' Earth. But that term is inappropriate for use in North Oxfordshire, so the denomination "Hook-Norton Beds" may be suggested instead. *Perisphinctes gracilis* (J. Buckman) has been recorded from the Stonesfield Slate of Stonesfield (Monogr. Moll. Great Oolite, Pal. Soc., p. 13), Eyeford (near Naunton), and Sevenhampton Common (near Cheltenham), so that effects further correlation. Above the "Slate" at Stonesfield, and in places around, is a marl which is rich in specimens of a form of *Rhynchonella concinna*. A similar fossiliferous deposit is seen at many of the sections in the Cotteswold Hills, and affords a most useful datum-level. It may be remarked that Walford's Neæran Beds are of the same date as the Upper Estuarines of such sections near Northampton as that of Hopping Hill, and as the upper portion of the Lower Fullers' Earth of the Doulting district in Somerset. Mr Walford compared them with the building-stones of Barnack and Stamford, but these are of much earlier date and comparable with the deposits of *discitæ* hemera in the Cotteswolds.

With regard to the Bathonian beds between the Stonesfield Slate and the Cornbrash, there is a considerable thickness of Great Oolite, with the usual kind of Forest Marble on top. Part of the lower portion of the Great Oolite, as already noted, is on the horizon of the Fullers' Earth Rock, haviug yielded *Tel. ? subcontractum*. The component beds change somewhat from place to place in this North-Oxfordshire district; but it is interesting to note that in the cutting at Ardley, on the new Ashendon to Aynho Line, the bed immediately below the Forest Marble has been called the "Cream Cheese Bed,"[1] and from all descriptions it must closely resemble in texture the peculiar Dagham Stones of the White Limestone Division of the neighbourhood of Cirencester.

The next stop was at Fawler. Those who are accustomed to work the Lias and Oolite on the western edge of the Cotteswolds, as, for example, at Leckhampton Hill, know full well that the *Capricornus*-Beds, which were formerly worked at the Pilford pit, are succeeded there by a considerable thickness of the Lower *Margaritatus* sandy shales; these by the Marlstone, which in turn is separated from the Inferior Oolite by something like 230 feet of deposit that is principally clay. Recently it has been discovered that the top and more sandy portion of this clay is of *variabilis* hemera. Upon this rests the Inferior Oolite, of which the following subdivisions have been recognised here, namely (in ascending order), the *Scissum*-Beds, Lower Limestone, Pea-Grit, Lower Freestone, Oolite Marl, Upper Freestone, Lower *Trigonia*-, *Buckmani*-, and Gryphite-Grits, Notgrove Freestone, Upper *Trigonia*-Grit, and, a short distance back from the edge, the *Clypeus*-Grit. The Inferior-Oolite between the Upper Lias and Upper *Trigonia*-Grit measures about 200 feet.

Now at Fawler, the top of the *Capricornus*-Zone, Dr F. A. Bather[2] thinks, may come at about 30 feet below the Marlstone. The Lower *Margaritatus*-Zone, according to that, would be about 30 feet thick. The Marlstone "has proved sufficiently rich in iron-ore to have been worked with profit." The discovery was made in 1859, but the working was discontinued in 1887. It is still visible in the road-side, and in the workings to the south-west and north-east of the road. It is especially well seen at the south-western end of the latter working, where it appears as a bed some 8 to 10 feet thick, dipping at an angle of about 10 degrees in a north-westerly direction. Concerning the Marlstone, Prof. E. Hull has written:—

1 Summary Progress Geol. Surv. for 1907 (1908), p. 150
2 Quart. Journ. Geol. Soc., vol. xlii. (1886), p. 144.

"At the outcrop the rock presents a rich ferruginous aspect, but when reached at positions where it has been protected from atmospheric influences, its colour is deep olive green; and the gradual change may be observed in blocks newly split. In its latter state, it appears to be oolitic under the lens.

"The character of the ore, before oxydization, is probably that of carbonate and silicate of iron, the latter imparting the green tinge; when exposed, it passes into a hydrated peroxide of iron. The quantity of silica is about 12 per cent., and of lime 10 per cent. Phosphoric acid is only present in minute quantity—0·55 per cent. From an analysis of nine samples made in the Museum of Practical Geology, the average quantity of metallic iron was found to be about 32 per cent." [1]

The Upper Lias, which has been dug at Fawler for brick-making,[2] varies somewhat in thickness, the measurements of investigators varying from 5 to over 16 feet. The section laid bare at the time of the visit of the Geologists' Association in 1908, exhibited 12 feet of Upper-Lias clay, with a thin band of pale earthy ferruginous limestone, containing Upper-Lias fossils, resting directly upon the Marlstone. The ammonites that have been obtained indicate that the Upper Lias here corresponds to the lower portion of the Upper Lias as developed near Cheltenham. The higher zones are unrepresented, and when one comes to the Oolite it is found that all its sub-divisions inferior to the Upper *Trigonia*-Grit are also lacking. There is a great non-sequence between the Upper Lias and Inferior Oolite here.

The Inferior Oolite at Fawler is thus broadly divisible:—

			Approximate thicknesses in *ft.*	*ins.*
Chipping Norton Limestone.		White oolitic lime-washed limestones, with few fossils: seen (*teste* Bather)	15	0
Clypeus-Grit	Marly Beds	(*a*) *Nerinæa*-Bed .. .. (*b*) *Terebratula*-Marl .. .. .. (*c*) Impure limestone .. .. .. (*d*) *Pholadomya*-Marl .. .. .. (*e*) Marl with indurated portions..	4	0
	Rubbly Beds	Limestones, rubbly, coarsely-oolitic; *Clypeus Ploti*, *Limatula gibbosa*, etc.	4	0
	Massive Beds	Limestones, more massive; usual *Clypeus*-Grit fossils: average	9	0
Upper *Trigonia*-Grit (*circa*)		Conglomerate-Bed: average ..	0	6

The Conglomerate-Bed has a very uneven under surface, but a level oyster-covered and often bored upper surface. It is, there can be little doubt, of *Garantianæ* or early *Truellei* hemera, and comparable with the Conglomerate-Bed of the Radstock district, and of Maes Knoll, Dundry. The lower part of the *Clypeus*-Grit is quite typical, both as regards faunal and lithic characters; but the marly beds are a more local deposit, and are succeeded by limestone called by previous authors the Chipping Norton Limestone.

The Members then drove into Charlbury and caught the 4.30 p.m. train.

1 "The Geologist," vol. iii. (1860), pp. 303-304. See also Mem. Geol. Surv., "The Geology of the Country around Woodstock, Oxfordshire" (1859), pp. 10-12; Mem. Geol. Surv., "Jurassic Rocks of Britain," vol. iv. (1894), pp. 303-306.

2 A railway-truck load of Upper-Lias clay is sent annually from Charlbury to Nether Stowey, in Somerset, for use in the tannery there. It is obtained from the field in which the wind-mill for pumping purposes is situated.

Fig. 1.—MOUNTAIN VALLEY IN THE ROCKIES, IN WHICH A VALLEY-GLACIER FORMERLY EXISTED

(From R. S. Tarr's "New Physical Geography," with the permission of Messrs Macmillan & Co. Ltd.)

Fig. 2.—PASS OF LLANBERIS, DOWN WHICH A VALLEY-GLACIER ONCE OBVIOUSLY FLOWED

(Reproduced by permission of the Photochrom Co.)

SOME GLACIAL FEATURES IN WALES AND PROBABLY IN THE COTTESWOLD HILLS

BY

L. RICHARDSON, F.G.S.

[Plates VII.-XII.]

(Read November 16th, 1909)

It is well-known that in late Tertiary times there was a glacial period. In certain parts of North Wales the evidence is very obvious, and includes such features as hanging-valleys, striated surfaces, *roches moutonnées*, boulders, and perched blocks. The view given in fig. 2, Pl. VII., is of the Llanberis Pass, in North Wales, now a classic demonstration-ground for the study of the products of glacial erosion. Therewith compare the view given in fig. 1, Pl. VII., which is of a Rocky-Mountain valley down which a mountain glacier once obviously flowed.

It is extraordinary what small changes in the average annual temperature would often suffice to cause glaciation of a district again.

> "Thus it has been recently estimated that a fall of but 3° (Fahr.) in the average annual temperature would result in the formation of small glaciers within the area of the Scottish Highlands, while a like fall of 12° within the Laurentian Lake district of North America would suffice to bring on a period of glaciation." [1]

It is held by many that uplift was one of the prime causes of the extension of the area of glaciation. Certainly the introduction of the land-surface into colder altitudes would be

1 Prof. W. H. Hobbs, "The Geogr. Journ.", February, 1910, p. 147.

adequate in many cases to bring about the formation of mountain-glaciers.[1] One of the principal features of mountain-glaciation is the formation of steep head-walled cwms.[2] In Snowdonia there are excellent examples of such cwms, and abundant evidence for the occurrence of a Glacial Period. Very similar cwms are to be seen in the Brecon Beacons; and those in the Brecon Beacons remind one of such great amphitheatral hollows as that of Charlton Common, and suggest that the excavation of this hollow—and of certain other similar ones in the Cotteswold Hills—may be in part due to somewhat similar erosive agents.

Two months after my return from Snowdonia, and the country around Bala, there appeared the masterly and suggestive paper on "Glacial Erosion in North Wales," by Prof. W. M. Davis, in the Quarterly Journal of the Geological Society of London.[3] In it, the origin of the cwms of Snowdonia receives considerable attention. Prof. Davis is a firm believer in the erosive power of moving ice, and fortifies his position with the aid of telling sketches of actual features.

His restoration of pre-Glacial Snowdon is particularly fascinating, and concerning it he writes that it was probably a

> "subdued mountain-form with dome-like central summit, large rounded spurs and smooth waste-covered slopes, and with mature valleys drained by steady flowing streams which branched delicately headwards, with steepened slope, and which joined each other northwards in the accordant fashion that so systematically characterises the drainage of all normal subdued mountain-masses."

During Glacial times, however, he says this full-bodied mass was transformed

> "chiefly by the glacial excavation of valley-head cwms and by the glacial widening and deepening of the valleys themselves, into a central peak which gives forth acutely-serrated ridges between amphitheatres: the serrated ridges changing into broad-spreading spurs as they are followed outwards; the wide amphitheatres, backed by high rocky cliffs, opening by great rock-steps to irregularly deepened trough-like valleys, with oversteepened, undissected sides, sometimes smooth, sometimes of a peculiarly roughened slope; the smaller lateral valleys hanging in strikingly discordant fashion over the floors of the larger valleys; and the streams, far from following graded courses in steady flow, frequently halting in lakes or hastening in rapids and cascades."

1 Prof. Hobbs rightly remarks that not sufficient distinction has been drawn between the types of land-form that result from the glaciation (1) of districts of strong relief that were not entirely submerged beneath snow and ice, but were sculptured by mountain-glaciers, etc.; and (2) from those that were sculptured beneath a glacier of continental dimensions.

2 Or cirque: Ger., *cirkus*: Scotland, *corrie* (uplands), *coire* (lowlands): Scandinavia, *botn*: and Bavaria-Austria, *kahr*.

3 *Loc. cit.*, 1909, pp. 281-344.

But what are of more immediate concern for the present purpose are such telling sketches of Prof. Davis's as figs. 14 and 21 (loc. cit., pp. 313 and 317), which depict ordinary valleys in a subdued mountain-mass *before* and—according to his view—*after* they had been occupied by valley-glaciers. According to his view, the valley-heads of stream-genesis became filled with snow, which was pressed down by additional falls to feed the valley-glacier below. In the bergschrund (or great gaping crevasse which so generally parallels the cwm-head walls, occurring between them and the ice-wall) the freezing and thawing of the water gradually initiated the steep topmost portion of the now precipitous head-walls, and the general downsliding of the granular ice and debris had the effect, by "frictional plucking and dragging," of scooping out the same cauldron-like hollows. Where the heads of two contiguous stream-valleys became névé-reservoirs, the intervening and originally-rounded spur between them usually became sharpened in its upper portion into a sharp, steep-sided, serrated ridge or "arête," as it is technically called.

Such in brief are the views of Prof. Davis with regard to the formation of the cwms of Snowdonia and the intervening arêtes. The last products of the receding valley-glaciers in waning Glacial times may be pointed to in the small moraines that so frequently half-inclose the little moraine-lakes that are backed by the steep precipitous head-walls of the cwms.

A later writer than Prof. Davis, namely, Prof. W. H. Hobbs, of Michigan, thinks, however, that while

> "the low-level sculpturing expressed by these sketches of Prof. W. M. Davis is, in the opinion of the writer, [*i.e.*, Prof. Hobbs], admirable, and a true rendering of nature. It is the failure to recognise any additional process of erosion in higher altitudes which destroys the value of the high-level sculpturing displayed. . . . It is the operation of an additional denuding process of the first importance, head-wall erosion, that differentiates all types of mountain-glaciers from continental ones. This distinguishing process is responsible for the development of the cirque. . . ."[1]

Personally, I think Prof. Davis set forth his views on how a cwm was formed fairly fully; but Prof. Hobbs writes that

> "The discovery of the method by which the glacier excavates its amphitheatre must be credited to a keen American topographer-geologist, Mr Millard D. Johnson, of the United States Geological Survey."

1 Geogr. Jour., 1910, p. 148.

Johnson discovered that the great gaping crevasse which generally comes between the head-walls of the cwm and the glacier-ice went right down to the rock beneath the névé, and that

> "the bed of the glacier, elsewhere protected from frost-work, was here subjected to exceptionally rapid weathering. By maintaining the rock wall continually wet, and by admitting the warm air from the surface during the day, diurnal changes of temperature have resulted in very appreciable mechanical effects, whereas above the névé only the seasonable effects were important."[1]

Indeed, Johnson's observation indicates that the maximum excavation of the cwm-wall takes place not above, but below, the névé, and shows "how a nearly perpendicular cirque wall is steadily cut backwards through basal sapping at the bottom of the bergschrund."

Prof. Davis's theory may well account for the cwms that appear to have been developed out of stream valley-heads; and Mr Johnson's, for the way in which the steep head-walls steadily receded; but Mr Johnson does not attempt to account for the actual origin of the cwms. I confess to having experienced some difficulty in accepting Prof. Davis's theory for the origin of all the cwms—especially those in the rounded hills now technically called "moels." Mr F. E. Matthes's very interesting observations on how snow-banks, without movement, steadily deepen the often very slight depression within which they lie by a process which he calls "nivation" (that is, excessive frost-work about the receding margins of the drifts during the summer season), however, certainly help matters.[2] On Cleeve Hill, near Cheltenham, for example, there are hollows that are very likely indeed being widened, and in places deepened by this process of nivation.

But for the present purpose nothing more need be added on the probable origin of cwms, for those with which we are really concerned have most likely originated in the way Prof. Davis has suggested. In a mountain-mass like Snowdon, as the contiguous cwms were developed, the hill-spurs were sharpened into arêtes; the central summit became sculptured to form a broken tooth-like projection; and doubtless the final products of the hanging-glaciers were moraine-heaps that now ofttimes enclose the well-known little glacier-tarns.

1 See Science, N.S., vol. ix. (1899), p. 106; and *ibid.*, pp. 112, 113.
2 Twenty-first Ann. Rep., U.S. Geol. Sur., 1899-1900, pp. 167-190.

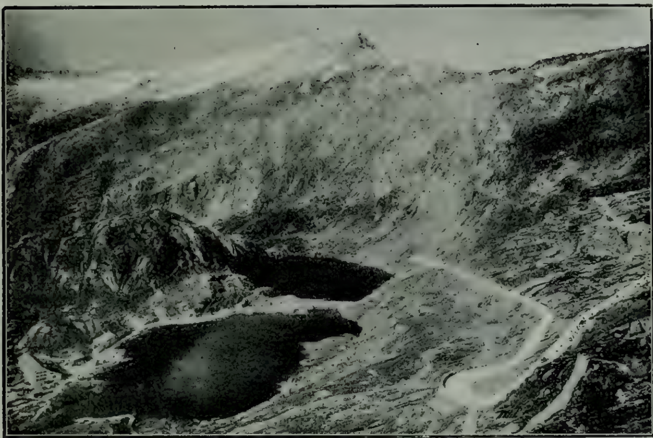
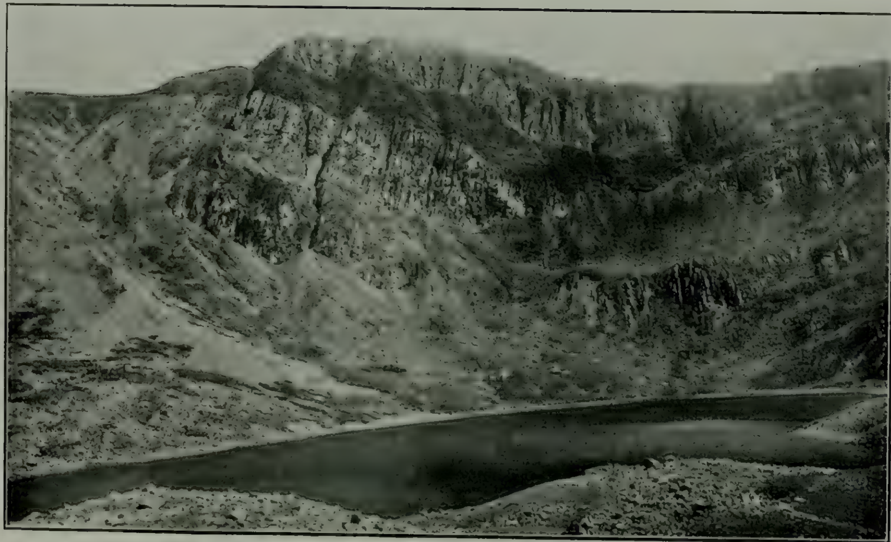


Fig. 1.—VIEW ON THE GRIMSEL PASS, SHOWING BROKEN TOOTH-LIKE SUMMIT, AMPHITHEATRAL CWM, AND GLACIER-TARNS

(From R. S. Tarr's "New Physical Geography," with the permission of Messrs Macmillan & Co. Ltd.)

Fig. 2—SNOWDON, FOR COMPARISON WITH THE SCENE DEPICTED IN Fig. 1



CADER IDRIS, CWM, AND GLACIER LAKE

(Frith & Co., photo.)

In Plate VIII., fig. 1, is a view of the Grimsel Pass, in Switzerland, which shows very clearly indeed the wide-spreading amphitheatral cwm, the glacier-tarns at its foot, and the peculiar broken tooth-like summits of the mountain-mass, due to the headward growth of the névé-reservoirs. Therewith compare the lower picture on the same plate, which is a reproduction of a photograph of the eastern part of Snowdon. High up on the slopes of Cader Idris, near Dolgelly, beneath the summit, is a beautiful little glacier-tarn, ponded back by a well-defined moraine, and backed by precipitous cwm-head walls (Plate IX.)

Now, although there are many features that are attributed to glacial origin which are independent of the rock-structure of the glaciated mountain-mass, it is nevertheless obvious that the pre-Glacial geomorphology of a given mountain-mass of normal-erosion production must have been mainly connected with the distribution of relatively hard and soft rocks, faults, anticlines and synclines, etc., and that the features so produced were developed and sharpened by the forces at work during the Glacial Period. Thus, while in Snowdonia, owing to the rock-structure, geographic position, and altitude, the products of Glacial erosion are numerous and well-defined, in other parts where the mountain-masses are lower, of more uniform and less deformed structure, and were less glaciated, it is apparent that the glacial features also will be less pronounced.

THE BRECON BEACONS

Some six miles away from Brecon, in a southerly direction, are the Brecon Beacons (Plate X.)—a residual portion of the great escarpment of the Upper Old Red Sandstone, which, starting as a comparatively ill-defined ridge between May Hill and the Forest of Dean, on the borders of Gloucestershire and Herefordshire, becomes—in spite of several interruptions—more and more pronounced as it passes through the southern portion of the latter county (as the Black Mountains), culminates in the sharp-peaked Brecon Beacons, and only commences diminishing conspicuously in altitude after it has passed the dark Carmarthen Fans, and has reached the neighbourhood of the county-town of Carmarthen. These hills are further south, less high and less deformed than the Snowdon Group, but possess features evidently connected with glacial erosion. The sketch in which the peaks are named (text-fig. 1),

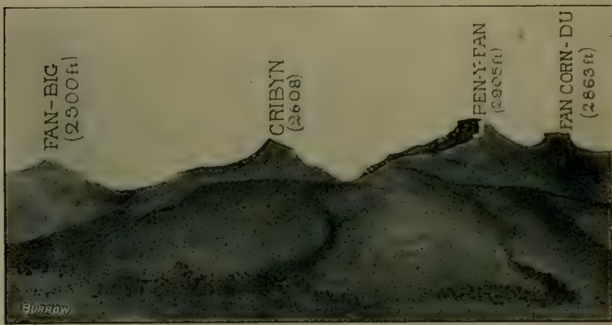


FIG. 1.—The Brecon Peaks, named and with altitudes (*E. Burrow*)

shows very clearly indeed the broken tooth-like aspect of their summits, which, as already noticed, is very characteristic of glacially-sculptured mountains, together with the great hollow cwms beneath them. The escarpment faces on the whole a little east of north, and most of the great cwms, whose head-walls impart the broken tooth-like aspect to the summits, have a similar direction.

This broken tooth-like aspect of the summits, as already remarked, is very characteristic of glaciated mountains, and the general resemblance in this respect, and in the great amphitheatre-like cwms of the portion of the Beacons depicted in Pl. XI., to the features as obtained in the neighbourhood of the Grimsel Pass (Pl. VIII., fig. 1), and at Snowdon, already commented on, is noticeable and instructive. It is rendered yet more complete by the occurrence in the hollow of the great cwm shown in Pl. XI., of a small moraine-contained (Pl. XII., fig. 1) tarn, locally known as Llyn-cwm-Llwch (Pl. XII., fig. 2).

Very similar phenomena of cwm and tarn obtain in that portion of the Black Mountains of Carmarthenshire often known as the Carmarthen Fans; while at Fan Gihirych, Fan Fawr, and Craig Cerig Gleisind, between the Brecon and Carmarthen Fans, are fine amphitheatral cwms in moel-like

THE BRECON BEACONS (EVENING)

(P. Morton, photo.)

(From Burrow's "Heart of Wales.")

THE PEAKS OF THE BRECON BEACONS AND THE GREAT AMPHITHEATRAL CWM

(*Maclardy, photo.*)

(*From Burrow's "Heart of Wales."*)

Fig. 1.—GLACIAL MORAINE AT THE OUTLET OF LLYN CWM LLWCH
(*P. Morton, photo.*)

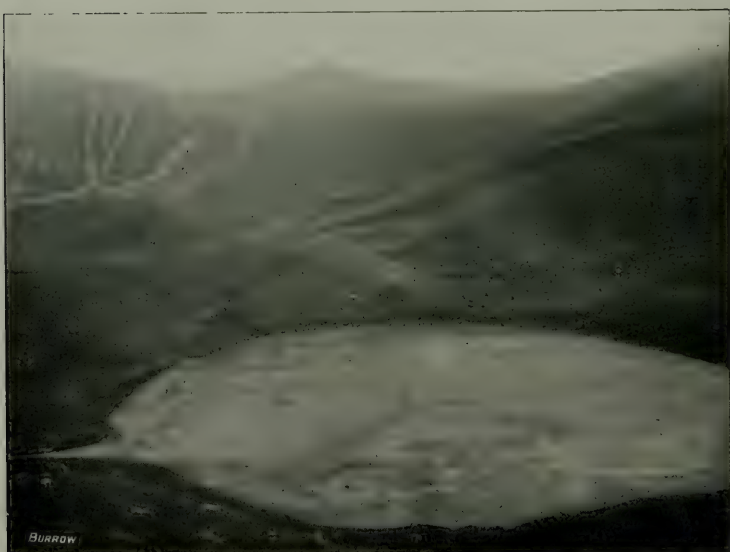


Fig. 2.—THE MORAINE-RETAINED TARN OF LLYN CWM LLWCH IN THE BRECONS

(*P. Morton, photo.*)
(*From Burrow's "The Heart of Wales"*)

masses. A moel not so glaciated is Moel Feudwy (1940 feet), close to the Carmarthen Fan.

All these cwms, it should be noticed, face between north and east. Further south, between Aberdare and the Vale of Neath, are the Craig-y-Llyn and the Craig-y-Bwlch: amphitheatral hollows facing north—the former with a median spur separating the glacial lakelet of Llyn Fach from that of Llyn Fawr (see Ordnance Survey Map: scale 2 inches to 1 mile: sheet 26).

Standing on the wind and grit-swept summit of the Brecons, Pen-y-Fan (2905 feet), and looking northwards over Brecon town, the view embraces the greater portion of the heart of Wales. In the immediate foreground long finger-like spurs, at first often sharpened to true arêtes, but later cefn-like, and the principal one eventually spreading and bifurcate, point north-north-eastwards. They are very noticeable, and have between them deep nants or valleys, some of U-shaped transverse-section, leading headwards into deeply-excavated cwms, whose head-walls rise sheer up in precipitous cliffs that vertically cleave the summits. In pre-Glacial times it is likely that this partially river-dissected escarpment of the Upper Old Red beds had a more subdued northern front. It was probably characterized by the features usually attributed to normal erosion, and not undercut by the agents of marine planation.

The Brecon-Beacon group was then most likely a matured residual hill-mass, with rounded summits and smooth-backed spurs drained by a system of rivulets, such as one would expect in a coarse-textured mountain district. But in Glacial times the region was effectively glaciated, and moving snow and ice spread outwards in all directions from the Brecon Beacons as the centre. In closing glacial times, however, the snow and ice lingered longest on the chilly north-north-eastward-facing slopes, and névé-reservoirs filled the valley-heads of river-genesis. The débris from the Beacons, which is scattered far and wide over the surrounding district, is sufficient evidence of the erosive and transportive power of moving ice, and the steep-cut head-walls of the cwms, the occasional moraine-contained lakelets, the valley-waterfalls that cascade over the rock-steps, and associated phenomena, are eloquent testimony of a by-gone glacial episode.

COTTESWOLD HILLS

Having explained the probable origin of certain cwms in Snowdonia, and the more opened-out amphitheatral hollows in the Brecons, we now come to one of the main objects of this paper, namely, to suggest that certain semi-circular combs in the Cotteswold Hills may have had a somewhat similar history. One of the most conspicuous of these semi-circular combs is that at Charlton Common—the eastern portion of the hill-mass of which Leckhampton Hill is the western.

Separating the Charlton-Common comb from others less noticeable on either side, are the remains of what, in pre-Glacial times, may well have been more massive round-backed spurs. Now, however, they are in parts sharpened, dislocated and dissected. In the hollows, and more particularly about the place where the steeper scarp of Inferior Oolite gives place to the gentler slope of the Upper-Lias clay, are noticeable belts of small-sized gravel, best described as "granular." Somewhat similar, but often coarser gravel, forms long drawn-out mounds beyond, and in the Charlton comb they trail converging-wise down the hollow. Above these belts of more granular gravel is relatively angular débris that has fallen in later times from the steep limestone-cliffs above, and is mixed now with quarry-spoil.

The Inferior Oolite is thickest on the sides of the main escarpment that roughly trends, first from north-east to south-west, and then southwards from Wotton-under-Edge to Bath. It is noticeable that all the amphitheatral hollows in this oft-incised north-east and south-west-aligned portion, face between north-west and north-east—the best-formed usually facing due north. And it is in such northerly or north-easterly-directed hollows that the gravel-deposits are most in evidence, for example, on Stinchcombe Hill, in the Dursley Valley under Break-Heart Hill, at Haresfield, in Witcombe Woods, and at Charlton Common.

While such amphitheatral combs and gravel-deposits are of frequent occurrence respectively in and on the hill-sides down in the vale there are extensive deposits of roughly-worn limestone and ironstone-fragments from the Lias and Oolites of the escarpment; quartzose sand, with a varying amount of well-rolled, and somewhat stratified gravel (made up of fragments also from the Oolite and Lias); and the so-called "Northern Drift," which comprises quartzite pebbles (obviously from the Bunter), pieces of flint, chert, etc.

The present distribution of these several types of Superficial Deposits—sometimes capping the undulations in the vale, and at others filling up inequalities in its surface, while clear-swept valleys often exist between—points emphatically to the conclusion that, previous to their distribution, while the main land-features were not widely different from what they are to-day, the actual surface of the vale-land was somewhat differently sculptured, and that while deepish valleys now lie buried beneath thick deposits of quartzose sand, valleys exist where once spread clay.

What precisely were the conditions that obtained in the Lower Severn Valley and the Cotteswold Hills during Glacial times is doubtful, and for the present purpose does not matter much, for certain points are obvious. One is that previous to the introduction of the foreign constituents of the Superficial Deposits af the Lower Severn Valley—and it will be sufficiently accurate to say, in pre-Glacial times—the actual surface of the vale was of somewhat different land-relief, and it is equally obvious that such was the case also with regard to the upland and its flanks.

Hence, restricting our attention to the hill-mass now called Leckhampton Hill and Charlton Common, it may be suggested that, in pre-Glacial times, it was a portion of a normally subdued escarpment, incised by the growing obsequents of the River Severn, whose numerous branching heads sprang from the valleys between rounded spurs on the hill-sides, and flowed Severnwards down well-graded slopes across an undulating vale-land.

But then came the Glacial Epoch. Over the inequalities of the vale were strewn the deposits of sand derived from further north, and snow collected on the hills, and especially in the many-branching stream-valley-heads in the hill-sides.

The snow, pushed down by the increasing fall above, plucked up and carried forward fragments of Inferior-Oolite and Liassic limestones, which it brought up against the deposits of yellow quartzose sand that were being introduced into this portion of the Vale. This appears probable, because the gravel of Inferior-Oolite and Liassic limestones usually fringes the deposits of quartzose sand on the escarpment side, while its entirely local origin is evidenced by the essentially local suite of derived fossils which it contains.

The fossils found in the gravel-pit at Charlton Kings could all have been derived from the hills immediately to the east. The smaller Jurassic fragments, however, that are found composing the lenticular and intermittent layers in the quartzose sands, may well have been derived from more northern sources—from the more northern portions of the Cotteswold Hills, including the Bredon outlier.

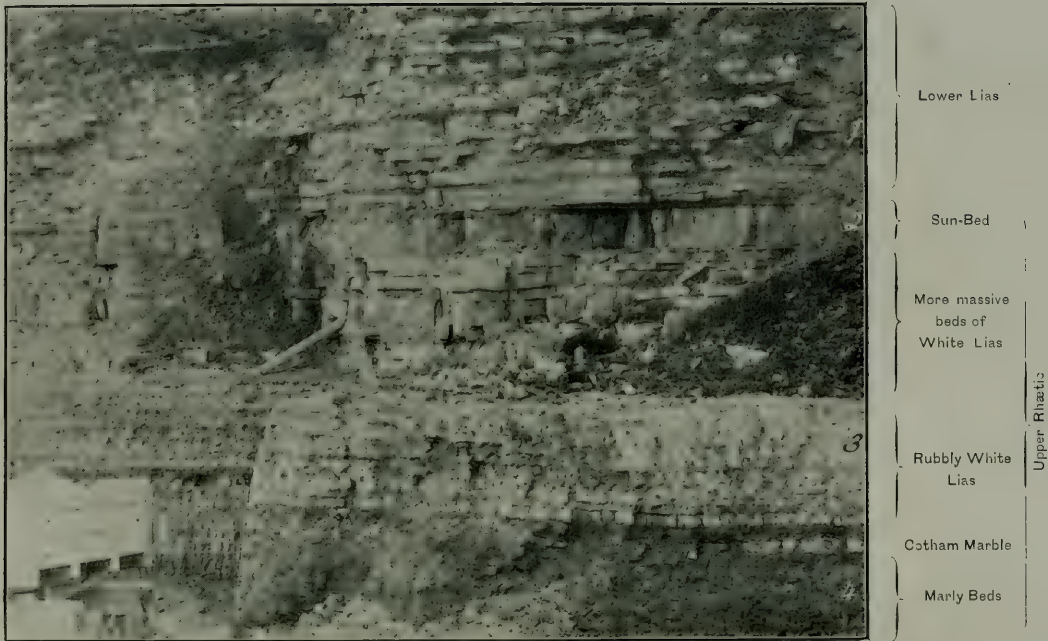
Snow lingered longest, in waning Glacial times, in the combs of the Cotteswolds that faced north, north-east and east, probably in the form of snow-banks.

Even now in winter snow lies longest on such chilly, sunless slopes as those of Charlton Common. During Glacial times the down-sliding snow would drive and carry forward much limestone-material. The penultimate products of the waning, hanging snow-bank may well be the elongate banks of gravel above referred to, and the ultimate products of the snow-bank the belt of granular gravel. If the rocks had been different in structure and dip, and the hills higher, there would probably have been a more cwm-like hollow with the equivalent to this gravel-belt impounding a small cwm-lake.

And so in closing Glacial times we may picture the snow accumulated in the great amphitheatre-like hollow of Charlton Common, and in those of its lesser neighbours, gradually working down, steepening the Inferior-Oolite scarps at the head of the combs, and sharpening the upper portions of the dividing and once rounded intervening spurs into incipient arêtes.

Another noticeable comb that opens northwards, and has oversteepened head-slopes, is that to the north of Wistley Hill, on the south side of the western entrance to the Dowdeswell wind-gap.

The suggestion that some other cause, other than ordinary excavation by the headward growth of streams, must be looked for to account for some of these Cotteswold combs, receives additional support when it is remembered how precipitous would be the back-walls of these combs if the head-cliffs were restored by the addition to them of the angular débris at their foot, and the belt of "granular" gravel were removed.



SECTION OF RHÆTIC AND LOWER-LIAS BEDS IN THE RAILWAY-CUTTING AT SALTFORD, NEAR BATH

(*J. G. Grey, photo.*)

NOTES ON A WHITE LIAS SECTION AT SALTFORD, NEAR BATH

BY THE

Rev. H. H. WINWOOD, M.A., F.G.S.

[Plate XIII.]

(Read December 14th, 1909)

During some alterations in 1909 for the extension of the sidings at the Saltford Station, between Bath and Bristol (on the Great Western Railway), a section of the whole Rhætic subdivision known as the White Lias was exposed on the left or south-west side of the line. As good exposures of this subdivision are rarely seen in the quarries of the district, I made several visits during the progress of the work, and measured the beds as they were gradually opened up. Since then, as walling of Pennant Sandstone has entirely concealed the section, the following notes may be a useful record.

The existence of White-Lias beds on the portion of the line between Saltford and the tunnel was well-known to William Saunders and Charles Moore, both of whom alluded to the sections. Indeed, until lately, the Sun-Bed (or top-bed of the White Lias) could be plainly seen on the lower part of the right bank as the train sped along to Bristol. After the section of White Lias on the Bath and Mangotsfield Railway, near the Weston Station, described by myself (Proceedings Bath Nat. Hist. and Antiq. F. C., 1871), and a smaller one at Kelston, on the same Railway, the one recently exposed at Saltford is the most important in this district.

As the Members of the Cotteswold Field Club may not be familiar with the controversy respecting the question whether these beds should be classed with the Lower Lias above, or the Rhætic Beds below, perhaps I may be permitted to allude to it shortly.

The name was introduced by William Smith in 1815, and was then used by the quarrymen, who saw how distinct the colour was from that of the blue beds of the Lower Lias above. In a paper contributed to the Geological Society (Quart. Journ. Geol. Soc., 1860, vol. xvi., p. 374), an eminent Member of the Cotteswold Club seems, in a hasty visit to the Beer-Crowcomb Section, near Ilminster, to have mistaken the true position of the White Lias with regard to the zones of the Lower Lias. In describing the *Planorbis*-Zone, he writes: "In general it consists of a series of thin greyish or bluish argillaceous limestones, with alternating beds of laminated shale; or sometimes the entire series forms a thick bedded argillaceous cream-coloured limestone called the 'White Lias' by William Smith." This statement called forth that classical paper of Charles Moore (Quart. Journ. Geol. Soc., vol. xvii., 1861), "On the Zones of the Lower Lias, and the *Avicula-contorta*-Zone," in which he clearly showed that a mistake had been made, and that the White Lias had been included in the *Planorbis*-Zone, whereas it occupied a much lower position. Moore attributed the mistake to the observer not recognising the greyish-white-looking bands of stone in the blue Lias quarry from the creamy limestones occupying a much lower position. Since then, the true position of the White Lias, as belonging to the top of the Rhætic Series, has been, with one or two exceptions, generally recognised.

With these few preliminary remarks I will proceed at once to describe the section.

The total thickness of the White-Lias beds (using this term in a broad sense, but to be more correct, Upper-Rhætic beds) was about 16 feet 4 inches, measuring, that is, from the lowest exposure of an 11-inch bed of White Lias up to the clay on the top of the "Sun-Bed" of William Smith. The fossils were by no means plentiful, but the usual casts of bivalves (*Modiola*, etc.), occurred in the broken up rubbly beds of the White Lias (No. 3 in the photograph, Pl. XIII.; No. 12 in the section on page 48). The blue clay below (No. 4 in the photograph, and No. 16 in the section) contained bands of shale literally covered with Ostracoda.

Attention should be directed to No. 1 in the section. Throughout the best exposures which have come to my notice in this immediate district, that arenaceous band invariably overlies the "Sun-Bed," showing a remarkable contrast between the dense white limestone beneath, which must have been deposited in deep water, and the sandy deposit of shallow-water origin above. The marine conditions must have altered considerably—as indicated by the fossils—for whereas the limestone is almost destitute of organic remains, the arenaceous shale above is crowded with *Ostrea liassica*. So that here, it appears to me, is the dividing line between the Rhætic White Lias and the basement-beds of the Lower Lias above.

The position of the Cotham Marble was not at first quite clear. I came to the conclusion, however, that a certain irregular indurated marly bed (No. 14 in the section), at the base of the Rubbly Beds—the surface knobbly and the interior veined with arborescent markings, resting on grey clay (No. 15)—represented the Cotham Marble. With reference to the change of conditions between the Rhætic and the Lower Lias, it has been noticed that, whilst the latter beds teemed with saurian life, the former presented no evidence of such life. The White Lias shows evidence of slow deposition, and of having been subject to erosion, as indicated by boring molluscs and their impressions on its surface. Many of the beds and intervening bands of clay were iron-stained and saturated with water. If the Rhætic Series can be divided, as Mr L. Richardson writes, into an upper and lower stage, in my opinion, the beds above described, from the "Sun-Bed" (No. 3 on page 48), but No. 2 in Plate XIII., to the solid bed No. 19, if not to No. 22, form a good example of the Upper Rhætic. The *Pteria* (*Avicula*)-*contorta*-Beds, which were not actually exposed in the section described, coming in below.

WHITE LIAS SECTION AT SALTFORD, NEAR BATH

		Thickness in feet	inches
Lower Lias	Lower-Lias limestones and thin shale-bands. (Some 12 or 13 thin beds of Lower Lias, with intervening bands of grey clay follow upwards from the "Sun-Bed." The blue Lias clay capping the top of the bank makes a strong contrast with the grey outside colour of the lower beds).		
	1. Arenaceous shale with *Ostrea liassica* ..	0	2
	(Dividing-line between Lias and Rhætic)		
White Lias	2. Yellow clay	0	3
	3. "SUN-BED." Hard white limestone ..	1	5
	4. Thin bed of limestone	0	2
	5. Limestone, massive	0	4
	6. Limestone, massive	0	2
Upper Rhætic	7. Limestone, massive	0	6
	8. Yellow clay parting		
	9. Limestone	1	0
	10. Rubbly bed; fossiliferous	1	0
	11. Solid bed	0	6
	12. Rubbly beds	3	0
	13. Grey clay	0	6
	14. COTHAM MARBLE	0	3
	15. Yellow or grey clay	0	5
	16. Light blue clay; Ostracoda	3	0
	17. Yellow irony clay	0	6
	18. Grey marl	0	4
	19. Solid bed, ferruginous on outside ..	1	0
	21. Grey marl	1	1
	22. Solid bed, irregular	0	11
		16	4

NOTE ON A WHITE-LIAS SECTION AT SALTFORD, NEAR BATH

BY

L. RICHARDSON

The section in the railway-cutting at Saltford near Bath, shows the sequence of beds from below the White Lias, through that subdivision, and thus into the Lower Lias. It is the usual sequence that obtains in the neighbourhood of Bath.

The *Ostrea*-Beds of the Lower Lias that cap the section are obviously of the usual type, and their line of demarcation from the top-bed of the White Lias (or "Sun-Bed") is very distinct—the peculiar arenaceous layer noticed by Mr Winwood parting them. I have elsewhere mentioned that the White Lias of South Gloucestershire and the neighbourhood of Bath and Radstock usually admits of division into an upper and more well-bedded portion, and a lower or more rubbly and fossiliferous part. This same dual subdivision is noticeable at Saltford.

The layer noticed by Mr Winwood as such is undoubtedly Cotham Marble. The clay-bed on top of it is interesting. In places in the Polden Hills the equivalent clay-bed is a very tough blue-black clay, and its obvious connection there with the Cotham Marble suggests that the clay-bed here above the Cotham Marble should be relegated to the division below rather than to the White Lias proper above. The pale light blue [*teste* Rev. H. H. Winwood] marly beds below the Cotham Marble teem with Ostracoda (*Darwinula liassica*, etc.), and are the equivalents of similar beds in the railway-cutting near Chipping Sodbury, described by Professor S. H. Reynolds and

Dr A. Vaughan, and of those at Sodbury Cliff noticed by myself. I think beds 21 and 22 are also probably Upper Rhætic.

The White Lias and subjacent "Upper Rhætic" beds of my previous papers, should, I think, be grouped together to form the Upper Stage of the Rhætic Series. The reason why the *Pteria-contorta* Black Shales, the "Upper Rhætic" of my former papers, the White Lias, and the Lower Lias limestones are usually so distinctive from one another, both as regards faunal and lithic characters, is, because in most sections they are non-sequentially related.

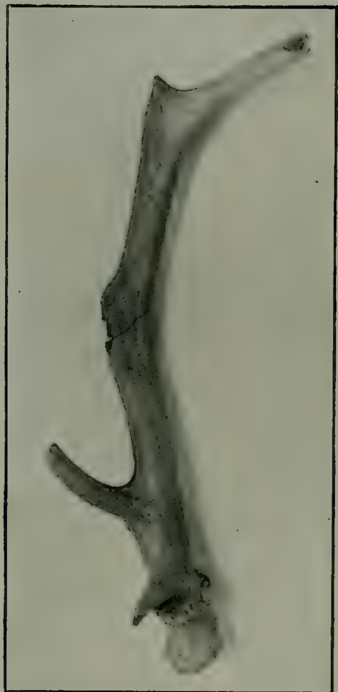


Fig. 1.—ANTLER OF RED DEER FROM THE GRAVEL-BED AT STANLEY DOWNTON

(Length measured outside the bend, 28 inches)

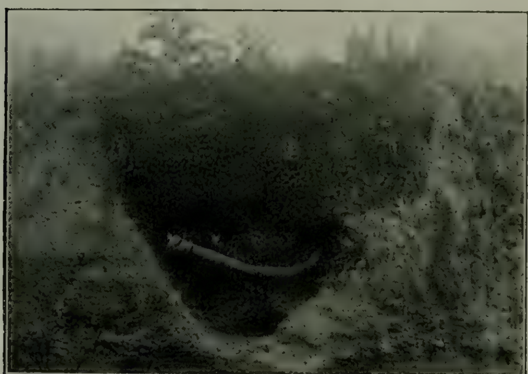


Fig. 2.—THE ANTLER *in situ*

(*C. Upton, photo.*)

NOTES ON AN ANTLER OF A RED DEER FROM THE GRAVELS AT STANLEY DOWNTON, NEAR STROUD

BY

CHARLES UPTON

[Plate XIV.]

(Read January 18th, 1910)

The Antler, the subject of this note, was found some years ago in the Stanley-Downton Gravel-pit. The pit is situated in an elevated patch of gravel lying between King Stanley and Leonard Stanley. The antler was not imbedded in the gravel itself, but was found in what appeared to be a "trough" or depression in the gravel. Nothing was observed to indicate whether the "trough" had been formed artificially or by natural agencies, although the former would appear to be the most likely. The depth of the "trough" would be about three feet, and the antler was lying approximately two feet below the surface. There was nothing on the surface to point to the existence of the "trough," which was filled in with a dark reddish infilling, consisting of an admixture of surface-soil and pebbles from the gravel. No flints or other bones were observed, but about two or three broken shells of *Helix nemoralis* were embedded in the infilling material. In this connection it should, however, be mentioned that circumstances prevented the further investigation of the "trough," so that its extent and purpose could not be ascertained. The illustration (Pl. XIV. fig. 2) is from a photograph taken before the antler was completely extracted; while fig. 1, Pl. XIV. shows the antler in its present condition. That it was not shed in the annual moult is shown by the circumstance that the basal portion remains attached, and it will be noticed that at the base, and quite close to the attachment to the skull of the animal, are two cuts, such as might have been made with a heavy and somewhat sharp-edged weapon, and that the brow-tine has been splintered off in precisely the manner which would have occurred if the weapon which caused the cuts had struck it in its descent. Moreover, the blows were given just where they would be most likely to kill or disable the animal The third and fourth tines have also disappeared; the fracture of the fourth is left in a rough condition, but the scar from which the third has been removed shows obvious traces of having been scraped or rubbed smooth. The hypothesis which I put forward, albeit with some hesitation, is that the animal which bore the antler was killed or stunned by blows on the head, the marks of which remain, and that the antler, after removal from the skull, was itself converted into a club-like weapon by the removal of such of the projections as would have interfered with its use as such.

GEOLOGICAL INFORMATION OBTAINED DURING THE CONSTRUCTION OF THE HATHERLEY AND ARLE SEWERS AT CHELTENHAM

BY

L. RICHARDSON

(Read January 18th, 1910)

During the past few years the Cheltenham Corporation has laid two extensive sewers to its sewage-farm at Haydon. The one runs from the sewage-tank near Dean Close School, and the other from that near the Electric Light Works.

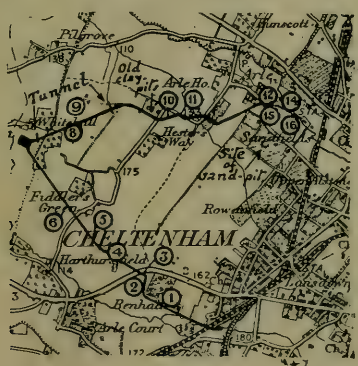


FIG. 1—Map (1 inch = 1 mile) to show the courses of the sewers.

A sketch-map is given to show the courses of these sewers (text-fig. 1). Geologically, the sewers are in the Lower Lias, except for a space of about half-a-mile immediately to the west of the Electric Light Works, where the Arle Sewer is in sand (Superficial Deposits). The following fossils were collected at the places indicated on the map by the corresponding figures: *Oxynotoceras oxynotum* (1); *Arietites turneri and Asteroceras* cf. *brooki* (Sow.) (2); *Vermiceras landrioti* (d'Orb.) (3); *Pleurotomaria anglica*, Sow. (4); *Arnioceras hartmanni* (Oppel) (5); and *Gryphæa arcuata*, common (6).

In all, evidence of seven Liassic zones was obtained, namely, those laid down during the hemeræ *marmoreæ*, *rotiformis*, *gmuendensis*, *birchi*, *turneri*, *obtusi*, and *oxynoti*.

Hatherley Sewer.—There is nothing to record with regard to this Sewer beyond what is appended to the map (text-figure 1), and the information given above.

Arle Sewer.—I am indebted to Mr Edwin Earp for the following details concerning this sewer:—

"The new outfall sewer from the Arle Tanks adjoining the Refuse Destructor and Electric Light Works, will convey most of the sewage from Charlton Kings and Cheltenham to the Corporation Sewage-Farm at Haydon, on the western border of the borough. The route is *via* Hester's Way and Arle Village, and is about two miles in length, with a gradient in the sewer of 1 in 800. From Haydon Farm to Arle Village (about two-thirds of its length) the sewer is egg-shaped in section, measuring 3 ft. 9 ins. by 2 ft. 6 ins. internally, and is constructed of concrete in the invert half lined with bricks; while the upper portion is a double-ring brick-arch. The depth at which it is laid varies from 6 feet to 40 feet, and in this section the excavations were chiefly in stiff blue Lias clay. Where the depth ranged from 15 ft. to 40 ft. between Haydon Farm and Hester's Way, the sewer was constructed in tunnel, with pits about one hundred feet apart. The excavation and the work generally in-tunnel was greatly impeded by the presence of rock and water. The first few feet of excavation consisted of loamy and gravelly clay, followed by stiff clay, and a seam of rock was met with at 12 feet deep, and springs of water at about 23 feet deep, after which rock was again met with in places. From Arle Village to the Arle Tanks the sewer is of 30-inch diameter stoneware pipes, and is laid on and partly surrounded with concrete; it has a gradient of 1 in 242, with a depth varying from 6 to 14 feet. The subsoil in this section is of sand, varying in depth from 3 to 11 feet, with hard blue clay underlying it, and a large quantity of water on top of the blue clay.

"The total cost is about £12,000."

The heaviest piece of work, as will be understood from the above, was the tunneling through the hill immediately to the west of Whitehall Farm (8). The tunnel for its entire length was through tough blue Lias clay. Some impure limestone-nodules occurred in the clay, and the fossils obtained from it were *Coroniceras meridionalis* (Reynes), *Ætomoceras colesi* (J. Buckman), *Agassizoceras sauzeanum* (d'Orbigny), *Plagiostoma gigantea*, Sowerby, and *Gryphæa arcuata:* the ammonites indicating *rotiformis-birchi* hemeræ. The last two fossils are quite common on the surface of the field at the place indicated by the figure (9) on the map.

Several of the tunnel working-shafts proved the presence of a superficial deposit of gravel and some sand upon the Lias clay. From the base of the Superficial Deposit issued forth a considerable quantity of water, and water also came out from the clay at about 23 feet down. Except for this, the tunnel would have been remarkably dry, for it was extraordinary how little water there was in the blue clay other than hydroscopic.

In the field north of Hester's-Way Farm [1] (10) the clay dug out yielded numbers of specimens of *Dentalium parvulum*, Richardson (*ex* J. Buckman, MS.), *Actæonina* sp., *Cerithium* sp., and fragments of *Arietites turneri* (Sow.) Fragments of ammonites of the same species were found in the clay dug out of the trench where it followed the road (11); while *Gryphæa arcuata* occurred sparingly in the selenitic clays exposed in the trench where it cuts across the field so as to avoid the bend of the road. Here also were found many saurian vertebræ.

The trench crosses the Arle Road where the sand and clay meet, but along the lane up which it is continued the junction is complicated by clay that has been tipped. At the stile there is four feet of sand; but then, for some 30 yards before it turned north-eastwards, the trench exposed patches of sand with tipped clay above. In the field to the north-east,

1 Formerly there was a clay-pit one-sixth of a mile to the north of this farm, but it has been filled up with gas-lime from the Cheltenham Gas-Works.

at about a quarter of the way across it, the sand is very pure and yellow (6 feet) and rests upon very dark blue Lower-Lias clay. The sand is continuous across the field, and has a little well-rolled, small-sized Jurassic gravel mixed with it. A similar deposit was proved where the sewer runs alongside the Sandfield Road; but where it leaves that road (12), blue Lias clay occurs very near to the surface. The sand-bed, however, is soon entered again (13), and, as far as the number 14 on the map (text-fig. 1), is beautiful pure sand, with but little gravel mixed with it. At 14, however, the surface of the sand-bed was seen to decline (in the section) under an increasing thickness of yellow, blue-blotched clay with calcareous layers—a deposit of the brook near at hand. At the brook the sand-bed rises up again, so that on the left bank a few feet only of re-deposited clay occurred on top of the sand, and on the right bank none. From the bed of the Chelt some very dark-blue, clayey humus was dug out. It is useful to know the relations of the yellow blue-botched clay to the sand-bed, and it is obvious that the sand-bed has had a broad shallow hollow excavated out of it by the Chelt, and this hollow has been filled up by alluvial material—in the present case, mainly this pale-coloured clay.

THE BOTANY OF THE COUNTRY ROUND BUILTH WELLS

(COTTESWOLD CLUB MEETING, 12th to 15th July, 1909)

BY THE

Rev. H. J. RIDDELSDELL, M.A.

The botanical character of the district covered is singularly uniform: perhaps chiefly on account of the absence of limestone of every kind. The geological formation is Silurian and Ordovician (for botanical purposes identical), with intruded igneous rock near Builth itself. The only variation introduced into the uniformity of the botanical aspect of the country is due to the presence of water: in the form of hill bogs, streams, rivers, lakes. The flora is at once enormously enriched by this new feature: more particularly, the banks and rocks of the Wye afford a wonderful series of rare and interesting plants.

The ground examined on the 12th by a small party which arrived early, was the hill Carneddau, close to Builth, in Radnor county. The igneous rock referred to above forms the main part of the hill. The flora is characteristically of the heath-type, and reminds the botanist strongly of that of the Malverns, though it is apparently less rich. The only parts of Gloucestershire which we can compare with such a country are the coal-fields of Bristol and the Forest of Dean, together with the tail end of the Malverns, which comes into the county near Bromsberrow. The Cotteswold Hills and the Vale of Gloucester nowhere show such an association of plants, many of which only occur there with the utmost rarity, while a few are probably absent altogether. What has been said of Carneddau applies also to the other districts investigated by the Club during its stay at Builth. The basis of the flora in each case was ericetal: the divergences from this type were few: the main body of plants seen each day was the same. For instance, after looking at *Matricaria suaveolens* Buch. by the roadside, a rapidly-increasing American alien, we got at once, on Carneddau, into a mass of *Viola Riviniana* Reichb., *Stellaria graminea* L. in a large flowered form which seems common this year, *Linum catharticum* L., *Ulex Gallii* Planch., *Potentilla erecta* Hampe, *Alchemilla arvensis* Scop., *Galium saxatile* L., *Campanula rotundifolia* L., *Vaccinium Myrtillus* L., *Calluna vulgaris* Hull, *Veronica officinalis* L., *Pedicularis sylvatica* L., *Thymus Serpyllum* L., *Rumex Acetosella* L., *Juncus squarrosus* L., *Carex pilulifera* L., *Agrostis tenuis* Sibth., *Aira caryophyllea* L., *A. præcox* L., *Deschampsia flexuosa* Trin., *Sieglingia decumbens* Bernh., *Festuca ovina* L., *Nardus stricta* L., *Pteris*, and *Blechnum*. Among these common heath plants were noted also the following scarcer species:—*Viola canina* L., *Polygala oxyptera* Reichb., *Mœnchia erecta* Gaertn., in some plenty; *Sagina apetala* Ard., *Genista tinctoria* L., *Ornithopus perpusillus* L., *Vicia angustifolia* L., *Rosa tomentosa* (aggregate), *Sedum anglicum* Huds., in great quantity; *Sherardia arvensis* L., *Filago minima* Fr., *Wahlenbergia hederacea* Reichb., *Myosotis versicolor* Sm., *Verbascum Thapsus* L., *Plantago lanceolata* L., var: *sphærostachya* Röhl., *Orchis ericetorum* Linton, *Carex contigua* Hoppe, *Festuca bromoides* L. In wet places of various kinds, chiefly bogs, we saw *Ranunculus hederaceus* L., *Caltha palustris* L., *Viola palustris* L., *Lychnis Flos-cuculi* L., *Stellaria uliginosa* Murr., *Hypericum elodes* L., *Lotus uliginosus* Schkuhr, *Potentilla palustris* Scop., *Epilobium palustre* L., *Galium palustre* L., var: *Witheringii* (Sm.) which seems the commonest form of this species; *Valeriana dioica* L., *Senecio aquaticus* Hill, *Menyanthes trifoliata* L., *Myosotis repens* G. & D. Don, *Juncus bufonius* L., *J. bulbosus* L., *Potamogeton polygonifolius* Pourr., *Eriophorum angustifolium* Roth., *Carex pulicaris* L., *C. echinata* Murr., *C. panicea* L., *C. Œderi* Retz, var: *œdocarpa* And., *C. inflata* Huds., *Glyceria fluitans* Br.

The list of plants on this hill was afterwards enlarged by the addition of *Lepidium heterophyllum* Benth., var: *canescens* (Gren. & Godr.), *Dianthus deltoides* L., *Malva moschata* L., *Trifolium medium* L., *Sedum purpureum* Tausch., *Jasione montana* L., *Melampyrum pratense* L., *Polypodium vulgare* L.

The morning of the 13th was spent by the same advance party by the side of the Wye at Boughrood (Breconshire), where the main party was joined on the arrival of the 2 o'clock train. *Fumaria officinalis* L., and two other species were found close to the station, in Radnorshire. The bridge over the Wye had seven ferns growing upon it, viz., three common species of *Asplenium*, *Ceterach*, *Phyllitis*, *Polystichum aculeatum* Roth., and *Polypodium vulgare* L. Close by, on the Radnorshire side, was more of *Matricaria suaveolens* Buch.

The botany of the river banks is very rich indeed. Above the flood mark, on the Breconshire side, the flora is again characteristic of heathy ground, and includes *Hypericum pulchrum* L., *Cytisus scoparius* Link., *Lathyrus montanus* Bernh., *Potentilla erecta* Hampe, *Serratula tinctoria* L., *Campanula rotundifolia* L., *Digitalis purpurea* L., *Melampyrum pratense* L., var: *hians* Druce, *Listera ovata* Br., *Deschampsia flexuosa* Trin., &c. In the same locality is also found *Orobanche major* L., growing on *Cytisus; Malva moschata* L., *Prunus avium* L., *Rhinanthus Crista-galli* L., *Primula vulgaris* Huds., *Euphorbia amygdaloides* L., *Habenaria bifolia* Br., *Orchis maculata* L., *Festuca elatior* L. But the richest ground by far is the steep-wooded bank, reaching down to the water-washed rocks in the river. The following list of plants is in illustration :—*Thalictrum minus* L., var: *odoratum* (Gren. & Godr.), *Caltha palustris* L., *Saponaria officinalis* L., a probable introduction; *Hypericum maculatum* Crantz, *Geranium pratense* L., *Epilobium obscurum* Schreb., *Sedum purpureum* Tausch., *S. anglicum* Huds., *Galium Cruciata* Scop., *Valeriana sambucifolia* Mikan., *Senecio aquaticus* Hill, *Solidago Virgaurea* L., *Tanacetum vulgare* L., *Arctium minus* Bernh., *Lactuca muralis* Gaertn., *Hieracium vagense* Ley, *H. acroleucum* Stenstr., var: *mutabile* Ley, *H. scanicum* Dahlst., *Campanula latifolia* L., *Myosotis repens* G. &. D. Don, *Clinopodium vulgare* L., *Stachys palustris* × *sylvatica* (= *ambigua* Sm.), by the bridge; *Lysimachia vulgaris* L., *Allium vineale* L., *A. Schœnoprasum* L., *Luzula sylvatica* Gaud., *Phalaris arundinacea* L., *Poa nemoralis* L., *Agropyron caninum* Beauv., and beautiful forms of *Phleum pratense* L., and *Cynosurus cristatus* L., with very long delicate filaments, such as is sometimes found especially in more Northern latitudes. *Alchemilla vulgaris* L., type (i.e. *pratensis* Pohl.), was found on river gravel on the Radnorshire side; and *Papaver dubium* L., and *Linaria minor* Desf. near the railway station.

In the afternoon the whole party saw something of the same type of flora on the Wye rocks, &c., above Builth, in Radnor county, with the addition of *Lepidium heterophyllum* Benth., var. *canescens* (Gren. & Godr.), *Solidago Virgaurea* L., var: *cambrica* (Huds.), *Festuca bromoides* L., *F. elatior* L., var. *arundinacea* (Schreb.) and a white-flowered form of *Allium Schœnoprasum* L.

On the 14th the whole party went to Rhayader; did something at the botany of the Elan Valley, and of Llyn Gwyn Gweddw, near Rhayader. The flora was mainly that of elevated heaths: the hill bogs added some interesting plants. The most interesting additions to the typical list already given are *Ranunculus Lenormandi* F. Schultz, at the very top of the pass; *R. Flammula* L., *Viola palustris* L., *V. lutea* Huds., in great plenty, and almost wholly the pure yellow form; *Polygala vulgaris* L., *P. serpyllacea* Weihe, *Montia fontana* L., var. *minor* All., *Hypericum maculatum* Crantz, *H. humifusum* L., *H. pulchrum* L., *H. elodes* L., *Cytisus scoparius* Link., *Lotus uliginosus* Schkuhr., *Rosa tomentosa* (aggr.), *Rosa canina* L., var. *dumalis* (Bechst.), *Cotyledon Umbilicus-Veneris* L., *Drosera rotundifolia* L., *Epilobium angustifolium* L., *E. obscurum* Schreb., *Hydrocotyle vulgaris* L., *Galium palustre* L., var. *Witheringii* (Sm.), *Jasione montana* L., *Wahlenbergia hederacea* Reichb., *Erica Tetralix* L., *Euphrasia brevipila* Burnat and Gremli, *Pinguicula vulgaris* L., *Stachys officinalis* Trev., *Teucrium Scorodonia* L., *Rumex Acetosella* L., *Orchis ericetorum* Linton, *Narthecium ossifragum* Huds., *Scirpus cæspitosus* L., *Eriophorum vaginatum* L., *E. angustifolium* Roth., *Carex contigua* Hoppe, *C. echinata* Murr., *C. leporina* L., *C. Goodenowii* Gay, *C. pilulifera* L., *C. panicea* L., *C. binervis* Sm., *C. flava* L., *C. hirta* L., *C. inflata* Huds., *Aira caryophyllea* L., *A. præcox* L., a short-leaved form of *Deschampsia cæspitosa* Beauv., *Molinia cærulea* Moench. The lake and its swampy margin produced *Caltha palustris* L., *Nymphæa lutea* L., *Potentilla palustris* Scop., *Poterium officinale* A. Gray, *Epilobium palustre*

L., *Valeriana dioica* L., *V. sambucifolia* Mikan, *Achillea Ptarmica* L., *Lobelia Dortmanna* L., *Menyanthes trifoliata* L., *Myosotis repens* G. & D. Don, *Potamogeton natans* L., *P. polygonifolius* Pourr., *Carex curta* Good.

The morning of the 15th took us to Aberedw, with its typically ericetal vegetation, the Edw gorge, and Wye banks, and the great Aberedw rocks. The chief plants of the day were *Ranunculus fluitans* Lam., in the river; *Meconopsis cambrica* Vig., *Hypericum perforatum* L., *H. pulchrum* L., *Geranium molle* L., *G. dissectum* L., *G. lucidum* L., *Trifolium arvense* L., *Vicia hirsuta* Gray, *V. Orobus* D.C., *Lathyrus montanus* Bernh., *Spiræa Ulmaria* L., var: *denudata* Boenn., *Rosa obtusifolia* Desv., *Saxifraga hypnoides* L., *Cotyledon Umbilicus-Veneris* L., *Sedum purpureum* Tausch., *S. anglicum* Huds., *S. reflexum* L., *Circæa lutetiana* L., *Sanicula europæa* L., *Œnanthe crocata* L., *Heracleum Sphondylium* L., var. *angustifolium* Huds., *Asperula odorata* L., *Petasites ovatus* Hill, *Hieracium lasiophyllum* Koch, *Lactuca muralis* Gaertn., *Jasione montana* L., *Campanula latifolia* L., *Mentha gentilis* L., *Galeopsis Tetrahit* L., *Alisma Plantago-aquatica* L., *Melica nutans* L., *Poa nemoralis* L., *Bromus giganteus* L., the three common species of *Asplenium*, *Athyrium Filixfœmina*, *&c.*

A fair number of these plants are of great rarity, and more still are of special interest to Gloucestershire botanists, because they are so rarely seen in that county. *Mœnchia*, *Sedum anglicum*, *Wahlenbergia*, *Ranunculus hederaceus*, *Potentilla palustris*, *Dianthus deltoides*, *Sedum purpureum*, *Orobanche major*, *Thalictrum minus*, *Hieracium vagense*, *H. lasiophyllum*, *Campanula latifolia*, *Allium Schœnoprasum*, *Viola lutea*, *Drosera*, *Pinguicula*, *Narthecium*, *Lobelia*, *and Meconopsis*—to select only a few—are all interesting in this respect. Indeed, it seems that *Campanula latifolia* and *Orobanche major* are new discoveries for Breconshire; and *Viola canina*, *Valeriana dioica*, *Lobelia*, *Carex contigua and C. inflata* for Radnorshire.

THE INFERIOR OOLITE AND CONTIGUOUS DEPOSITS OF THE SOUTH COTTESWOLDS*

BY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

[Plates XV.-XXI.]

CONTENTS

I.—Introduction.

In previous papers I have described in detail the Inferior-Oolite and contiguous deposits of the Bath-Doulting[1] and Rissington-Burford districts.[2] Between these two, however, is an upland tract of considerable extent where Inferior-Oolite rocks occur. It embraces the South, the greater part of the Mid, and the North Cotteswolds.

The Inferior Oolite of the northern portion of the South Cotteswolds, and of certain sections still further south, has

* This paper was communicated on November 13th, 1906, but some additions have since been made.

1 Quart. Journ. Geol. Soc., vol. lxiii. (1907), pp. 383-436.

2 *Ibid.*, pp. 437-443. The Burford-Rissington district is in the Mid Cotteswolds, but it has been already described.

received considerable attention at the hands of several geologists: that of the Mid Cotteswolds is fairly well known; but that of the North—excepting of the Cleeve-Hill plateau—still requires a considerable amount of attention.

It is proposed, therefore, to deal with the Inferior Oolite and contiguous deposits of the Cotteswold Hills in two papers. The first and present one describes the stratigraphy of the beds in the South Cotteswolds, and shows the connection between these beds and those in the Bath-Doulting district, and through them with those in Dorset and Normandy. The second will deal with the beds of the same Series in the Mid (*pars:* see footnote on page 63) and North Cotteswolds, and on the one hand will show their connection with the South-Cotteswold rocks, and on the other with the beds in the Rissington-Burford district.

(i.) *Geographical Extent of the Inferior Oolite in the South Cotteswolds.*—The South Cotteswolds are twenty-four miles long, and extend from Lansdown, near Bath, to Rodborough-Hill, near Stroud.

In the neighbourhood of Bath, deep ramifying valleys run far northwards into the hill-country; but from Tog Hill, near Doynton, as far north as Hillsley, the escarpment is free from noticeable combs. Between this latter locality and Uley Bury, however, the upland is again greatly incised, and long straggling hills alternate with deep sinuous valleys. Thence northwards, as Lycett wrote, "the heights are much more wall-like, affording on their summit a pleasing variety of bare ground, of oolite quarries and of beech woods," and terminate in Selsley Hill, which overlooks the populous vale of Stonehouse. To the east is the Nailsworth Valley, which is separated from the deep, canal-like Chalford Valley by Rodborough Hill and Minchinhampton Common.

In the South Cotteswolds, in the southern portion, the Inferior-Oolite rocks do not give rise to any very striking features. This is due, partly to the fact that they occur at a comparatively low altitude; partly to their thinness; and partly again to the thick succeeding deposits of Fullers' Earth and Great Oolite diverting the eye from any small feature they might make. As the hills are followed to the north, however, the altitude at which the Inferior-Oolite beds crop out rises; the outcrops of the Fullers' Earth and Great Oolite recede, and, as a result, the superficial extent of the Inferior Oolite broadens.

(ii.) *Historical Retrospect.*[1]—When correlations of the South-Cotteswold Inferior-Oolite rocks have been attempted, and this remark particularly applies to the "Top-Beds," they have been none too successful; but this is not altogether to be wondered at, for the stratigraphy is by no means easy to make out—the rocks at the southern end approximating to those of the Bath-Doulting district, and those at the northern end to those in the Mid Cotteswolds, while in the intervening area the transition between the two takes place.

The first definite reference to the geology of the South Cotteswolds is contained in Conybeare and Phillips' "Outline of the Geology of England and Wales" (1822), but they do nothing more than simply describe the trend of the hills between Stroud and Bath, and remark that they "appear to be generally capped by the Great Oolite, and to exhibit the strata we are now describing [that is, the Inferior Oolite] in their escarpment." (*loc. cit.*, p. 251).

Between 1822 and 1850 there appeared Murchison's "Outline of the Geology of Cheltenham" (1834); his "Silurian System" (1839); and a second edition of the former work "augmented and revised by H. E. Strickland and James Buckman" (1844, Cheltenham; 1845, London). All these works contain remarks on the Inferior Oolite, but are confined to the Cheltenham district.

Their influence on South-Cotteswold geology, however, is clearly indicated in the Rev. P. B. Brodie's paper of 1850, "On Certain Beds in the Inferior Oolite, near Cheltenham,[2] in which reference is made to Selsley Hill. It shows that considerable subdivision of the Inferior Oolite had been accomplished. Brodie was unable to decide if what are now called the *Scissum*-Beds, Lower Limestone and Pea-Grit were represented at Selsley; but observed the Oolite Marl, "somewhat reduced in bulk" and full of *Nerinæa* and other shells, overlaid by "flaggy bastard freestone"—the Upper Freestone of present nomenclature. Between the Upper Freestone and

1 The section on Plate XXI. should be studied before reading the Historical Retrospect.
2 Quart. Journ. Geol. Soc., vol. vi. (1850), pp. 239-249.

Upper *Trigonia*-Grit, Brodie thought there came "a coarse kind of freestone about 50 feet thick, which took the place of the Gryphite-Grit and rubbly oolite [*Buckmani*- and Lower *Trigonia*-Grits]" of such places as Leckhampton Hill; but judging from some remarks made later by Lycett, it was the Lower Limestone to which Brodie was referring, having wrongly interpreted its stratigraphical position.

To Brodie's paper were appended "Notes on a Section of Leckhampton Hill," by H. E. Strickland.[1] In this appendix Strickland recorded seven subdivisions of the Inferior Oolite at Leckhampton Hill: those enumerated in the left-hand column below:

Subdivisions at Leckhampton Hill	Lycett's three main subdivisions
1. *Trigonia*-Grit	Upper Ragstone
2. Gryphite-Grit	
3. Rubbly Oolite, with many fossils	
4. Fragmentary oolitic freestone ..	Freestone
5. Oolite Marl	
6. Freestone	
7. Pea-Grit and Belemnite-Bed ..	Lower Rag[stone] and Sands

Brodie's paper was communicated on January 9th, 1850. On July 30th of the same year, Lycett read one entitled "A Tabular View of Fossil Shells from the middle divisions of the Inferior Oolite in Gloucestershire."[2] In connection with the present subject, the chief point of interest is that he made three main subdivisions of the Inferior-Oolite Series—those stated in the right-hand column above.

He also made a very laudable attempt to indicate the changes that these three subdivisions underwent from north to south. According to him, the lowest subdivision, the Lower Ragstone and Sands, increases in thickness from two feet at Leckhampton Hill to 40 feet at Stroud, and 70 feet at Bath. The median or Freestone subdivision, he writes, "is somewhat diminished at Stroud, and loses the greater portion of its volume, including the Oolite Marl and all the upper beds before it reaches Bath, where it is represented by 60 feet of freestone" (*loc. cit.*, p. 65). The Oolite Marl, it is true, dies out a short distance to the south of Selsley Hill, and the Pea-Grit disappears as an easily-recognizable horizon after Coaley

1 Quart. Journ. Geol. Soc. vol. vi. (1850), pp. 249-251.
2 Proc. Cotteswold Nat. F. C., vol. i. (1849-53), pp. 62-86.

Wood; but the "disappearance" of the Freestone subdivision is more complete than this. In the neighbourhood of Bath the *whole* of it has gone, and the Upper *Trigonia*-Grit rests directly upon the Upper-Lias sands. The freestone of the Bath district, referred to by Lycett, is a supra-Upper *Trigonia*-Grit Inferior-Oolite deposit—not an inferior one. Lycett also wrote that the Upper Ragstone disappeared *altogether* to the south of Wotton-under-Edge. This is not quite correct: all except the Upper *Trigonia*-Grit do; but this subdivision is continuous from Stroud to the immediate neighbourhood of the Mendips.

In 1856, the attention of students of the Inferior Oolite and Lias was directed by Dr Thomas Wright to the question as to where the precise line of demarcation between Lias and Oolite should come. Dr Wright gave excellent records of the sections at Frocester and Wotton-under-Edge, and was the first to apply the term "Cephalopod-Bed" to the richly ammonitiferous deposit that occurs at the base of obviously Inferior-Oolite rocks in these sections. He grouped it, together with the Cotteswold Sands, with the Lias.[1]

James Buckman, in a paper on "The Oolite Rocks of Gloucestershire and North Wilts," published in 1857,[2] however, strongly objected to Wright extending the Upper Lias so as to include the Sands and Cephalopod-Bed, because he thought that the Sands and Cephalopod-Bed were the equivalents of the "mixed pisolitic beds" of the neighbourhood of Cheltenham. No doubt his erroneous correlation arose from the idea that what is now called the Lower Limestone at such sections in the South Cotteswolds as Frocester Hill was equivalent to the Lower Freestone of such localities as Leckhampton Hill, and since the Pea-Grit Beds came *below* the Lower Freestone at Leckhampton, their equivalents in the Stroud district must be looked for *below* the Lower Limestone.

The same year saw the production of two memoirs intimately concerned with the Inferior Oolite of the Cotteswold Hills. The one was by Prof. E. Hull on "The Geology of the Country around Cheltenham" (Mem. Geol. Surv.); and the other was by Dr J. Lycett, entitled "The Cotteswold Hills."

1 Quart. Journ. Geol. Soc., vol. xii. (1856), pp. 292-325.
2 *Ibid.* (1858), pp. 98-130.

Until the appearance of the former work the subdivision now known as the *Clypeus*-Grit had not attracted any particular attention; but then Hull remarked that "towards the south-eastern part of the district, the Ragstone gives place to a coarse, rubbly, white oolite, which always occurs at the top of the formation immediately below the Fullers' Earth. This bed, which may be called the *Clypeus*-Grit, is characterised by many of the fossils of the Ragstone."

Lycett, in his "Cotteswold Hills," dealt in some detail with the Inferior-Oolite Series as a whole, introducing the classic—if now seldom-used terms "*Cynocephala*-," "*Fimbria*-," and "*Spinosa*-Stages."[1] The first term covered the "Sands" and Cephalopod-Bed: the second, the beds between the Cephalopod-Bed and Ragstones; and the third, the Ragstones. Lycett, like Hull, had noticed that "the beds of the '*Spinosa*-Stage' higher than the Upper *Trigonia*-Grit," were worthy of separate designation, and suggested the appellation "*Pholadomya*-Grit" for them; but as Hull's term "*Clypeus*-Grit" has priority by a few months, it is the one that should be used. Lycett's correlation of his three stages with the deposits at Dundry Hill, near Bristol, was unsuccessful, and his comparison of the beds, which are now known to be *Buckmani*- and Lower *Trigonia*-Grits, at Rodborough Hill, was equally unfortunate.

In 1858, in the joint memoir by A. C. Ramsay, W. T. Aveline, and Prof. E. Hull on the "Geology of Parts of Wiltshire and Gloucestershire," the *Clypeus*-Grit of Rodborough Hill is spoken of as the "Upper Ragstone," and the subjacent beds of the "*Spinosa*-Stage" there as the "Lower Ragstone"; while a thickness of 25 feet is assigned to the latter.[2] At Wall's Quarry, north of Minchinhampton, however, the thickness of the "Lower Ragstone" is given as only 9 feet, but "this fact" is stated to be "in harmony with the observed alternation of the Inferior Oolite, both towards the east and south from Leckhampton Hill, the typical section of the formation."

The year 1858 saw the completion of Dr A. Oppel's "Die Juraformation Englands, Frankreichs, und des Südwestlichen

1 "Cotteswold Hills," p. 72. 2 *Loc. cit.*, p. 10.

Deutschlands," in which work the author draws the line between Lias and Oolite immediately below his *Torulosus*-Zone. This is the present *Moorei-aalensis* deposit, so that it follows that he considered the line of division between the Lias and Oolite to come between the *Moorei*- and *Dumorticria*-Beds.

On February 15th, 1859, Sir William V. Guise communicated his valuable "Notes on the Inferior Oolite Beds in the Neighbourhood of Bath."[1] In it, he pointed out that the Inferior-Oolite freestones of that neighbourhood, and of Dundry Hill as well, were not equivalent to the *Fimbria*-Stage as Lycett had suggested, but came above, instead of below, the Upper *Trigonia*-Grit. Having made this important correction, however, he fell into the error of correlating the Inferior-Oolite freestones of the Bath district with the Dundry Freestone, not noticing that whereas the former came *above* the Upper Coral-Bed the latter came *below*.

Wright, in his paper of 1860, "On the Subdivisions of the Inferior Oolite in the South of England, compared with the equivalent beds of that formation on the Yorkshire Coast"[2]—which marked a very great advance in our knowledge of the Inferior-Oolite rocks of this country, and was an excellent attempt to effect more widely-extended correlation—placed 2 feet 6 inches of "Intervening-Beds" at Rodborough Hill as Gryphite-Grit, and 1 foot as Lower *Trigonia*-Grit. His ideas were no doubt somewhat influenced by Lycett, who held that *all* the "Intervening-Beds" at Rodborough belonged to the Gryphite-Grit. As to the age of the Inferior-Oolite freestones near Bath, he thought that they probably belonged to the "upper subdivision," but was not very emphatic about the matter.

Dr H. B. Holl, in his paper "On the Correlation of the Inferior Oolite in the Middle and South of England," overlooked Sir William Guise's paper. As already remarked, Sir William showed sufficiently-clearly that the Dundry Freestone and the Inferior-Oolite Freestone near Bath, both belonged to a higher horizon than Lycett had imagined. Holl also undertook to point this out, and went further, attempting a more precise correlation.[3]

1 Proc. Cotteswold Nat. F. C., vol. ii. (1854-1860), pp. 170-175.
2 Quart. Journ. Geol. Soc., vol. xvi. (1860), pp. 1-48.
3 *Ibid.*, vol. xix. (1863), pp. 306-317.

At Horton, in the South Cotteswolds, there are, in descending order, these beds: White Oolite, *Clypeus*-Grit, and Upper *Trigonia*-Grit, and the first two equal the *Clypeus*-Grit of such places as Leckhampton Hill. Holl called the White Oolite the "Upper Ragstone," and thought it represented the *whole* of the *Clypeus*-Grit of more northern sections. The local *Clypeus*-Grit of Horton, together with the Upper *Trigonia*-Grit, he denominated "Lower Ragstone," and paralleled them with the Upper *Trigonia*-, *Buckmani*-, and Lower *Trigonia*-Grits of Rodborough. Holl also noticed that while his "Lower Ragstone" rested directly upon the "Building Freestone" at Horton, in the Vale of Nailsworth it reposed upon the Oolite Marl (which was a few inches thick); while when followed still further north it became increasingly-widely separated from the Oolite Marl by the wedge-like incoming of the Upper Freestone.

Between 1863 and 1880 little of importance appeared. Prof. James Buckman returned to the discussion on the allocation of the "Sands," and endeavoured to indicate the dates of the various deposits thus colloquially designated and their equivalents; but his conclusions have not proved very satisfactory.[1]

In 1880 Edwin Witchell communicated a useful paper entitled "Notes on a Section of Stroud Hill, and the Upper Ragstone Beds of the Cotteswolds."[2] Witchell noticed above the true *Clypeus*-Grit of Stroud and Rodborough Hills some beds of "compact white fine-grained oolite," which he thought worthy of distinct designation, and therefore called them the "White Oolite." Hull had said that the beds immediately below the Fullers' Earth "towards the south-eastern part of the Cheltenham district" were also "rubbly white oolite." So Witchell thought his beds must correspond to Hull's. Nevertheless, he could not understand why Hull termed them "*Clypeus*-Grit," for the rocks that merited that name in the Stroud district came *below* his White Oolite. Therefore he ventured to amend matters, applying his term "White Oolite" to the topmost beds and restricting the appellation "*Clypeus*-Grit" to the beds full of *Clypeus Ploti* and *Terebratula globata*, auctt. non Sow.

1 Quart. Journ. Geol. Soc., vol. xxxiii. (1877), pp. 1-9, and vol. xxxv. (1879), pp. 736-743.
2 Proc. Cotteswold Nat. F. C., vol. vii., pt. 1 (for 1879-80), pp. 117-135.

Witchell very nearly succeeded in unravelling the stratigraphy of the beds above the Upper *Trigonia*-Grit. Apparently he was the first to discover the Upper Coral-Bed at Rodborough Hill; but he was not aware that it extended any further south than this. It was doubtless his failure to see in the "Coralline Beds" of Dundry the equivalent of the Rodborough Hill Upper Coral-Bed that led him into the error of correlating his White Oolite with the Dundry Freestone—a mistake Holl had made before him.

In 1882 Witchell published "The Geology of Stroud and the Area drained by the Frome."[1] It is a useful book, and contains much valuable information. In the "General Section" of the Inferior Oolite in the vicinity of Stroud, "sandy limestone" and "freestone" is mentioned as occurring between the Cephalopod-Bed and Pea-Grit proper. Witchell described the freestone as the "Lower Limestone," and dealt with it in some detail, giving, amongst others, a section at Selsley Hill to show its correct stratigraphical position. He also commented upon the "thinning out" of the Pea-Grit to the south of Stroud, and to the difficulty of distinguishing between the Lower Limestone and the Lower Freestone, when that bed is absent. Concerning the "Ragstone Beds," he did not give much additional information. The "Intervening Beds" at Rodborough he grouped all together as Gryphite-Grit, and the lower 2 feet of the Upper *Trigonia*-Grit of Leigh's Quarry on Selsley Hill he assigned to the same subdivision.

The next two papers to be noticed are also by Witchell. The one "On the Pisolite and the Basement Beds of the Inferior Oolite of the Cotteswolds," was contributed to the Quarterly Journal of the Geological Society for 1886;[2] the other, with very nearly the same title, to the Proceedings of the Cotteswold Club.[3] Both have the same object, but, as it happens, the Quarterly-Journal paper is the more satisfactory of the two. The common purpose was to point out that there were beds between the Cephalopod-Bed and Pea-Grit proper which were worthy of distinct appellation. Lycett and Wright had both of them thought that the lower portion, or Witchell's "sandy ferruginous beds" corresponded to the Pea-Grit of the

1 Pp. 37-68. 2 Pp. 264-271. 3 Vol. viii., pt. 1 (for 1881-82), pp. 35-49.

Cheltenham district, and therefore paralleled the overlying Lower Limestone with the Lower Freestone. It might have been thought that what remained of the Pea-Grit at Selsley Hill was sufficiently typical to prevent any such mistake being made. Lycett did not omit to notice it, but thought it was simply a marly bed in the *Fimbria*-Stage, and therefore at a higher horizon than the Pea-Grit of the Cheltenham district.

Witchell's essay "On the Genus *Nerinæa*, and its Stratigraphical Distribution in the Cotteswolds,"[1] although eminently palæontological, contains some interesting observations on the extension of the Pea-Grit to the south of Stroud, and clears up effectually the confusion that had arisen through Lycett and others thinking that what is really Pea-Grit was a bed in the "Freestone" division.

In 1887 appeared part 1 of "A Monograph of the Inferior Oolite Ammonites of the British Islands," by S. S. Buckman, and in part 2 detailed records of the Cephalopod-Bed Sections at Frocester Hill, Coaley Wood, Stinchcombe, and Nibley Knoll, are given ; but little attention is paid to higher beds.

In 1888 Witchell wrote "On a Section of Selsley Hill."[2] The geology of the hill is set forth in detail, but there is really very little that is new, for he had announced his important discoveries in earlier papers. The "dapple-beds" of the Lower Limestone are described at some length, and reference is made to the "Gryphite-Grit." The strain of his statement, that "the Gryphite-Grit of Selsley Hill is without the characteristic fossil *Gryphæa sublobata*. This is another peculiar feature of the Selsley beds," almost suggests that he was beginning to doubt if his identification of the bed as Gryphite-Grit were correct. As a matter of fact, of course, it was not, for it is now known that he had mistaken a portion of the Upper *Trigonia*-Grit for the Gryphite-Grit.

In 1889 there appeared Mr S. S. Buckman's paper "On the Cotteswold, Midford, and Yeovil Sands, and the Division between the Lias and Oolite."[3] The old controversy is again reviewed, sections of the Cotteswold Sands at Buckholt Wood, Coaley Wood, Nibley Knoll, and Little Sodbury are discussed, and it is shown that the Cotteswold, Yeovil and Midford Sands

1 Proc. Cotteswold Nat. F. C., vol. ix., pt. 1 (1885-6), pp. 21-37. 2 Proc. Cotteswold Nat. F.C., vol. ix., pt. 2 (for 1886-87), pp. 96-107. 3 Quart. Journ. Geol. Soc., vol. xlv. (1889), pp. 440-473.

are not of the same date. Some of the sections named above had been previously noticed in his Monograph, but in this paper some corrections and additions are made.

The late W. H. Hudleston, in his "Monograph of the British Jurassic Gasteropoda. Part 1. Gasteropoda of the Inferior Oolite," gives a general account of the Inferior Oolite of the South Cotteswolds;[1] but the Horton section is the first he describes, while the other sections he notices are "Nailsworth Hill and District" and "Rodborough Common." With regard to Rodborough, he makes the noteworthy observation that it is the last place, working in a southerly direction, where the "characteristic gryphite" occurs in the "Gryphite-Grit." He apparently accepted Witchell's statement that Rodborough Hill was the furthest point south at which the Upper Coral-Bed occurred.

In the Memoir of the Geological Survey, "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)" vol. iv. (1894), a general account is given of the Inferior Oolite of the South Cotteswolds.[2] The section at Horton is noted, and three subdivisions of the Ragstones are made, namely, the Upper *Trigonia*-Grit, *Clypeus*-Grit, and White Oolite; but as regards the rest of the district, little subdivision or correlation of its beds is made. A quarry on Break-Heart Hill is noticed, but as to the precise age of the beds exposed there the author is in doubt. They are now known to belong to the Freestone (Aalenian) division of the Inferior Oolite.

In 1895 Mr S. S. Buckman published "The Bajocian of the Mid Cotteswolds."[3] The only portion of the South Cotteswolds referred to is Rodborough Hill; but the author clears up the mistake that had been made there with regard to the "Intervening Beds." He shows that one portion is Lower *Trigonia*-Grit, and the other probably *Buckmani*-Grit; but as he had found no specimens of *Terebratula Buckmani* or other distinctive fossil *in situ* in the latter subdivision, he could not say for certain whether or not it was *Buckmani*-Grit. In a report of an excursion of the Geologists' Association

1 *Loc. cit.*, pp. 56-65. 2 *Loc. cit.*, pp. 102-119. 3 Quart. Journ. Geol. Soc., vol. li. (1895), pp. 388-462.

to the quarry in 1897, he records that the "Upper *Trigonia*-Grit rests directly upon the Lower *Trigonia*-Grit, all the other beds seen at Cleeve Hill the day before not being represented here."[1]

For a gap, then, of about ten years, the Inferior Oolite of the South Cotteswolds received no recorded attention; but in 1905 the Cotteswold Club visited the sections between Hawkesbury and its hamlet of Hawkesbury Upton. The present writer has described the sequence of the beds exhibited there in the account of the excursion, recognising—in ascending order—the *Opaliniforme*- and *Scissum*-Beds, Lower Limestone, Upper *Trigonia*-Grit, White Oolite (or Limestone), and Fullers' Earth—the Inferior Oolite measuring in all some 60 feet. The section called the "Hawkesbury-Monument Quarry" is also described, but the correct allocation of a certain "bed 9" between the *Clypeus*- and Upper *Trigonia*-Grit is left unsettled, although provisionally grouped with the former. It may be provisionally paralleled with the Dundry Freestone.[2]

On June 2nd, 1906, Rodborough Hill was visited by the same Club, under the guidance of the writer.[3] At this excursion the correctness of Mr S. S. Buckman's provisional identification of the *Buckmani*-Grit was endorsed by the discovery *in situ*, at "The Fort" Quarry, of *Terebratula Buckmani*. In the Mount-Vernon Quarry the Upper Coral-Bed was seen and studied, and the writer quoted Witchell's view with regard to its assumed limited geographical extent, but stated how widely-distributed it really was, being represented at Midford and Dundry Hill, to mention but two places. He then added some remarks on the post-Upper-Coral-Bed deposits of the Bath-Doulting district and their equivalents in the Cotteswold Hills.

In the June of the same year this Club visited Selsley and Frocester Hills. In the report of the excursion, some notes on the former hill are published, and the sequence at the latter is set forth—the *Opaliniforme*- and *Scissum*-Beds, Lower Limestone, Pea-Grit-Equivalent and Lower Limestone being identified.[4]

The discovery of a *Prosopon*, probably from beds occupying the position of the White Oolite of Witchell, or the

1 Proc. Geol. Assoc., vol. xv., pt. 5 (1897), p. 182. 2 Proc. Cotteswold Nat. F. C., vol. xv., pt. 3 (1906), pp. 192-195. 3 *Ibid.*, vol. xvi., pt. 1 (1907), pp. 12-16. 4 *Ibid.*, vol. xvi., pt. 1 (1907), pp. 16-19.

Anabacia-Limestones of the Bath-Doulting district, and its naming by Dr Henry Woodward, F.R.S., afforded an opportunity of pointing out in a short note entitled "On the Stratigraphical Position of the Beds from which *Prosopon Richardsoni*, H. Woodward, was obtained," the probable equivalents of the Doulting Beds in the South Cotteswolds.[1] In the Bath-Doulting district, above the Upper Coral-Bed, the subdivisions that have been made are the Doulting-Stone, *Anabacia*-Limestones, and Rubbly-Beds. The Doulting-Stone finds its equivalent in the local *Clypeus*-Grit of Horton and of Scar Hill, Nailsworth; the *Anabacia*-Limestones in Witchell's White Oolite at Horton; while the Rubbly-Beds are represented in the variable deposit, as regards thickness, that caps this White Oolite and yields *Terebratula globata*, auctt. non Sow., abundantly.

Lastly, in 1908, the Geologists' Association visited that portion of the South Cotteswolds which lies between Stroud and Wotton-under-Edge, and the stratigraphical details recorded in the present paper, in so far as that portion is concerned, were pointed out on the ground and checked.[2]

This brings the historical retrospect down to the present time, and prepares the way for the presentation of Plate XXI., which shows the subdivision and correlation of the Inferior-Oolite rocks of the South Cotteswolds that has been accomplished by the exertions of former investigators, combined with the contributions of the present writer.

(ii.) *On the Lower and Upper Limits of the Inferior-Oolite Series.*—At the southern end of the South Cotteswolds the Inferior Oolite is about 30 feet thick, and at the northern, about 182 feet 8 inches. Above, throughout the South Cotteswolds, is the Fullers' Earth; below, the Upper Lias (Toarcian).

"In the Bath-Doulting district there is no Inferior-Oolite deposit of pre-*Garantianæ* date." The deposit of this date, the Upper *Trigonia*-Grit, there rests directly, but non-sequentially, upon the Liassic beds, except in the immediate neighbourhood of the Mendip Hills. North of the Avon Valley, however, additional beds begin to come in between the Upper *Trigonia*-Grit and the Upper Lias, and eventually these two deposits, which are in apposition at the southern end of the South Cotteswolds, are parted by at least 160 feet of strata at the northern end.

1 Geol. Mag., 1907, pp. 82-84. 2 Proc. Geol. Assoc., vol. xx. (1908), pp. 514-529.

The cause of this incoming of beds from south to north, and their mutual relations, must be left to be discussed at a later page (pp. 84-85), because it is first of all desirable to mention what deposits immediately over- and under-lie the Inferior-Oolite Series in the South Cotteswolds.

The bottom-bed of the Inferior Oolite, and therefore that which rests directly upon the Upper Lias over the southern portion of the South Cotteswolds, is the Upper *Trigonia*-Grit. The deposit that occupies this basal position in the northern portion is the *Aalensis*-Bed, but it is usually ill-defined, and its successor, the *Opaliniforme*-Bed, or "hard cap to the Cephalopod-Bed," as it is often colloquially called, is more readily identified.

The Series upon which the Inferior Oolite reposes is thus divisible:

(1) Marls, brown, ironshot, with impure limestones, forming the Liassic portion of the Cephalopod-Bed.

(2) Sands, yellow, with hard bands, and nodule-shaped masses called "burrs" (constituting the "Cotteswold Sands"); passing down into

(3) Clays, blue, with hard blue-grey limestone-bands resting upon the Marlstone of the Middle Lias.

At the southern end of the South Cotteswolds there are few exposures of these Upper Lias beds; but at the northern end many. The best are at Wotton-under-Edge.

The Liassic clay (3) is mainly of *falciferi-bifrontis* date. The "Sands" (2) at the northern end of the district under review are of *Lilli-variabilis* date—pre-*striatuli*, and at the southern end mainly, if not wholly, post-*striatuli;* while in the intervening district, near "The Springs," the *striatulum*-niveau comes *in* the Sands, which means that here their greater bulk is of *striatuli* hemera (Sodbury Sands).

The Cephalopod-Bed is only well-exposed from Hawkesbury northwards, and is then best seen in the neighbourhood of Wotton-under-Edge and Dursley. The hard cap to the Cephalopod-Bed is of *opaliniformis*-date, and, like the ill-defined *Aalensis*-Bed that underlies it, belongs to the Inferior Oolite. Therefore a more detailed account of it will be found at a later page. Of the remaining component zones of the Cephalopod-Bed, it may be pointed out that, with the aid of Mr S. S. Buckman, the *Struckmanni*-Bed has been indicated in most of the sections, and also a new horizon distinguished by a special ammonite—the *Pedicum*-Bed. The limits of this zone are generally co-extensive with those of the well-known "Linseed-Bed," so it will not be difficult to locate; and Mr Buckman writes (February 28th, 1909), "it always occurs above the main mass of the *Striatulum*-Beds, over the lowest stone-bands, and always contains its own species of *Pseudogrammoceras*."

Throughout the district dealt with, except, of course, where it has been removed by denudation in comparatively recent times, the Inferior Oolite is succeeded by the Fullers' Earth. Near Bath it is said to be about 148 feet thick, and in the neighbourhood of Stroud, between 70 and 80. Satisfactory sections, however, are few and far between, and therefore our knowledge concerning its faunal and lithic characters is not nearly so extensive as might be desired. Springs and damp ground, however, occupying a position between the scarps of Inferior and Great Oolite, constitute a ready index to its presence, and there are a number of minor exposures. The principal of these are:

(1) Near "Prospect Stile," on the hill north-west of Weston, near Bath:

(2) In the path across the fields near Ringswell (at a place five-sixteenths of a mile south-east by south of Marshfield Church), where argillaceous limestones, crowded with specimens of *Ornithella ornithocephala* (Sow.), and its varieties, and similar to the equivalent beds at Dyrham, crop out:

(3) In the lane-side, a quarter of a mile south-south-west of Cold-Ashton Church, where *Rhynchonella Smithi*, Walker, was found:

(4) In the road-side near the barn, a quarter of a mile north-east by north of Horton Rectory:

(5) In the road-sides below Hawkesbury Monument, where there are bands of limestone crowded with *Ostrea acuminata*, Sow.:

(6) In the track-side near the head of Tresham Combe, and at the top of a quarry in the same combe (where the associated beds of limestone yielded *Ostrea acuminata*, Sow, and *Pseudomonotis echinata* (Sow.), and the clay, *Cristellaria cultrata*, Montf, and *Cytheridea Bradiana* (Jones).

(7) On Tor and Symond's-Hall Hills, near Wotton-under-Edge—at both of which places *Ostrea acuminata* abounds, almost wholly composing limestone-beds:

(8) On Break-Heart Hill, where the clay yielded to Mr C. Upton five species of *Ostracoda* and the associated limestones are full of *Ostrea acuminata*:

(9) At Bown Hill, immediately to the south of Selsley Hill, whence Mr Upton has obtained *Cristellaria* sp., and five undetermined species of Ostracoda: and

(10) Near Avening, where *Ostrea acuminata*, Sow., is again conspicuously abundant.

All these exposures, however, are insignificant. The only good one now open is at the head of the little combe east of Dyrham Wood, and distant about a mile from the village in a southerly direction. As this section is the most important in the South Cotteswolds, a sketch-map is given to show its precise position (text-figure 1). The dot at the eastern end of the wood under the word "exposure" indicates its position.

Fig. 1.—Map to show the position of the Fuller's-Earth Section, near Dyrham. (1 inch = 1 mile).

The deposits exposed are beds of argillaceous limestone, intercalated in the usual kind of Fullers' Earth. They abound in specimens of *Ornithella ornithocephala* (Sow.), in all stages of growth; while the other fossils include *Belemnopsis* sp. (fragment), *Ostrea acuminata*, Sow., *Goniomya angulifera* (Sow.), *Isocardia nitida*, Phillips, *Rhynchonella Smithi*, Walker, *Ornithella triquetra* (Sow.), *Serpula plicatilis*, Münster, and *Serpula quadrilatera*, Goldfuss.

Of good sections not now open may be mentioned those:

(1) In the tunnel at Box:[1]

(2) On the slopes of Lansdown, when some excavations were being made: and

(3) In the tunnel works east of Old Sodbury.

It was from data supplied by the Box Tunnel that Lycett arrived at his estimate of 148 feet for the thickness of the Fullers' Earth in the neighbourhood of Bath. Mr H. B. Woodward, F.R.S., has criticised it as being too great, because none of the wells near Bath that he knew of had proved more than 70 feet;[2] but at the Monkswood Reservoir the Rev. H. H. Winwood has found it to be between 150 and 180 feet thick.[3]

A shaft in connection with the tunnel near Old Sodbury, proved the Fullers' Earth—exclusive of 45 feet of "passage-beds" into the Great Oolite—to be 90 feet thick, and to

1 "The Cotteswold Hills" (1857), p. 85. 2 Mem. Geol. Surv., "The Jurassic Rocks of Britain," vol. iv. (1894), p. 93. 3 Proc. Bath Nat. Hist. and Antiqu. F. C., vol. vii. (1895), p. 150. Prof. H. Reynolds and Dr A. Vaughan, Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 740-742.

contain a "fairly constant series of argillaceous limestone (10 feet)," comparable apparently with the *Ornithella*-Beds of Dyrham. They yielded *Pseudomonotis echinata* (Sow.), *Chlamys vagans* (Sow.), *Rhynchonella Smithi*, Walker, *Rhynchonella* sp. nov., and *Ornithella ornithocephala* (Sow.)

There is not a sufficiency of evidence for dating precisely the Fullers' Earth of the South Cotteswolds, but the following remarks will show what is probable.

Ammonites subcontractus, Morris and Lycett, and *Ammonites Morrisi*, Oppel, have been recorded from the Fullers'-Earth Rock of Somerset and the Weatherstones and Shelly Beds of Minchinhampton Common, near Stroud. If the Fullers'-Earth Rock is equivalent to these Minchinhampton beds, as this evidence seems to indicate, then the *Ostrea-acuminata*-Clays—which occur just below the Fullers'-Earth Rock in Somerset—must be equivalent to the Fullers'-Earth clays with *Ostrea-acuminata*-Limestones in the northern portion of the South Cotteswolds. *Ostrea Knorri*, Voltz, is abundant at the base of the Fullers' Earth in the neighbourhood of Doulting; but, so far, has not been recorded from the South Cotteswolds. It has been found, however, (first by Mr C. Upton, and subsequently by the writer, in company with Mr Upton), on the north side of the Slad Valley, and the writer has seen specimens—presumably from the Fullers' Earth—from Cooper's Hill, near Gloucester, also in the Mid Cotteswolds.

Specimens of *Zigzagiceras* have been procured from the base of the Fullers' Earth between Midford and Coombe Hay (in a cutting on the new railway); Mr Winwood has obtained one, near to, if not identical with *Zigzagiceras procerum* (Seebach), from the Fullers' Earth of Lansdown, near Bath; while as far north as Kingscote, a specimen—probably of the same species—has been collected.

Hence it would appear that the bottom-portion of the Fullers' Earth, throughout the South Cotteswolds, is of *zigzag* hemera.

TABLE I.—FOSSILS FROM THE FULLERS' EARTH OF THE SOUTH COTTESWOLDS

SPECIES	Lansdown, Bath	Ringswell	Near Cold Ashton	Near Dyrham	Sodbury Tunnel	Tresham Combe	Break-Heart Hill	Kingscote	Bown Hill
Protozoa									
1. Rhizopoda									
Foraminifera									
Cristellaria cultrata, Montf.						*	*		
——— sp.									*
Vermes									
5. Annelida									
Serpula plicatilis, Münster				*					
—— *quadrilatera*, Goldfuss				*					
Molluscoidea									
2. Brachiopoda									
Ornithella ornithocephala (Sow.) and varieties ..		*		*				*	
Rhynchonella Smithi, Walker				*	*				
——— sp. nov.					*				
Terebratula globata, auctt. non Sow...								*	
Mollusca									
1. Pelecypoda									
Goniomya angulifera (Sow.)				*					
Isocardia nitida, Phillips ..				*	*				
Ostrea acuminata, Sow. ..				*		*			
Chlamys vagans (Sow.) ..					*				
Pseudomonotis echinata (Sow.)					*	*			
5. Cephalopoda									
Zigzagiceras procerum (Seebach)..	*							*	
Belemnopsis sp...				*					
Arthropoda									
1. Branchiata									
1. Crustacea									
Ostracoda									
Cytheridea Bradiana, Jones						*			
5 other spp. not identified..							*		*

II. Subdivisions recognizable in the Inferior Oolite of the South Cotteswolds, and the probable causes that governed their distribution.

The subdivisions recognizable in the Inferior Oolite of the South Cotteswolds are shown in Plate XXI. (end of paper). Therefrom it will be observed that the series has been divided into two main parts, the Freestone and Ragstone Divisions, which are very different lithically, the former consisting mainly of massive freestones, and the latter principally of rubbly ragstones. The Ragstone Beds have been further separated into "Intervening Beds" and "Top-Beds"—the latter being uppermost. The Top-Beds have the most extensive geographical distribution in the South Cotteswolds; the Intervening-Beds the least; while the Freestone Beds occupy an intermediate position as regards geographical extent.

(xxvii.) *Aalensis*-Bed (hemera *aalensis*).—In the South-Cotteswold sections it is not always easy to separate the *Aalensis*- from the *Moorei*-Bed as regards lithic structure, and ammonites indicative of the former hemera have usually been labelled simply "*Moorei*-Bed." When separated on the palæontological evidence, the *Aalensis*-Bed is found to be extremely thin, and best seen at Coaley Peak and Wotton-under-Edge. On the Dorset coast the equivalent beds are much thicker and more readily discernible (see S. S. Buckman, Quart. Journ. Geol. Soc., vol. lxvi., 1910, p. 64).

(xxvi.) *Opaliniforme*-Bed (*opaliniformis*).—This stratum forms the hard cap to the Cephalopod-Bed. As regards lithic structure, it is easily separable from the beds *below* by its non-"marly," but pale-yellow arenaceous-limestone character, and by being usually speckled with angular irony grains instead of smooth oval limonite-granules; and from the beds *above* by its more metallic ring when struck with a hammer, and its more compact but less arenaceous character. The bed certainly extends as far south as the neighbourhood of Sodbury, but it is best exposed at Frocester Hill, in Coaley Wood, at Cam-Long Down, Wotton Hill, and Nibley Knoll. It is important to notice that at the base of the *Opaliniforme*-Bed, and joined on to it, there is often present a rubbly deposit, of which the component pebbles are frequently coated with iron-oxide, while the interstices between them are filled up with the same material. In other words, there are distinct signs of a non-sequence between the *Opaliniforme*- and underlying beds in many of the sections in the northern portion of the South Cotteswolds.

(xxv.) *Scissum*-Beds (*scissi*).—These beds have been traced as far south as Sodbury, and are usually considerably-arenaceous limestones with specimens of *Gresslya*, *Pholadomya*, *Volsella* and *Pinna* of very nearly if not the same species as occur higher up in the *discitæ* deposits. Indeed, it is noteworthy how much the *Scissum*-Bed fauna resembles that of the Lower *Trigonia*- and *Buckmani*-Grits. The beds are well-exposed at Wotton Hill, Nibley Knoll, and the top of the "Long-wood" section, where Mr Charles Upton has collected *Tmetoceras scissum* (Benecke), and several other interesting ammonites.

The upper surface of the *Scissum*-Beds frequently shows signs of erosion that presumably took place during the pause in the process of deposition that evidently preceded the initiation of the necessarily changed conditions that favoured the formation of the Lower Limestone.

(xxiv.) Lower Limestone (early *Murchisonæ*): now—1910—dated as *Ancolioceras*.[1]—At many places in the neighbourhood of Cheltenham, the *Scissum*-Beds are almost immediately succeeded by the pisolitic beds of the Pea-Grit, but in the South Cotteswolds there follow oolitic limestones measuring, at Selsley Hill, some 38 feet. These beds have been actively-worked on Selsley Hill, where many of the component strata are "dapple-beds," that is, limestones with pebbles of very similar material, which are evidently the product of a pene-contemporaneous erosion. The fossils, also, are very few in number, and only the small specimens (gastropods) are at all well-preserved, and even they are rolled; while the larger forms, as a rule, are represented by fragments only.

(xxiii.) Pea-Grit (*Murchisonæ*).—The Pea-Grit is first definitely recognizable in coming north from Bath in the large quarry in Coaley Wood, but it is probable that the thin rubbly layer at Wotton Hill and the Nunnery-Lane Quarry, near

1 S. S. Buckman, F.G.S., Quart. Journ. Geol. Soc., vol. lxvi. (1910), p. 79.

Dursley, is on its horizon. That is all that can be said, and south of Dursley it is perhaps best to designate the beds between the Upper *Trigonia*-Grit and *Scissum*-Beds simply the "Freestone-Beds." From Coaley Wood northwards, however, the Pea-Grit can be traced by way of Frocester Hill to Selsley Hill, where it is found to have expanded and to be replete with fossils which at Crickley Hill, near Gloucester, characterise the *top-portion* of the Pea-Grit. This, combined with the fact that the upper surface of the underlying Lower Limestone is waterworn, and frequently has small oysters attached to it, suggests that the lower portion of the Pea-Grit is absent from Selsley, and that the top-portion there rests non-sequentially upon the Lower Limestone. The gap is partly bridged over at Rodborough Hill, where massive pisolitic limestones have come in, and the top-portion has also become more pisolitic. Specimens of *Nerinœa* are frequently abundant in the Pea-Grit, and connect the deposit in which they occur in point of time with the *Nerinœa-cingenda*-Bed of Blea Wyke or Ravenscar, on the Yorkshire coast.

(xxii.) Lower Freestone (late *Murchisonœ*).—This rock is of the usual lithic aspect, and—amongst other places—can be studied at the Coaley-Wood Quarry and Frocester Hill. At Selsley Hill it is very indifferently exposed, the paucity of sections in it probably being due to its inaccessibility, owing to faulting and land-sliding, rather than to non-presence. Witchell thought it might be as much as 70 feet thick, and I see no reason to differ from him.

(xxi.) Oolite Marl and (xxii.) Upper Freestone (*bradfordensis*.—These deposits have a less extended geographical distribution than the underlying Lower Freestone, not extending further south on the western face of the hills than Pen Wood, but owing to certain earth-movements are present further south *away* from the hill-edge in the neighbourhood of Nailsworth.

It is difficult to indicate precisely where the line of demarcation between the Oolite Marl and Upper Freestone comes in the South-Cotteswold sections, and although I have done so where possible, it must be remembered that while the marl *usually* occupies the inferior position, marly conditions may extend upwards and replace even the whole of the Upper Freestone, as is the case at "The Frith" Quarry, near Stroud.

In the deposit of *bradfordensis* hemera exposed on the flanks of the Minchinhampton-Common and Rodborough-Hill upland, specimens of *Nerinæa* are not uncommon, and on the evidence of other sections would appear to occur at about the same horizon as *Rhynchonella Tatei*, although where the one is common, the other is not, and *vice versa*.

It may be that at the northern end of the South Cotteswolds only the top-portion of the Oolite Marl is present. Certain sections in the Mid and North Cotteswolds have suggested either a slight break between the deposits of *Murchisonæ* and *Bradfordensis* hemeræ, or very little deposit being made locally in early *bradfordensis* times. But be this as it may, towards the close of *bradfordensis* hemera there was considerable crust-flexuring and production of slight anticlines and synclines. It is improbable that any important deposit was made over the site of the present South Cotteswolds during the *concavi* hemera. If it was, then there is no trace of it left now. The elevation which took place in late *bradfordensis* hemera and the erosion which ensued, have been termed the "Aalenian Upheaval" and "Denudation." Probably the anticlinal and synclinal axes were not widely divergent from those which were developed at the close of the time-of-formation of the Bajocian deposits.

Upon the disturbed Aalenian rocks the Bajocian deposits were laid down—the successive beds overlapping one another as subsidence proceeded. In the South Cotteswolds, and then only at the northern end on Rodborough Hill, the Lower *Trigonia*-Grit immediately succeeds the Upper Freestone, and it is in turn followed by the *Buckmani*-Grit, which does not extend across the Nailsworth Valley on to Selsley Hill.

(xiv.) Lower *Trigonia*-Grit (*discitæ*).—This is of the usual lithic aspect—a grey-brown shelly ragstone with iron-specks, and contains the ordinary assemblage of fossils. From it, at Rodborough Hill, many new species were obtained by Lycett.

(xiii.) *Buckmani*-Grit (post-*discitæ*).—The *Buckmani*-Grit, which has about the same geographical extent as the Lower *Trigonia*-Grit in the South Cotteswolds, is definitely identifiable on account of its having yielded at Rodborough Hill specimens of *Terebratula Buckmani* and *Ter. crickleyensis*, and separable, as regards lithic structure in the relative absence of iron-specks, and by its more arenaceous character.

(vi.) Upper *Trigonia*-Grit (early *Garantianæ*).—The Upper *Trigonia*-Grit reposes non-sequentially upon the *Buckmani*-Grit at Rodborough Hill, and spreads southwards over the whole of the South Cotteswolds, overlopping the basset edges of the inferior subdivisions of the Oolite.

BAJOCIAN DENUDATION.—Between the Upper and Lower *Trigonia*-Grits at Rodborough Hill is a considerable stratigraphical break: the Gryphite-Grit, Notgrove Freestone, *Witchellia*-Grit, *Bourguetia*-Beds and *Phillipsiana*-Beds, deposits present near Cheltenham, and also deposits of *Blagdeni* and *niortensis* hemera as well, are absent. It is undesirable to commit one's-self to saying if all these subdivisions, or which of them, were probably laid down over the site of a portion of the South Cotteswolds. For the present it will perhaps be best to say that some were no doubt laid down over the northern portion of the South Cotteswolds, and were removed during the Bajocian denudation, which preceded the deposition of the Upper *Trigonia*-Grit.

(vi.) Upper-*Trigonia*-Grit (cont.).—In the South Cotteswolds, except at the extreme southern end, where portions look as if they had been subjected to some working-up, the Upper *Trigonia*-Grit is of the usual aspect—a hard, grey, shelly limestone full of fossils. At Nibley Knoll it is only 1 foot 4 inches thick, and at Wotton Hill is scarcely typical; but it should be noticed that throughout this portion of the Cotteswolds fragments of *Trichites* are common at the top. The upper surface of the Upper *Trigonia*-Grit is generally covered with oysters, and is frequently bored, even when there is a thin bed present which may be referred to the horizon of the Dundry Freestone.

(v.) Dundry Freestone (late *Garantianæ*).—A thin limestone bed, sometimes occurring as lenticular masses, at others as a continuous stratum, is recognisable in certain sections. It rests upon an oyster-covered and bored surface of the Upper *Trigonia*-Grit, and exhibits the same phenomena itself, only the borings in it are much more conspicuous. The identification of this deposit with the Dundry Freestone is only of scientific interest.

(iv.) Upper Coral-Bed (*Truellei*).—Above the thin bed of Dundry Freestone, or where it is absent, the Upper *Trigonia*-

Grit, occurs very sporadically indeed, the Upper Coral-Bed—a deposit which indicates by its wide extent in the Cotteswold Hills, Bath-Doulting District, and Dundry Hill, near Bristol, a prevalence of very similar conditions in this part of the West of England at the time of its formation. It was by the discovery at the Coombe-Hill Quarry, near Wotton-under-Edge, of a specimen of *Lissoceras psilodiscum* (Schloenbach) that the date of the deposit was first definitely fixed.

(iii.) Doulting Stone or *Clypeus*-Grit.—At Doulting the Doulting Stone is about 44 feet thick, but at Midford only 11 feet 9 inches. At the southern end of the South Cotteswolds it is probably about the same, and has similar faunal and lithic characters. Traced to the north, however, it gradually changes. At the Horton-Rectory Quarry it is easy to see in the massive-bedded local *Clypeus*-Grit of that locality, although it has become more rubbly and fossiliferous, the equivalent of the Doulting Stone: and even as far north as Selsley and Rodborough Hills, the massive character is still to a large extent preserved in the equivalent deposit. It is possible that the bottom-portion of the Doulting Stone, or local *Clypeus*-Grit, of certain localities is equivalent to the top-portion of the Upper Coral-Bed of certain others.

(ii.) *Anabacia*-Limestones or White Oolite.—The *Anabacia*-Limestones are generally very distinct in the Bath-Doulting district on account of their being whiter and more flaggy than the underlying yellower and more massive-bedded Doulting Stone, and are usually characterised by an abundance of the little coral *Anabacia complanata* (Defrance). At the southern end of the South Cotteswolds they are much the same in appearance, but at the Horton-Rectory Quarry they are somewhat softer and more oolitic; while at Scar Hill, Nailsworth, they have changed again, being more compact and less-conspicuously oolitic. Nevertheless, the identity of these limestones of the more northern sections with those of the southern is evident. North of Sodbury it is best to use Witchell's term "White Oolite" for these beds, for the characteristic coral is not abundant thence. Interesting to relate, however, when the White Oolite has assumed the appearance of typical, rubbly *Clypeus*-Grit, along with the Doulting Stone, as in the Cheltenham district, this little coral is frequently in evidence, and at places is quite common.

It should be mentioned here, that it is probable that Edwin Witchell did not always apply the term "White Oolite" to contemporaneous deposits. He identified the white limestones of Horton as his "White Oolite," and so when I use the term "White Oolite," I mean deposits of the same date as those at Horton.

(i.) Rubbly-Beds.—The Rubbly-Beds are not well-developed in the South Cotteswolds, and often are not much more than a rubbly development of the top-portion of the White Oolite, with occasional specimens of *Terebratula globata*, auctt., and *Holectypus depressus*. At the Stancombe Quarry on Stinchcombe Hill, however, they are typically developed, being rubbly limestones with those conspicuous yellow-coloured pisolite-like spherules, and crowded with *Terebratula globata*, and less commonly *Holectypus depressus*, etc.

The changes which the Doulting Stone, *Anabacia*-Limestones and Rubbly-Beds undergo during their course through the South Cotteswolds may be summarised as below, and it is important to note the restricted use of the term *Clypeus*-Grit in the Middle South Cotteswolds.

Southern end of the South Cotteswolds	Middle South Cotteswolds	Mid Cotteswolds
(i.) Rubbly Beds	(i.) Rubbly Beds	
(ii.) *Anabacia*-Limestones	(ii.) White Oolite	(i.-iii) *Clypeus*-Grit
(iii.) Doulting Stone	(iii.) *Clypeus*-Grit	

The massive bedding of the true Doulting Stone is faintly preserved all through in the more-bedded lower portion of the *Clypeus*-Grit.

III.—Local Details.

For descriptive purposes the South Cotteswolds may be divided into four areas, namely, (1) the Bath-Dodington, (2) the Dodington-Dursley, (3) the Dursley-Selsley, and (4) the Rodborough-Nailsworth Areas.

In the first of these the only sections worth visiting are at North Stoke, Tog Hill, and "The Springs," near Dodington: in the second there are excellent sections near Horton Rectory and Hawkesbury Monument; on Winner's Hill, near Alderley; on the hill north of Wotton-under-Edge; and on Stinchcombe Hill: in the third at Uley Bury, Frocester and Selsley Hills:

and in the fourth, at "The Fort" and Mount-Vernon Quarries on Rodborough Hill, and near Nailsworth at Scar Hill, Hazelwood and Longfords.

(1) The Bath-Dodington Area.

On the south side of the Avon Valley the Inferior Oolite is thus divisible:

Sequence of Inferior-Oolite Beds at Midford

			Thickness in feet	inches
		Fuller's Earth		
Inferior Oolite (Bathonian)	(i.)	Rubbly Beds (top-portion only)	0	6
	(ii.)	*Anabacia*-Limestones	11	0
	(iii.)	Doulting Stone	11	9
	(iv.)	Upper Coral-Bed	8	0
		Non-sequence: Dundry Freestone wanting		
	(vi.)	Upper *Trigonia*-Grit	5	0
		Non-sequence: Bajocian and Aalenian wanting		
Upper Lias (Toarcian)		Midford Sands	100	7

On the north side of the Avon Valley there is the same succession, but the Upper Coral-Bed is only very poorly developed, and at the Box Tunnel (according to the late Robert Etheridge) the total thickness of the beds is only 30 feet.[1]

I have investigated all the numerous valleys running up northwards into the southern end of the South Cotteswolds, but have found few sections worthy of note. The rocks are frequently greatly disturbed by landsliding: sometimes so much so as to give the impression that the Great Oolite underlies the Inferior—a phenomenon noticed by the Rev. H. H. Winwood near the Monkswood Reservoir.[2]

At this southern end of the South Cotteswolds then, the Upper *Trigonia*-Grit rests directly upon the Sands. These appear to be of ? *Dumortieriæ*,[3] *dispansi* and *Struckmanni* hemeræ;[4] and may be of *striatuli* hemera as well.

A well at Primrose Hill, to the east of Weston, proved Sands with sand-burrs, from which Mr Winwood obtained "*Dumortieria radians* and *Lima toarciensis*, Desl.,"[3] and therefore of *Dumortieriæ* hemera; resting upon a local Cephalopod-Bed, which contained "*Ammonites communis*, *A. bifrons*, and *Rhynchonella Moorei.*" From this it would appear that the lithological succession of the Toarcian beds is similar to that at Timsbury Sleight.[5]

1 "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)." Mem. Geol. Surv., vol. iv. (1894), p. 98. 2 Proc. Bath Nat. Hist. and Antiqu. F.C. vol. vii. (1895), p. 153. 3 Geol. Mag. (1888), p. 470. 4 Quart. Journ. Geol. Soc., vol. lix. (1903), p. 452. 5 *Ibid.*, vol. lxiii. (1907), table facing p. 416.

At the Monkswood Reservoir, however, Mr Winwood observed the Upper *Trigonia*-Grit resting directly upon blue clay, from which a specimen of *Ammonites capricornus* was obtained. This phenomenon again may be due to slipping; but, if not, it opens up some very interesting questions in connection with the relations of the Cotteswold-Hills and Dundry-Hill areas of sedimentation in late Liassic times.

The Upper *Trigonia*-Grit is of the usual aspect, but in places shows evidence of having been worked up again after its original deposition, possibly by an erosion following the crust-pressures that governed the limits of the area over which the Dundry Freestone was laid down.

(1) The Upper *Trigonia*-Grit has been exposed at Hill House, to the north-west of Box (where it can form but a very small outlier):[1]
(2) At the Monkswood Reservoir:
(3) In the Woolley-Langridge Valley at Turner's Court, or "Torney's-court," as it is now called:
(4) At Charlcombe: and
(5) In a road-cutting just after leaving North Stoke for Kelston.

In the quarry at Torneyscourt the rock is much disturbed, and comprises white, oolitic, seldom-fossiliferous limestones at the top (Doulting Beds); and brown, slightly-ironshot limestones below, which yielded the following fossils that are indicative of deposits of *Garantianæ* and *Truellei* hemeræ; *Acanthothyris spinosa* (Schlotheim), *Acanthothyris*, sp. nov., *Zeilleria Hughesi* (Walker), *Ctenostreon pectiniforme* (Schloth.), *Lithophagus inclusus* (Phillips), *Trigonia costata*, Sow., *Ostrea*, sp., *Myoconcha* (internal cast), and corals (*Isastræa*).

In the Kelston-Road Section (5) the Upper *Trigonia*-Grit has a thin layer of corals on top of it, and separating it from the succeeding Doulting Stone.

The Doulting Beds were formerly exposed in a number of quarries in this part of the Bath District, for example, "at the northern end of Beacon Hill, near Charlcombe"; "south-west of Gwenfield Farm," and again at Primrose Hill; but are now best seen at Slade's Farm, Ditteridge, and in a deep water-course at Charlcombe, where is the section that was described by Sir William V. Guise. The Upper *Trigonia*-Grit here is 4 or 5 feet thick.[2]

1 "The Jurassic Rocks of Britain," etc., vol. iv. (1894), p. 98. When I visited the locality in 1905, extensive drain-excavations revealed blue clays between the farm and the road to the north. No fossils were found in the clays. 2 Proc. Cotteswold Nat. F.C., vol. ii. (1865), pp. 171-172.

Coming now to the western face of the hills, in the lane from North Stoke to Bitton, is the section that was recorded by Prof. S. H. Reynolds and Dr A. Vaughan,[1] on the authority of Mr S. S. Buckman. It is at the top of the lane in which Charles Moore found what he thought might be a thin representative of the Marlstone.[2] It is unnecessary to recapitulate here all the details that have been given by Prof. Reynolds and Dr Vaughan; it will suffice to say that they record that the Upper *Trigonia*-Grit rests upon sands and sandstones of *Dumortieriæ-striatuli* hemeræ.

In the road-side near the schools at Upper Cheney, there is an exposure of much-disturbed rock; but the sequence appears to be as follows:

SEQUENCE AT UPTON CHENEY

III. Doulting Stone	1. Limestones, pale-yellowish oolitic.
IV. Upper Coral-Bed and VI. Upper Trigonia-Grit	2. Limestone, rubbly, somewhat ironshot, with corals (principally near the top); *Ostrea* sp., *Trigonia costata*, Sowerby, *Ctenostreon pectiniforme* (Schlotheim), *Terebratula globata*, auctt. non Sow., and a fragment of *Polyplectites* cf. *linguiferus* (d'Orbigny).
	Non-sequence: Bajocian and Aalenian wanting.
Cotteswold Sands	3. Sandstone, hard, calcareous. (In a sand-pit on the right-hand side of the road, a short distance to the east, is seen a considerable thickness of yellow, micaceous sands with "sand-burrs.")

Although no definite indications of the Cephalopod-Bed occur in this section, deposits of the hemeræ ? *aalensis*, *Moorei*, *Dumortieriæ* and *dispansi*, have been observed in the neighbourhood.[3] The record of *Polyplectites* is particularly interesting, in that this ammonite occurs at the base of the deposit of *Truellei* date in Normandy, and there gives its name to a bed ("*Linguiferus*-Bed") that immediately overlies the *Garantiana*-Bed.[4]

The top-portion of the *Anabacia*-Limestones—of which the uppermost layer is considerably bored—with the overlying Rubbly Beds (similar to those at Twerton Hill), is seen in an old quarry in the corner of a field east of the road at Tog-Hill Farm.

1 Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 736, 737. 2 Proc. Somerset Arch. and Nat. Hist. Soc., vol. xiii. (1867), p. 152. 3 Proc. Bristol Nat. Soc., vol. x., p. 1 (1903: issued for 1901), p. 9; and *ibid.*, pt. 2 (1903: issued for 1902), p. 154. 4 Proc. Cotteswold Nat. F.C., vol. xvi. pt. 2 (1908), p. 188.

A little under a mile south-by-east of Dyrham, and east of Dyrham Wood, is the Fullers'-Earth section which was noticed above (page 78).

The quarries by the road-side in Dyrham Camp (near the 10th milestone), are in Doulting Stone; but the same subdivision is better seen in a quarry between "The Springs" (the source of the R. Boyd) and Dodington Ash, in the neighbourhood of which the sequence of beds is as follows:

SEQUENCE BETWEEN DODINGTON ASH AND "THE SPRINGS."

		Thickness in feet	inches
	Pond north-east of the clump of trees on the south side of the road.		
Fullers' Earth.	1. Clay.		
I. & II.	Rubbly-Beds and top-portion of the *Anabacia*-Limestones, not exposed.		
	"The Springs" Quarry.		
II. *Anabacia*-Limestones	2. Limestones, oolitic: at the top single examples of *Syncyclonema demissum* (Phillips), *Terebratula globata*, auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman, seen: ..	5	0
III. Doulting Stone	3. Limestones, shelly. The bottom-portion of this bed is rather rubbly, and much more shelly than the strata below; *Trichites* (fragments), *Ctenostreon pectiniforme* (Schlotheim), *Ostrea*, *Terebratula globata* auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman	2	0
	4. Limestones, dense, white, non-oolitic, sparry: shell-fragments, and a *Rhynchonella* near the top: seen ..	6	6
	Rubble on the bank on the opposite side of the road yielded fossils indicative of deposits of Truellei-Garantianæ hemeræ.		
IV. & VI. Upper Coral-Bed and Upper *Trigonia*-Grit	5. Ragstone, shelly: *Acanthothyris spinosa* (Schlotheim), *Terebratula globata*, auctt. non Sow., *Zeilleria Waltoni* (Dav.), *Rhynchonella hampenensis*, S. Buckman, *Parkinsonia* (fragment), *Isastræa Richardsoni*, E. & H. (large mass), *Opis similis* (Sow.) *Clypeus Hugi*, Agassiz, and ? *Microsolena excelsa*, E. & H.		
Non-sequence.	*Bajocian and Aalenian wanting.*		
	In the deep and usually dry watercourse.		
Sodbury Sands	6. Sands and sandstones: numerous ammonites—*Haugia* cf. *inæqua*, S. Buckman, *H. fascigera*, S. Buckman, *Haugia* (nearest to *H. fascigera*), *Grammoceras toarciense* (d'Orbigny) and *Phlyseogrammoceras dispansum* (Lycett).		

H. B. Holl noticed that fragments of *Trichites* were abundant in the quarry here, and their occurrence along with *Ctenestreon* reminds one of the Vallis-Vale section, where there is a similar association at or about the same horizon.

The actual junction of the rubbly rock, with an assemblage of fossils of *Garantianæ-Truellei* hemeræ with the Sands was not observed, but it is not likely that any limestone of pre-*Garantianæ* date intervenes.

The Sands exposed in the deep and usually dry water-course are particularly interesting on account of their being for the most part of *striatuli* hemera. To the south, at Timsbury Sleight, the *Striatulum*-Beds come *below* the ("Midford") Sands; but to the north *above* the ("Cotteswold") Sands.

From the succession indicated above, it will be seen that at the northern end of the Bath-Dodington Area the sequence is the same as at the southern: the main difference being that the equivalent of the Doulting Stone has become more fossiliferous.

(2) The Dodington-Dursley Area.

This area is characterised by having a well-marked and typical Cephalopod-Bed at the top of the Cotteswold Sands, and freestone-beds (which increase in thickness to the north) between the Cephalopod-Bed and Upper *Trigonia*-Grit.

It is in this stretch of country that the principal change from the typical Doulting Stone to the true *Clypeus*-Grit—as developed at the Bath-Road Quarry, Nailsworth—takes place; but there is not a corresponding change in the *Anabacia*-Limestones. They retain, more or less, their usual appearance throughout the whole area: only in places do they exhibit at the top a rubbly appearance that is suggestive of the Rubbly Beds.

Between "The Springs" and Old Sodbury there are no exposures of any use.

Sequence in the neighbourhood of Old Sodbury.

From time to time the neighbourhood of Old Sodbury has furnished some very valuable details. These, combined with those still obtainable here and at the Horton-Rectory Quarry, render it possible to present the following generalized section:

SEQUENCE IN THE NEIGHBOURHOOD OF OLD SODBURY.

			Thickness in feet	inches
	Fullers' Earth	1. Clay (*exposed in various openings*)		
Inferior Oolite (55 feet): Bathonian	I. Rubbly-Beds or their equivalents, and the top of the II. White Oolite—not exposed: say		8	2
		HORTON-RECTORY QUARRY.		
	II. White Oolite	1. Limestone, white, oolitic, flaggy; a few brachiopods: seen ..	10	0
		2. Rubble, cemented together by infiltrated carbonate of lime, and resembling old mortar ..	0	2
	III. *Clypeus*-Grit	3. Limestone, brown and grey, obscurely oolitic, with a very irregular top; *Terebratula globata*, auctt. non Sow. (common), *Rhynchonella hampenensis*, S. Buckman	8	0
		4. Limestone, grey and pale-brown sparry limestone, massive, top well-planed and has oysters adhering to it in places. At 1 ft. 6 ins. below the base of bed III, 3, the limestone is rubbly; *Terebratula globata*, auctt. non Sow., and *Rhynchonella hampenensis*, S. Buckman, not uncommon in the lowest portion; *Syncyclonema demissum* (Phillips), *Nerinæa Guisei*, Witchell, *Acrosalenia spinosa*, Agassiz, and *Isastræa*, sp. indet. ..	7	4
	IV. & V. Horizon of Upper Coral-Bed and Dundry Freestone	5 Brown marly material, containing pebble-like bodies	0	2
	VI. Upper *Trigonia*-Grit	6. Limestone, yellowish-brown and grey, ironshot, shelly, with a very irregular and water-worn surface, oysters in places; *Trigonia costata* (Sowerby), *Ctenostreon pectiniforme* (Schloth.), *Alaria hortonensis*, Hudleston, *Pentacrinus*-ossicles, etc. ..	3	6
		Non-sequence. Beds VII. *to* XXIII. *wanting.*		
Aalenian	XXIV. Lower Limestone	7. Limestone, brownish-grey, oolitic, well-bedded, passing down into browner and less regularly-bedded hard limestones, with more conspicuous shaly partings, and containing fragments of a *Rhynchonella* and *Pentacrinus*: seen 9 feet. According to Holl, these limestones are 12 feet thick, and rest upon "yellow sandy rock containing *Gresslya*," 2 to 3 ft. in thickness	12	0

Section at Little Sodbury (after S. S. Buckman).

			Thickness in feet	inches
Aalenian	XXV. ? *Scissum*-Beds	8. Straw-coloured, shelly, sandy limestone: about	2	0
Aalenian	XXVI. *Opaliniforme*- & XXVII. *Aalenia*-Beds	9. Reddish-brown, very hard ironshot limestone: about	1	0
		(Beds XXV., XXVII., Mr Buckman parallels with the "sandy ferruginous limestone," and, with a query, with the "*Opalinum*-Beds")		
Upper Lias (205 feet 4 inches) Toarcian	*Moorei*-Beds	10. Greyish, much ironshot marl; *Dumortieria Moorei* (Lycett), *Rhynchonella cynocephala*, auctt.	4	6
	Dumortieria-Beds	11. Darker, soft mudstone, much ironshot; *Dumortieria metita*, S. Buckman, *Rhynchonella cynocephala*, auctt.	2	6
		12 Grey ironshot marl..	3	0
	Dispansum-Beds	13. Grey sandstone	0	4
		Details obtained during the construction of the South-Wales Direct Line—(S. H. Reynolds and A. Vaughan).		
	Striatulum- [*variabilis*-, & ? *Lilli*-] Beds	14. Sands, micaceous, with lenticular bands of hard sandy limestone	185	0
		15. A pyritous bed full of "*Hildoceras bifrons* (Bruguière)"		
	Bifrons-Beds	16. Limestone, compact, marly, with angular jaspery fragments; *Dactylioceras commune* (Sow.), *Dacty. Holandrei* (d'Orbigny) "*Hildoceras Levisoni* (Simpson)" and *Rhynchonella Moorei*, Davidson	10	0
		17. Marl, compact, cream-coloured; *Belemnites* aff *vulgaris*, Y. & B. *Rhynchonella* sp., *Harpoceras falciferum*, auctt.		
	Marlstone	18. "Rock-Bed."		

As will be seen from this record, the Inferior Oolite appears to be some 55 feet thick near its escarpment, but further to the east it may increase in thickness, for Prof. Reynolds and Dr A. Vaughan, from details obtained during the construction of the South-Wales Direct Line, estimate it at about 70 feet.[1]

Messrs Reynolds and Vaughan had to construct the detailed sequence of Inferior-Oolite beds in the neighbourhood of the Cross-Hands Inn, and estimate their thicknesses from specimens brought up from the shafts and labelled as to the depth from which they had been obtained. They had also to

1 Quart. Journ. Geol. Soc., vol. lviii. (1902), pp. 734-739.

assign the fossils picked up off the spoil-heaps to their probable subdivisions on the evidence of any matrix which might be adhering to them, or in which they might be embedded.

These authors assign a thickness of 10 feet to the Upper *Trigonia*-Grit. At the Horton-Rectory Quarry, which is barely a mile and a half away to the north, it certainly does not exceed 3 feet 6 inches. Probably the 10 feet includes the Doulting Stone. The rock-specimens described by Messrs Vaughan and Reynolds, and numbered in their paper 3, 4 and 5 (pp. 737, 738), are probably all Upper *Trigonia*-Grit. Their records of *Ctenostreon pectiniforme* (Schlotheim), which is so common in the top-portion of the Upper *Trigonia*-Grit of the South Cotteswolds, and of the *Montlivaltia* sp. (which is of the same form as that which is abundant at Stantonbury Hill in the Bath-Doulton District) are of distinct interest.[1]

Above the 10 feet of rock that these authors referred to, the Upper *Trigonia*-Grit, was "blue, yellow and white oolite." Judging from their record of *Thamnastræa* aff. *mettensis*, E. and H., *Cladophyllia*, and *Collyrites ovalis*, Leske, I should think that these beds embrace the *Anabacia*-Limestones, for corals are sparsely distributed through the *Anabacia*-Limestones of such sections as Avoncliff, near Bradford-on-Avon; while *Collyrites ovalis* is also a distinctive fossil. There appears to be no evidence of the Upper Coral-Bed at Sodbury, and it is absent also from the Horton section.

In a disused quarry, a little to the south-east of the "Cross-Hands Inn," are white oolitic limestones—the equivalents of the *Anabacia*-Limestones and Doulting Stone. They contain a few specimens of *Terebratula globata*, auctt. non Sow., and *Syncyclonema demissum* (Phillips): the two subdivisions being separated by a layer of crystalline carbonate of lime as at Horton (page 93).

Before leaving the beds of *Garantianæ* and post-*Garantianæ* date, it may be remarked that the "White Oolite" was identified by Holl with his "Upper Ragstone" and the *Clypeus*-Grit, *plus* the Upper *Trigonia*-Grit, with his "Lower Ragstone."

At Sodbury there are the first definite indications of the presence of beds between the Upper *Trigonia*-Grit and Cephalopod-Bed. Now, unfortunately, the sections of them are few and indifferent, but in Holl's time there were some in the lane leading from the "Cross Hands Inn" to Old Sodbury, and—as far as he could determine—the thickness of the intervening beds was 8 to 11 feet. Of this, the bottom 2 or 3 feet was his "*Gresslya*-Bed"—our *Scissum*-Beds. Messrs Reynolds and Vaughan allocate a thickness of from 30 to 35 feet to these sub-Upper *Trigonia*-Grit Inferior-Oolite beds.

1 Quart. Journ. Geol. Soc., vol. lxiii. (1907), pp. 419-420.

Below the *Scissum*-Beds comes the Cephalopod-Bed. The *Moorei*- and *Dumorticria*-Bed portion, of the usual richly-ironshot and fossiliferous type, is to be seen in an opening below the fine ancient earthwork on the hill above Little Sodbury, and formerly was visible (with inferior beds) in the deep lane above the same village. Now, however, this latter section is quite overgrown, and it is necessary to rely upon the details obtained and recorded by Mr Buckman,[1] and re-stated —with certain emendations—in the generalized section given on page 94.[2]

Horton-Rectory Quarry.

The section now under consideration is certainly one of the most interesting in the South Cotteswolds, affording as it does a view of the beds in an area none too rich in exposures. The Fullers' Earth, Rubbly Beds, and the top-portion of the *Anabacia*-Limestones have been removed by denudation, but there is a considerable thickness of the last-named subdivision still remaining. Holl identified it with his "Upper Ragstone,"[3] and Edwin Witchell with his "White Oolite."[4] When I use the term "White Oolite" henceforth in this paper I mean rock on the same horizon as this Horton "White Oolite," because it is by no means certain that the white-coloured limestones of various localities that Witchell called "White Oolite" are of precisely the same age.

The thick-bedded limestones between the conspicuous White Oolite and the fossiliferous Upper *Trigonia*-Grit correspond to the Doulting Stone of the Bath-Doulting district, and to the *Clypeus*-Grit of such sections as that of the Bath-Road Quarry, Nailsworth; and its massive nature is certainly reminiscent of the Doulting Stone of the typical locality. In the lower portion of the *Clypeus*-Grit, *Nerinæa Guisci*, Witchell, is not uncommon. It will be recollected that this gastropod characterises this subdivision as far south as Radstock, and—so far as is known at present—as far north as Rodborough Hill, near Stroud.

1 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 446. 2 The fossils that were procured by the Rev. Steinhauer, and were figured by Sowerby, came no doubt from the Upper *Trigonia*-Grit of a quarry "situated at the very top of the road which runs straight up the hill." 3 Quart. Journ. Geol. Soc., vol. xix. (1863), p. 306. 4 Proc. Cotteswold Nat. F.C., vol. vii., pt. 2 for 1879-80 (1880), p. 120; "Geology of Stroud" (1882), p. 62.

The Upper *Trigonia*-Grit is richly-fossiliferous, even more so than in the neighbourhood of Stroud: specimens of *Trigonia costata* (Sow.) and gastropods being particularly abundant and well-preserved. The late W. H. Hudleston has dealt with the gastropods in his monograph, and has given a section to show the horizons whence they came,[1] which differs in but a few unimportant points from that recorded in the present paper. The same remark applies to Mr H. B. Woodward's record.[2] It will be noticed that there is no Upper Coral-Bed here.

The Upper *Trigonia*-Grit rests upon a very well-planed and bored surface of the underlying Freestone. The total thickness of the Freestone at Horton is said to be 12 feet, and on the evidence of a number of specimens of *Amusium personatum* (Goldfuss) would appear to be correlative with the bottom-portion of the Pea-Grit or the top-portion of the Lower Limestone of sections around Cheltenham. There is no evidence of the bed called the "*Rhynchonella subringens*-Bed" in this quarry.

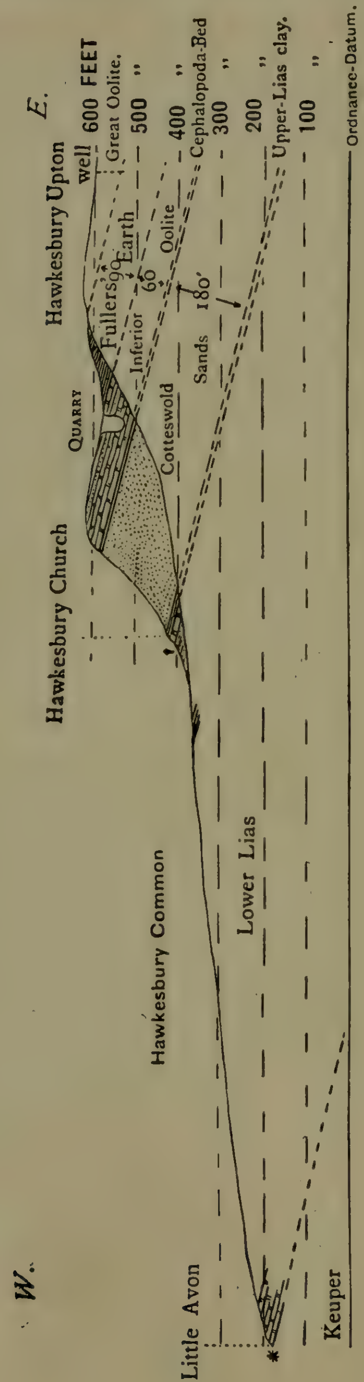
A mile and a half further north the same succession of beds as at the Horton Quarry is to be made out in the sides of the cart-track near the barn on Church Hill, Hawkesbury; but it is unnecessary to record details of this somewhat indifferent exposure, as the succession is so much plainer in the large quarry alongside the road between Hawkesbury and its hamlet of Hawkesbury Upton.

Sequence between Hawkesbury and Hawkesbury Upton

It is remarkable that the sections here have not attracted more attention. Holl noticed that the section was similar to that at Horton, but that there was the Fullers' Earth exposed above, and a greater thickness (probably 25 feet) of Freestone below;[3] Mr H. B. Woodward passed over it altogether in his historic survey of the Oolites;[4] and it was not until 1906 that it received detailed notice, when it was described by the present writer.[5]

1 "Gasteropoda of the Inferior Oolite," Monogr. Palæont. Soc. (1888), pp. 57-59. 2 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 106. 3 Quart. Journ. Geol. Soc., vol. xix. (1863), p. 310. 4 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 106. 5 Proc. Cotteswold Nat. F.C., vol. xv., pt. 3 (1906), pp. 192-194.

FIG. 2.—SECTION ACROSS THE ESCARPMENT OF THE SOUTH COTTESWOLDS.



* Rhætic. † Marlstone. (Scales: vertical, 1 inch = 400 feet; horizontal 3 inches = 1 mile.)

Between the Marlstone, upon which Hawkesbury Church is situated, and the Fullers' Earth is about 262 feet 6 inches of deposit. Of this, about 12 feet is Upper-Lias clay; 180 feet Cotteswold Sands; and about 60 feet Inferior Oolite.

A certain portion of the Cephalopod-Bed, with the *Scissum*-Beds above, is to be seen in an opening on the left-hand side of the road just before arriving at the main quarry. In the main quarry about 27 feet of Freestone—over twice as much as at Horton—are present. Upon the Freestone rest non-sequentially the Ragstones, but they are difficult of access here, and are best investigated in some quarries to be noticed shortly ("Hawkesbury-Monument Quarry").

A spring, also by the road-side, denotes the presence of the Fullers' Earth, which is here full of specimens of *Ostrea acuminata*, Sowerby.

The following is the sequence at Hawkesbury:

SEQUENCE AT HAWKESBURY

				Thickness in feet	*inches*
	Fullers' Earth	1.	Grey and yellow clay with some argillaceous limestone-beds, full of *Ostrea acuminata*, Sowerby		
Inferior Oolite	II. White Oolite.	2.	Limestone, white, oolitic: about	10	4
	III. *Clypeus*-Grit.	3.	Limestone, rubbly in places	9	6
	Non-sequence. Upper Coral-Bed and Dundry Freestone absent.				
	VI. Upper *Trigonia*-Grit	4.	Ragstone, very shelly: usual fossils	4	10
	Non-sequence. Beds VII-XXIII (*inclusive*) *absent*				
	XXVI. Lower Limestone	5 to 9	Limestones, massive-bedded; *Amusium personatum*	20	4
			[Gap: probably similar beds, for say	6	10]
	XXV. *Scissum*-Beds	10 14.	Limestones, somewhat sandy	7	4
	XXVI. *Opaliniforme*-Bed	15.	Limestone, pale-brown, somewhat sandy; *Volsella sowerbyana* (d'Orb.), *Montlivaltia*	1	4
Upper Lias	Cephalopod-Bed	16-24.	Impure ironshot limestones and marls	9	2
	Cotteswold Sands	25.	Sands, fine-grained, pale-yellow, micaceous ..	180	0
	Upper-Lias Clay	26.	Clay, blue: about	12	0
	Marlstone	27.	"Rock-Bed."		

By the side of the road to Wickwar, below Hawkesbury Monument, the Top-Beds of the Oolite are very well displayed in a quarry in work. This section I have described in detail in the Proceedings of the Cotteswold Naturalists' Field Club,[1] so only a summary of the sequence need be given here:

HAWKESBURY MONUMENT QUARRY

		Thickness in feet	inches
Fullers' Earth.	1. Clay: has filled in cracks in the White Oolite		
II. White Oolite.	2. Limestones: seen in quarry about 6 feet, add say 4 feet	10	0
	3. Fairly regular deposit of rubble and calcite (compare Horton and quarry near the "Cross-Hands Inn," pp. 93 and 95 respectively)	0	1
III. *Clypeus*-Grit.	4-8. Limestones, with well-marked partings, not very fossiliferous ..	9	3
	Non-sequence. Upper Coral-Bed absent.		
V. Dundry-Freestone Equivalent.	9. Shaly, very much iron-shot limestone, resting upon an oyster-covered surface of the underlying bed..	0	2[2]
VI. Upper *Trigonia*-Grit.	10. Ragstone, shelly, well iron-shot: usual fossils ..	4	6
	Non-sequence. Beds VII.-XXIII. (*inclusive*) *absent.*		
XXIV. Lower Limestone.	Limestone: top well-planed, bored, and oyster-covered: seen	3	0

At the the time I wrote the report of the excursion of the Cotteswold Club to Hawkesbury I was uncertain to which bed 9 should be given. I now think it had better be designated the Dundry Freestone Equivalent. Probably it represents only a small portion, as it rests upon a bored surface of the Upper *Trigonia*-Grit, and is itself bored.

The Freestones, replete with specimens of *Amusium personatum* (Goldfuss) along certain horizons, and having the Upper *Trigonia*-Grit resting on their bored and planed surface, are to be seen in the old disused quarry in the woods at Chandler's Cliff, between Hawkesbury Upton and Hillsley. The small quarry in work by the road-side is in the Freestones, and lower down the hill is an exposure of Cotteswold Sands

1 *Loc. cit.*, vol. xv., pt. 3 (1906), p. 194. 2 Erroneously printed as 2 feet 2 inches in the Cotteswold Club Report.

FREESTONE QUARRY AND COOMBE VALLEY FROM WARREN WOODS WOTTON-UNDER-EDGE

(Albert Durn, photo.)

(From Burrow's "Guide to Wotton-under-Edge.")

with traces of the Cephalopod-Bed above. *Pseudogrammoceras pedicum*, S. Buckman, was found here.

North of Hawkesbury the hill-country is greatly intersected by ramifying valleys with lateral combs, but the geologic structure is very simple, and readily-read with the aid of a geological map.

In Tresham Comb, there is an exposure of the Cephalopod-Bed shortly beyond the second gate that is passed through in ascending the valley; while a little higher up (on the same side of the wheel-tract—the right) is a quarry in the Freestones and Upper *Trigonia*- and *Clypeus*-Grits. *Amusium personatum* occurs in the Freestones, and a specimen of *Parkinsonia Parkinsoni* (Sow.) was obtained from the Ragstones. Owing to rock-sliding, it was not possible to obtain reliable details of the Top-Beds, but Fullers' Earth occurs above, and has yielded *Cristellaria cultrata*, Montf., and *Cytheridea Bradiana*, Jones. The usual *Ostrea-acuminata*-Limestones are present, and contain not uncommonly *Pseudomonotis echinata* (Sow.).

On the hill east of Alderley is the quarry in which *Prosopon Richardsoni*, H. Woodward, was found. The section was described in the Geological Magazine for 1907 (pp. 82-84), so it will suffice to say that it shows the ? Rubbly Beds, White Oolite, *Clypeus*-Grit, Dundry-Freestone-Equivalent, and Upper *Trigonia*-Grit.

On Tor Hill is a large quarry in which the Freestones are worked. In the shallower northern portion the Upper *Trigonia*-Grit is seen above, and has 1 foot 2 inches above its base a layer crowded with *Rhynchonellæ*.

Similar Freestones to those at Tor Hill have been worked at Boxwell, and again in the conspicuous quarry on the hill north of Coombe, near Wotton-under-Edge: that in which the Dursley Rural District Council have placed a reservoir. Here the basal layers of the Upper *Trigonia*-Grit are seen resting upon the "Bored-Bed," at 20 feet below which is a rubble-bed that may well be on the horizon of the Pea-Grit. In the limestones below it *Amusium personatum* is particularly abundant.

To the north of Wotton-under-Edge, between Wotton and Symond's-Hall Hills, are several sections which afford an almost complete view of the succession from the Cotteswold Sands to the Great Oolite. The satisfactory nature of the locality for studying these beds was long ago recognised by Lycett[1] and Wright:[2] the latter geologist giving a generalized account and section (text-figure) of beds from the Lower Lias to the top of the Inferior Oolite.

Ascending Wotton Hill, the first exposure (Wotton-Hill Quarry—II.) is in an old quarry, now much overgrown, on the north side of the road. It shows the top-portion of the Sands, the Cephalopod-Bed, and the basal portion of the Oolite. It has long been known as a locality rich in specimens of *Grammoceras striatulum* (Sow.), and *G. toarciense* (d'Orb.), and, in my opinion, is the best place in the South Cotteswolds for studying the Cephalopod-Bed and its relations with the sub- and super-jacent deposits. It will be observed that the two rather prominent limestone-bands and intervening marl below the *Dispansum*-Beds, usually referred to as the "*Striatulum*-Beds,"[3] have been more precisely dated. The *Scissum*-Beds occur at the top of the quarry, and, as at Haresfield, yield *Pholadomya fidicula*, Sow., and *Volsella sowerbyana* (d'Orb.) not infrequently.

There is a gap between this section and the large quarry where the Freestone and Ragstone-Beds have been worked for road-metal; but the Freestone must be between 30 and 40 feet thick. The beds seen in this second, and very large, quarry are detailed under the heading of "Wotton-Hill Quarry—I." in the record given on page 104. Of previous workers, Mr H. B. Woodward has mentioned its existence,[4] and the late W. H. Hudleston noticed that the Upper *Trigonia*-Grit rested upon the Freestone without the intervention of any Gryphite-Grit; that *Nerinæa Guisci* occurred in its usual position in the *Clypeus*-Grit; and that about the middle of the Freestone there was a "slight unconformity in connection with a bed of *Nerinæa*."[5]

The Upper *Trigonia*-Grit is not typically developed in this quarry; but the most interesting points are that there is a layer of lenticular masses of coral on the horizon of the Upper Coral-Bed, and that between it and the Upper *Trigonia*-Grit is a thin deposit referable to the Dundry Freestone.

1 "Cotteswold Hills" (1857), pp. 16-18, 50. 2 Quart. Journ. Geol. Soc., vol. xii. (1856), pp. 306-309: see also "Jurassic Rocks of Britain—Lower Oolitic Rocks of England (Yorkshire excepted)," Mem. Geol. Surv, vol. iv. (1894), pp. 106-107. 3 See Proc. Geol. Assoc., vol. xx. (1908). p. 525. 4 *Ibid.*, p. 106. 5 "Gasteropoda of the Inferior Oolite," Monogr. Palæont. Soc. (1888), p. 59.

WOTTON HILL, SHOWING THE FREESTONE QUARRY, FROM MOUNT PLEASANT, WOTTON-UNDER-EDGE

(*Albert Durn, photo.*)

(*From Burrow's "Guide to Wotton-under-Edge."*)

The Top-Beds are much more accessible in a quarry about a mile away, which may be called the "Coombe-Hill Quarry." It was from the Upper Coral-Bed here that a specimen of *Lissoceras psilodiscum* (Schloenbach) was procured. The discovery was of particular importance, in that it afforded the first definite evidence for the date of the Upper Coral-Bed, namely, *Truellei* hemera, which has now been recognised at such widely-separated localities, and has proved so valuable a datum-level in correlating the "Top-Beds." This quarry also reveals the fact that the *Clypeus*-Grit is becoming increasingly fossiliferous, and the appearance of *Clypeus Ploti*, Klein, is interesting.

Continuing up the road in the direction of Symond's-Hall Hill, the presence of the Fullers' Earth is easily discerned in the hummocky nature of the ground. There is a small exposure in the field to the right of the road at an altitude of about 670 feet, and deposits of clay and limestone-bands replete with *Ostrea acuminata*, Sow., are visible. Still higher up the hill, about 780 feet above ordnance-datum, is a quarry in the basement-beds of the Great Oolite, the lowest of which have an initial Stonesfield-Slate aspect.

SEQUENCE AT WOTTON-UNDER-EDGE.

SYMOND'S-HALL-HILL QUARRY.

			Thickness in feet	inches
Great Oolite.		1. Limestone, fissile at the base		
		IN THE FIELDS ON THE HILL-SIDE.		
Fullers' Earth.		2. Clay, with limestone-bands, full of *Ostrea acuminata*, Sow.		
Inferior Oolite	I. Rubbly Beds	3. Not exposed. Add say ..	3	2
		COOMBE-HILL QUARRY		
	II. White Oolite	4. Limestones, flaggy: seen ..	2	6
		5. Limestone, oolitic, but harder than the beds above and below, and containing *Terebratula globata*, auctt. non Sow., abundantly.. ..	1	8
		6. Rubbly parting	0	4
		7. Limestone, white oolitic ..	5	0
	III. *Clypeus*-Grit	8. Limestone, hard, yellowish pisolite-like spherules ..	1	0
		9. Limestone, rubbly; *Pleuromya Goldfussi* (Lycett), *Limatula gibbosa* (Sow.), *Syncyclonema demissum* (Phillips), *Holectypus depressus* (Leske), etc.	0	5

Sequence at Wotton-under-Edge.—Symonds-Hall-Hill Quarry

continued

			Thickness in feet	inches
Inferior Oolite		10. Parting, irregular	0	0½
		11. Limestones, hard, rubbly in places at the top; *Homomya gibbosa*, Sow., etc... ..	3	4
		12. Limestones, two layers ..	0	8
		13. Limestone, shaly: 1 to 2 ins.	0	1
		14. Limestone; *Acanthothyris spinosa* (Schloth.): average	0	6
		15. Limestone, bored, very irregular upper surface with pebbles adhering: average	0	7
		16. Parting	0	0½
	IV. Upper Coral-Bed	17. Limestone, whitish, shelly, with lenticular masses of coral at the base; *Lissoceras psilodiscum* (Schloenbach), *Terebratula globata*, auctt. non Sow.	0	6
		Non-sequence		
	VI. Upper *Trigonia*-Grit	19. Ragstone, very shelly, being full of the usual fossils, and joined on to bed 17 here: seen	2	0
		Wotton-Hill Quarry—I.		
	IV. Upper Coral-Bed	17. A whitish shelly rock in lenticular masses, and with lenticular masses of coral (*Isastræa*) mixed with marly lime-washed matter; *Ctenostreon*	0	9
		Marly layer	0	1
		Slight non-sequence.		
	V. Dundry-Freestone-Equivalent	18. Limestone, hard, shelly, slightly iron-speckled, bored in places	0	2
		Slight non-sequence.		
	VI. Upper *Trigonia*-Grit	19. Limestone, hard grey, top bored and waterworn in places; *Ostrea* sp... ..	1	8
		20. Limestone, rubbly; fossils scarce	0	10
		Non-sequence. Beds VII. *to* XXI. ? (*inclusive*) *wanting.*		
	? XXII. Lower Freestone	21. Limestones, coarsely-oolitic	14	0
		22. Rubble and marl	0	1
		23. Limestones, massive ..	1	10
		24. Rubble: 1 to 3 inches ..	0	2
		25. Limestone, under side very irregular; *Nerinæa* ..	1	8
	? XXIII. Pea-Grit Horizon	26. Rubble; *Trichites* (fragments); 4 to 8 inches	0	6
	XXIV. Lower Limestone	27. Limestone, massive: seen 16 to 20 feet	18	0
		[28. Limestone: add say ..	3	9]

WOTTON-HILL QUARRY—II.

Series	No.	Bed	Description	Thickness feet	Thickness inches
Inferior Oolite	XXV.	*Scissum*-Beds	[29. Limestone: add perhaps ..	3	5]
			30. Limestones, arenaceous; *Pholadomya fidicula*, Sow., *Terebratula euides*, S. Buckman, with *Actinopora diplopora*, Branco, and *Stomatopora* on it	0	9
			31. Rubbly, but otherwise similar limestone	0	6
			32. Limestones, massive; *Volsella sowerbyana* (d'Orb.) ..	3	4
	XXVI.	*Opaliniforme*-Bed	33. Limestone, hard, slightly iron-speckled	1	0
			? *Indications of a non-sequence.*		
Upper Lias (Cephalopod-Bed)	XXVII.	*Aalensis*-Bed	34. [6] Dirty-grey, ironshot, indurated marl, very ferruginous where it is joined on to the bed above	0	6
			35. [7] Layer of dark-brown clay; *Rhynchonella cynocephala*, auctt.	0	2
		Moorei-Bed	36. [8] Grey and brown ironshot marl; *Zeilleria* ? sp. nov. near the top, *Lytoceras Wrighti*, S. Buckman, *Syncyclonema demissum* (Phillips)	1	6
			37. [9] Similar rock, but indurated to form a hard bed; *Rhynchonella cynocephala*, auctt.: maximum ..	1	4
			(*At the western end the beds have slipped forward and down*).		
		Dumortieria-Bed	38. [10] Brown and grey-dappled ironshot marl, with thin and impersistent hard bands; *Catulloceras Leesbergi* (Branco) (pl. xxxix. figs. 10, 11,)[1] *Dumortieria* sp. (pl. xlv., 15, 16), *Hudlestonia serridens* (Quenstedt), *Dumortieria novata*, S. Buckman; *Terebratula haresfieldensis*, Dav., in lower part	3	0
			39. [11] Marl, indurated, grey, sparsely ironshot, very ferruginous in places	0	8
		Dispansum-Bed	40. [12] Similar bed to the preceding; large belemnites, *Phlyseogrammoceras dispansum* (Lycett)	2	6
		Struckmanni-Bed	41. [13] Limestones in two beds with marl-parting, coarsely, but not richly-ironshot ..	1	8

WOTTON-HILL QUARRY—II.—*continued*

				Thickness in feet	inches
Upper Lias	Cephalopod-Bed	*Pedicum*-Bed "Linseed-Bed"	42. [14] Marl, coarsely-ironshot, dark-coloured; *Belemnites* spp., *Pseudogrammoceras Saemanni* (Dumortier) (Suppl., pl. xl.: or beds above)	1	0
		Striatulum-Bed	43. [15] Limestone, massive, iron-shot; *Grammoceras striatulum* (Sow.), *G. toarciense* (d'Orb.)	1	2
	Cotteswold Sands	*Variabilis*- & ? *Lilli*-Beds	44. Sands, fine-grained, micaceous, yellow, indurated near the top: *according to T. Wright*	123	0
		Falciferum-Bed	45. Clays, grey, sandy, with some limestone-nodules (exposed in a brick-yard): *according to Wright*	10	0
Middle Lias		*Spinatum*-Bed	46. "Rock-Bed"	12	0

N.B.—The numbers in square brackets against the beds are to connect this record with that given by Mr S. S. Buckman at Nibley Knoll.—Q.J.G.S., vol. xlv., 1889, *p.* 445.

Near the Monument on Nibley Knoll, which is such a land-mark, is a quarry in which the Upper Coral-Bed is very well displayed: better so than anywhere else in the South Cotteswolds, with the exception of Rodborough Hill. The section was noticed by Mr S. S. Buckman, but he simply recorded that the "Upper *Trigonia*-Grit" overlies the Freestone, which in turn succeeds to beds which he refers with a query to D^{1}, that is, to the "Sandy ferruginous beds" of Witchell.[2] He gives, however, a detailed account of the "*Opalinum*-Zone," Cephalopod-Bed, and Cotteswold Sands, which are exposed at the top of the bank by the lane-side between the quarry and North-Nibley village. This account is amplified in a paper published by the same author in 1889, the Freestone being referred to the "*Murchisonæ*-Zone"; while the Upper Lias deposits are more minutely subdivided.[3] Mr H. B. Woodward gives a record of the beds exposed in the quarry; but only makes two subdivisions—Ragstones and Freestones; while he publishes a summary of Mr Buckman's record of the beds in the lane-section.[4]

1 The numerals and figures in square brackets after the names of fossils refer to specimens figured in Mr S. S. Buckman's "Inferior Oolite Ammonites of the British Islands." Monogr. Pal. Soc. (1888-1908). Mr Buckman very kindly furnished me with this information. 2 *Idem.* (1888), pp. 46-47. 3 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 445. 4 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 107.

NIBLEY-KNOLL QUARRY.

			Thickness in feet	inches
III.	*Clypeus*-Grit	1. Limestone, whitish-grey, with small soft pisolite-like spherules, which, falling out, give the rock a pitted nature; *Pleuromya Goldfussi* (Lycett), *Syncyclonema demissum* (Phillips), *Ceromya striata* (Sowerby), *Serpula* sp., *Terebratula globata*, auctt. non Sow., all rare: seen	6	0
IV.	Upper Coral-Bed	2. Limestone, rubbly, whitish, and coated with lime; *Terebratula subsphæroidalis*, Upton (along a line at the top), *Clypeus Hugi*, Agassiz, [*Acrosalenia pustulata*, Forbes], *Ctenostreon pectiniforme* (Schloth.), *Limatula gibbosa* (Sow.), *Plagiostoma bellulum*, (M. & L.), *Syncyclonema demissum* (Phillips), *Chlamys articulata*, auctt., *Isastræa* sp.: 1 to 7 ins.	0	4
		Non-sequence. Dundry Freestone wanting.		
VI.	Upper *Trigonia*-Grit	3. Ragstone, very shelly, usual fossils, but *Acanthothyris spinosa* very abundant at 4 inches from the base ..	1	4
		Non-sequence. Beds VII.-XXI. (*inclusive*) *wanting.*		
? XXII.	Lower Freestone	4. Limestone; top-bed much bored and oyster-strewn	13	0
? XXIII.	Pea-Grit Equivalent	5. Rubbly layer; *Belemnites* spp.: 0 to 6 inches	0	3
		6. Limestone; *Amusium personatum* (Goldfuss)	10	0
		7. Rubbly layer; *Belemnites* sp... ..	0	5
XXIV.	Lower Limestone	8. Limestone, more massive; *Amusium personatum* common: seen	8	0

The sequence of the component layers of the Cephalopod-Bed is so essentially the same as at Wotton Hill that it is unnecessary to detail it here. It will be sufficient to draw attention to the presence of the newly-recognised *Pedicum*-Bed, better known to collectors as the "Linseed-Bed."

STINCHCOMBE HILL.

The sections now to be noticed are on that conspicuous promontory, Stinchcombe Hill, and its south-easterly extension, Break-Heart Hill.

Under the guidance of the writer, both the Geologists' Association and the Cotteswold Club have studied its structure, and reports of the excursions have appeared in the Proceedings of these Societies.[1] It will be unnecessary, therefore, to do

1 Proc. Geol. Assoc., vol. xx. (1908), pp. 526-529; Proc. Cotteswold Nat. F. C., vol. xvi., pt. 3 (1909), pp. 212-216 and pls. xviii. and xix.

more than record the actual succession, and to briefly indicate where the several deposits can best be studied.

The hill is most conveniently approached from Berkeley-Road Station. A slight rise leads up to the platform formed by the Marlstone, which—in this area in particular—has been extensively quarried for road-metal. At the south-eastern end of the large quarry still (1910) in work, near the Yewtree Inn, indications of the richly-fossiliferous "Transition-Bed" of the Midlands (a deposit of *acuti* hemera) have been noticed by Messrs Beeby Thompson and W. D. Crick; but they are difficult to find now.[1]

To the Marlstone succeeds the Upper-Lias clay, which may be anything up to 40 feet in thickness. A well sunk in the field in the hollow between the Yewtree Inn and the hill, and now marked by the windmill, proved the *Falciferum*-Beds; while in a "Section in the road at Stinchcombe," opposite Peers Court, Mr S. S. Buckman informs me, he obtained evidence of the *Bifrons*-Beds with the Cotteswold Sands above.[2]

On the way up the hill there is ample evidence of the Cotteswold Sands, and near where the wall commences above the gravel-pit, the Cephalopod-Bed is seen cropping out in the bed of the road. It is only indifferently exposed here, and is best seen in the deeply-cut lane leading from Break-Heart Hill down to the inn near Fording Brook. In this lane there is also the finest section through the Sands that there is in the Cotteswold Hills—the Sands being about 230 feet thick, and visible for nearly their entire thickness. Near the bottom of the lane some hardish bands are interstratified in the Sands, and have yielded a few specimens of *Haugia*. The lithic and faunal characters and sequence of component layers of the Cephalopod-Bed here are so similar to their equivalents at North Nibley and Wotton-under-Edge that a detailed record of this section is really unnecessary.

Passing on to the Common on the hill, a number of old quarries will be observed. The beds exposed in them are described in the record given on page 112. A rubbly layer is queried as being on the horizon of the Pea-Grit, and if this surmise is correct it makes, of course, the Freestone *above* it, Lower Freestone, and that below it, Lower Limestone.

1 Rep. Brist. Assoc. for 1891, p. 350. 2 Quart. Journ. Geol. Soc., vol. xlv. (1889), p. 446.

There are several other quarries in the Freestones on this hill, for example, near the top of the lane leading up from Fording Brook; at the top of Nunnery Lane; at Break-Heart Hill; and again in Hillside Wood.

There are no beds between the Upper *Trigonia*-Grit and Freestones in this hill-mass. Everywhere the former rests upon a water-worn and bored surface of the latter.

The quarry at Break-Heart Hill is the one concerning the date of the limestones in which Mr H. B. Woodward entertained some doubt. He leaned to its Inferior-Oolite age, but referred the beds to the horizon of Witchell's White Oolite instead of to the freestones of *Murchisonæ* hemera.[1] Actually, there are three feet of Upper *Trigonia*-Grit overlying about five times that thickness of Freestone.

Mr Woodward also referred to the Nunnery-Lane Quarry, describing it as the "section south of Dursley."

NUNNERY-LANE QUARRY.

(*Opening in the abandoned working above the main quarry.*)

			Thickness in feet	inches
III.	*Clypeus*-Grit	Rubble; *Limatula gibbosa* (Sow.), etc.		
VI.	Upper *Trigonia*-Grit	Ragstone, shelly: seen *in situ*, about ..	3	0
? XXII.	L. Freestone	Limestone: seen	6	0
		(*In the main freestone quarry*)		
? XXII.	Lower Freestone	Limestone: seen	8	0
? XXIII.	Pea-Grit Horizon	Rubbly rock of a yellower colour than the contiguous limestones, pisolitic in places, pebbly; *Rhynchonella subangulata*, Dav., *Terebratula* (? *T. plicata*, J. Buckman): about	0	10
XXIV.	Lower Limestone	Limestone: seen about	27	0

The Upper *Trigonia*-Grit is only thin here in comparison with its normal development in the Mid Cotteswolds; but is quite typical and replete at the top with fragments of *Trichites*. Its surface is oyster-strewn, and thereon rests a marly layer correlative with the Upper Coral-Bed, which at Stancombe Quarry has yielded quite a number of highly-interesting echinoids. The upward succession is best made out in the Stancombe Quarry, which is on the east side of Hollow Combe. It is divided into two portions by a trackway.

1 "The Jurassic Rocks of Britain, etc.," Mem. Geol. Surv., vol. iv. (1894), p. 88; see also Proc. Geol. Assoc., vol. xx. (1908), p. 527.

There is nothing particular to record with regard to the southern portion. The northern portion is also divisible into two parts—this time by a grass-covered slope, which marks a line of fault. In the first part of this northern portion is seen about 3 feet of the usual kind of Upper *Trigonia*-Grit, with a well-marked layer of oysters on top. Then comes a rubbly deposit, which is of exceptional interest, in that—as already mentioned—it has yielded a number of comparatively rare echinoids. In the Coral-Bed equivalent, and in presumably the basal portion of the overlying limestone-rubble, *Terebratula subsphæroidalis*, Upton, is by no means uncommon.

At the extreme northern end of the other portion of the quarry are bedded, unfossiliferous limestones, passing up into more rubbly rock, which contains *Clypeus Agassizi*, Wright, while this is followed by distinctly fossiliferous limestone—the whole constituting the local *Clypeus*-Grit. The White Oolite is represented by greyish, rather sandy-looking limestones, with few fossils except for *Acanthothyris spinosa* (Schlotheim); and then, capping the section, are the Rubbly-Beds—quite typical and abounding in *Terebratula globata*, auctt. non Sow., *Holectypus depressus* (Leske), etc.

Returning to the combe at the northern end of the hill, at the head of which a new house has been erected and a reservoir constructed, a number of interesting exposures were available when the pipe from the windmill in the bottom, near the Yew-tree Inn, to this reservoir on the hill-top, was being laid. The freestones were disclosed with the Upper *Trigonia*- and *Clypeus*-Grits above. Then in a trial hole, occupying a position *between* the *Clypeus*-Grit and Rubbly-Beds, and therefore *presumably* on the horizon of the White Oolite, were the interesting beds detailed below. Here and there on Stinchcombe Hill it seems probable that there are pockets of Fullers' Earth; but this deposit is best seen in a pond-side close to the road on Break-Heart Hill.

Deposits exposed in a Trial-Hole on Stinchcombe Hill.

	Thickness in feet	inches
1. Limestone, rubbly, pale-brown: *Pholadomya* spp., *Goniomya angulifera* (Sow.), *Natica bajociensis*, d'Orb., *Terebratula globata*, auctt. non Sow., *Perisphinctes pseudo-martinsi*, Siemiradzki	1	3
2. Clay, marly; Ostracoda and Foraminifera (*see below*)	0	2

3. Limestone, as before; *Terebratula globata*, auctt. non Sow., *Aulocathyris carinata* (Lamarck), *Acanthothyris spinosa* (Schlotheim) *Galeolaria socialis* (Goldfuss), *Collyrites ovalis* (Leske), etc. 0 10
4. Shaly marl with lumps of limestone in places; Ostracoda and Foraminifera: 3 to 5 inches 0 4
5. Limestone, brown, crystalline: seen 0 10

Associated apparently with the basal portion of the Rubbly Beds, and revealed in material thrown out of the excavation for the pipe, was some more greenish-yellow clay, very rich in Ostracoda and Foraminifera. Mr C. Upton mounted the specimens, and Mr Joseph Wright, F.G.S., of Belfast, very kindly identified them for me as far as was possible.

MICROZOA FROM STINCHCOMBE HILL.

SPECIES	Marl-Bed at the base of the Rubbly Beds	Marly Beds on the horizon of the White Oolite
Anomalina ammonoides (Reuss)	*	
Cornuspira cretacea, Reuss	*	*
Cristellaria acutauricularis (Fichtel)	*	*
—— *exilis*, Reuss	*	*
—— *italica*, Defrance	*	*
—— *Marcki*, Reuss	*	*
—— *rotulata* (Lamarck)	*	*
—— *tricarinella*, Reuss	*	*
—— sp. (intermediate between *C. acutauricularis and C. rotulata*)	*	*
Discorbina globularis, d'Orbigny	*	
Flabellina pulchra, d'Orbigny	*	*
? *Globerigina bulloides*, d'Orb.	*	
? —— *cretacea*, Reuss	*	
? *Lagina* sp.	*	
Lingulina semiornata, Reuss	*	
Marginulina bullata, Reuss	*	*
Nodosaria communis (d'Orb.)	*	
—— *farcimen* (Sold.)	*	
—— *obliqua* (Linné)	*	
—— *scalaris* (Batsch.)	*	
—— *raphanus* (Linné)	*	*
Planularia Bronni, Roemer	*	*
—— *parvula* (d'Orb.)		*
—— *pauperata*, T. & P.	*	*
Textularia trochus, d'Orb.		*
Verneuilina aff. *pygmæa* (Egger)	*	*
Cytheridea craticula, (Jones and Sherborne) ..		*
—— cf. *fullonica*, J. & S.		*
and 25 or 26 unidentified species		*
Chirodota-spicules (6-rayed)		*
Sponge-spicules		*

SEQUENCE AT STINCHCOMBE HILL, NEAR DURSLEY.

			Thickness in feet	inches
		(Pond in the wood by the road-side on Break-Heart Hill)		
	Fullers' Earth	1. Clay, bluish-grey and yellow, with *Cristellaria cultrata*, Montford, Ostracoda, 5 spp. and intercalated limestone bands almost wholly made up of *Ostrea acuminata*, Sow.		
		(Stancombe Quarry: north-west portion.)		
I.	Rubbly Beds	2. Limestones, rubbly, pisolitic; *Terebratula globata*, auctt. non Sow., one specimen with *Kololophus Terquemi* (Haime) on it, *Rhynchonella* spp., *Acanthothyris spinosa* (Schlotheim), *Limatula gibbosa* (Sow.), *Ceromya striata* (Sow.), *Natica bajociensis* (d'Orb.), *Clypeus Ploti*, Klein, *Holectypus depressus* (Leske), and var. *conicus*, Paris, etc.: seen	2	0
II.	White Oolite	3. Limestones, rather sandy-looking; *Ceromya plicata*, Agassiz, *Acanthothyris spinosa* (Schloth.): about 4 ft. seen: add say 1 ft.	5	0
III.	*Clypeus*-Grit	4. Limestone, somewhat hard, rather barren at the base, passing up into less-bedded oolite that contains *Clypeus Agassizi*. Wr., and this into a very shelly rock: seen	7	0
		(Stancombe Quarry: south-east portion.)		
		5. Limestone; *Camptonectes* sp. *Terebratula subsphæroidalis*, Upton, *Acanthothyris spinosa* (Schloth.): seen	2	6
		6. Limestone, rather hard	0	8
IV.	Upper Coral Bed	7. Rubbly deposit, very fossiliferous; *Acrosalenia pustulata*, Forbes, *Clypeus Hugi*, Agassiz, *Echinobrissus clunicularis* (Llhwyd), *Acanthothyris spinosa* (Schloth.), *Terebratula subsphaeroidalis*, Upton, *Serpula* 2 spp.	0	3
		Non-sequence. Dundry Freestone wanting.		
VI.	Upper *Trigonia*-Grit	8. Ragstone; usual fossils: seen ..	2	6
		(Small opening near the seat on the summit of the hill.)		
VI.	Upper *Trigonia*-Grit	9. Ragstone, very shelly; *Ctenostreon pectiniforme* (Schloth.), *Trichites undulatus*, Lycett, *Zeilleria Hughesi* (Walker), and usual fossils: seen about	3	0
		Non-sequence. Beds VII *to* ? XXI *incl. wanting.*		
		(Gap: grass-covered slope to old quarries: 8 to 10 *feet.)*		
? XXII.	Lower Freestone	10. Limestone: 4 to 6 feet	5	0

CAM LONG DOWN AND DURSLEY

(*G. A. Powell, photo.*)

(*From Burrow's "Borough Guide to Dursley."*)

SEQUENCE AT STINCHCOMBE HILL, NEAR DURSLEY—*continued*

			Thickness in feet	inches
? XXIII.	Pea-Grit horizon	11. Somewhat iron-stained rubbly deposit; *Pentacrinus*-ossicles, *Rhynchonella granulata*, Upton: 6 to 12 inches	0	9
XXIV.	Lower Limestone	12. Limestone: oolite	6	0
		13. Noticeable deposit of white "sand," made up of oolite granules: no microzoa	0	1
		14. Limestone, coarsely-oolitic	0	8
		15. Dark-red deposit of quartz sand: no microzoa	0	1
		16. Limestone, oolitic. top well-planed: seen	6	0
		[Unexposed: say	13	0]
XXV.	*Scissum*-Beds .. .. } *estimate*		7	4
XXVI. & XXVII.	*Opaliniforme* and *Aalensis-Beds* }			
	Cephalopod-Bed (Liassic portion): *estimate*		13	6
	Cotteswold Sands: estimate		230	0
	Upper-Lias clay: estimate: 30 to		40	0

(3) DURSLEY-SELSLEY-HILL AREA.

The physical feature of the district between Dursley and Uley is the deep, gulf-like hollow, out of which rise curious, smooth-sided, grass-clothed hills, of which Downham Hill ("Warren Hill" on the Geological Survey-Map) and Peakéd Down are conical, and Cam Long Down is noticeably flat-topped (Plate XVII). These outlying masses are the product of ordinary subaërial denudation, assisted by the "lie" of the rocks. They are based upon the easily-located Marlstone, to which succeeds the Upper-Lias clays and sands—together some 270 feet thick.

Ascending Cam Long Down by the track which passes through a deep cutting in the Cotteswold Sands, where that track emerges at the top of the Common, there is on the left an exposure of the *Dumorticria-Struckmanni*-Beds of the Cephalopod-Bed, while a little higher up is one in the portion which is of *opaliniformis-aalensis* date. The *Opaliniforme*-Bed is remarkable for its large, hard, yellow-coated granules, which render it readily identifiable. Yet higher up is a quarry in the Lower Limestone.

The details that have been obtained at Cam Long Down may thus be summarized:

SEQUENCE AT CAM LONG DOWN

(*Quarry on Cam Long Down*)

			Thickness in feet	inches
XXIV.	Lower Limestone	1. Limestones, massive		
XXV.	*Scissum*-Beds	2. Limestones, sandy; *Galeropygus agariciformis* (Wright)		
		(*Opening by the track-side to the west.*)		
XXVI. and XXVII.	*Opaliniforme*- and *Aalensis*-Beds	3. Limestone, hard, with yellow-coated specks; Ammonites much perished, and without test, [Walkeria, spp.], *Lytoceras Wrighti*, S. Buckman, *Pholadomya fidicula*, Sow.	2	6
		(*In another opening still further west.*)		
	? *Moorei*-Bed	4. Yellowish sandy marl with belemnites	0	7
	Dumortieria-Bed	5. Stone, bluish-yellow [*Dumortieria costula* (Reinecke) (xxxvii., 12 and 13), *D. signata*, S. B. (xlii., 6 and 7), *D. radians* (Reinecke) (xlii., 8 and 9), *D. metita*, S. B. (xlii., figs. 11, 22), *D. diphyes*, S.B. (xlii., 13-15), *Hudlestonia serrodens* (Quenstedt) (xxxviii., 11 and 12)], *Trigonia Ramsayi*, Wright, etc.		
		6. Yellowish marl	0	1
	Struckmanni-Bed	7. Limestone, with brown grains [*Pseudogrammoceras subquadratum*, S. B. (xxxv., 3-5), *P. pachu*, S. B. (xxxiv., 1 and 2), *Volsella sowerbyana* (d'Orb.), *Opis carinata*, Wright, *Protocardia Hulli* (Wr.), *Gresslya abducta* (Phillips), *Astarte lurida*, Sow.]	0	6
	Pedicum-Bed	8. "Linseed-Bed." Brown marl, with numerous dark grains	0	2
	Striatulum-Bed	9. Limestone, brown, with dark-brown grains; *Haugia Eseri* (Oppel.) ..	0	5
		10. Marl, dark-brown, filling in the inequalities of the bed below.		
	Variabilis- and *Lilli*-Beds	11. Limestone, bluish-grey, sandy (*Exposed in "The Gully."*)		
		12. Sands, yellow; *estimated at*	220	0
	Falciferum-Beds	13. Clay, blue, tenacious; *estimated at*	70	0
	Marlstone	14. "Rock-Bed"; *Rhyn. amalthei* (Quenstedt), and *Belemnites* spp. very abundant		

I am indebted to Mr S. S. Buckman for certain stratigraphical details, and for the information with regard to the ammonite-fauna.

COALEY WOOD

The large quarry in Coaley Wood is plainly visible from Cam Long Down. Descending the steep eastern slope of the hill, getting into the lane, and proceeding along it to "The Moors," the first turning to the right leads up through Coaley Wood. Soon after the lane becomes sunk, the hard sandy limestone which yields *Hildoceras semipolitum*, S. Buckman, so abundantly, and is of *Lilli* date, is seen projecting from the bank on the right-hand side. Then high up on the left, is the well-known Coaley-Wood section of the Cephalopod-Bed.

SEQUENCE IN COALEY WOOD

				Thickness in feet	inches
			(Old Quarry at Crawley Barns.)		
II.	White Oolite	1.	Limestones, white, flaggy, oolitic, with a noticeable amount of calcite in the matrix; *Acrosalenia spinosa*, Ag., *Terebratula globata*, auctt. non Sow. (rare)		
		2.	Marl, yellowish: average	0	1
III.	*Clypeus*-Grit	3.	Limestones; *Cardium citrinoideum*, Phillips		
			(Coaley-Wood Quarry.)		
VI.	Upper *Trigonia*-Grit.	4.	Ragstone, shelly, usual fossils		
			Non-sequence. Beds VII.-XXI. (incl.) wanting.		
XXII.	Lower Freestone	5.	Limestones, oolitic: about	35	0
XXIII.	Pea-Grit horizon	6.	Rubble and Marl	0	6
XXIV.	Lower Limestone	7.	Limestones, oolitic: 20 to 25 feet ..	22	0
			(Section of the Cephalopod-Bed at the top of the bank below the above quarry.)		
XXV.	*Scissum*-Beds	8.	Limestones, somewhat sandy: about	5	6
XXVI.	*Opaliniforme*-Bed	[4.]	Limestone, hard, grey-brown, with numerous small brown-grains; *Pseudolioceras Beyrichi* (Schloenb.) (xx., 7 & 8), *Canavarina* sp. (xiii., 4 & 5)	1	4
XXVII.	*Aalensis*-Bed	[5.]	Limestone, rubbly, conspicuously ironshot, and full of belemnites ..	0	6
	[? *Aalensis*- &] *Moorei*-Bed	[6.]	Limestone, rubbly; *Pleydellia leura*, S. B. (xxxiii., 8 to 10), *Astarte lurida* Sow., *Opis carinata*, Wr., *Cypricardia brevis*, Wr., and in this bed or that below, *Hinnites abjectus*, Phil., *Pleuromya*, *Gervillia fornicata*, Lycett ..	0	8

SEQUENCE IN COALEY WOOD—*continued*

			Thickness in feet	inches
Dispansum- and *Struckmanni-* Beds	[7.]	Limestone, hard, compact, pale-yellow with darker grains; *Pseudogrammoceras doerntense* (Denckm.) (xxix., 1 to 5), *P. placidum*, S. B. (xxix., 8 to 10 and xxxiii., 11 and 12), *P. Bingmanni* (Denckm.) (xxxiv., 3 to 5), *P. quadratum* (Haug) (xxxiv., 6 and 7), *P. regale*, S. B. (Suppl. p. cxlvi.), *P. Struckmanni* (Denckm.), *P. compactile* (Simpson), *Polyplectus discoides* (Zieten), *Hammatoceras insigne* (Schübler), *Phlyseogrammoceras dispansum* (Lycett), etc.	0	6
Pedicum-Bed	[8.]	" Linseed-Bed." Brown rubbly marlstone; *Haugia Eseri* (Oppel.) (xxv., 3 and 4), *H.* aff. *illustris* (Denckmann) (xxvi., 4), *Pseudogrammoceras subfallaciosum*, S. Buckman (xxxiii., 17 to 18), *P. expeditum*, S.B. (xxxiv., 10 and 11), *P. thrasu*, S.B. (xxxvi., 6 to 8), *P. pedicum*, S.B. (Suppl. p. cxlvii.)	0	7
Striatulum-Bed	9*a*.	Marl, with *Grammoceras toarciense* (d'Orbigny) (xxviii., 9 and 10), and *G. audax*, S.B. (xxviii., 4 to 6) ..		
	9*b*.	*filling up* inequalities between lumps of hard bluish-grey sandy stone: 2 to 3 inches	0	3
Variabilis-Bed	[10 to 15]	Sands, yellow, with more or less nodular bands of sandstone; *Phymatoceras pauper*, S.B. (Suppl., iii., 7 to 9), in bed 13 etc.	65	6
	[16]	Sandstone; *Haugia grandis*, S. B. (xxxii., 14 and 15), *Denckmannia obtecta* (Suppl., iv., 4 to 6).. ..	0	9
Lilli-Bed	[16*a* to 18]	Sands, fine, yellow, with a band of sandstone containing *Hildoceras semipolitum*, S.B. (xxii., 30 and 31), *Pseudolioceras quadratum* (xx., 3 and 4), *Plagiostoma* sp., *Hinnites objectus*, Phil., etc., estimated by Mr Buckman at	66	0
Bifrons- & *Falciferum*-Beds	[19.]	Clay, blue		
		" Rock-Bed "		

(*The numbers in square brackets refer to the numbers of the beds given in Mr S. S. Buckman's record in Quart. Journ. Geol. Soc., vol. xlv.*, 1889, *p.* 444.)

I am indebted to Mr Buckman for the more accurate dating of the deposits seen in this section, and for the allocation of the ammonite-fauna. The annexed sketch-section (fig. 3), will probably aid in the identification of the deposits, and it may be pointed out that between the line of oysters in bed 6 and the top of bed 7 is the horizon where evidence for the *Dumortieria*-Bed should have been found if that bed had been present.

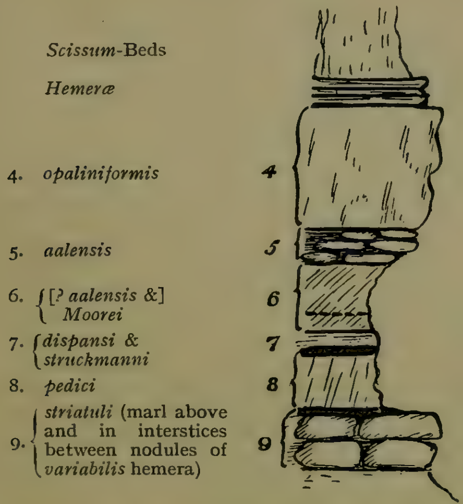


FIG. 3.—Profile-sketch of the Cephalopod-Bed in Coaley Wood, near Dursley.

Leaving Crawley Barns and proceeding towards Stroud, the "Money Quarry," as it is locally called, will be noticed after some 600 yards have been traversed. It exhibits the least typical Top-Beds of the Oolite that I have seen in the Cotteswold Hills, north of Sodbury. At the base of this section are yellowish-grey oolitic limestones (probably belonging to the top-portion of the *Clypeus*-Grit: seen 3 feet); then come flaggy, well-oolitic yellowish-grey limestones, without any marly partings (4 feet); while at the top are more rubbly limestones with specimens of *Clypeus Ploti* abundant. Some yellowish-green clay on the spoil-heaps showed that the Fullers' Earth had not long been removed, geologically speaking, by denudation.

Frocester Hill.—Leaving on the right the celebrated Uley Tumulus, or "Hetty Pegler's Tump," as it is locally called, the breezy and view-commanding Frocester Hill is soon reached. Here there is a very large quarry in the Lower Freestone and

Lower Limestone; while in the bank below, by the side of the main-road, is the section of the Cephalopod-Bed which has been examined by so many geologists.

Witchell was the first to point out that the main mass of the freestone in the large quarry was Lower Limestone and not Lower Freestone, and that the rubbly-bed about 12 feet from the top was on the horizon of the Pea-Grit. Certain authors had thought that the *Scissum*-Beds here were correlative with the Pea-Grit of the neighbourhood of Cheltenham, and therefore naturally paralleled the Lower Limestone and the Lower Freestone of Frocester with the Lower Freestone of the Cheltenham area. Brodie found a frond of a fern in the *Scissum*-Beds here, and Dr Wright recorded an exceptionally large number of fossils from the Sands. Wright estimated the thickness of the Sands here at "? 150 feet," and the blue clay at 80 feet.[1]

There are two tolerably satisfactory exposures of the Cephalopod-Bed. The one is by the side of the main-road below the quarry, and may be known as the "Frocester-Hill Section" proper. It is the one which I described in the report of the excursion of the Club to this locality. In that account I recorded such subdivisions of the Bed as were at once apparent on inspection, and it is unnecessary to say more concerning it than has already been published. The other exposure is a little further to the north, high up in the steep hill-side well above the road. It may be called the "Coaley-Peak Section."

Mr S. S. Buckman has very kindly sent me the following record of the Frocester-Hill roadside-section, which he made on October 24th, 1893, and has compared it with the section at Haresfield. Mr Buckman correlated, in a general way, these two sections as far back as 1888. The following record, however, is brought up to date. Mr Buckman comments in his notes sent to me on the lack of evidence here for deposit of *Dumortieriæ* hemera, and this, as he remarks, is the more noticeable when it is remembered how rich is the ammonite-fauna at Pen Wood, only a comparatively short distance further north.

1 Quart. Journ. Geol. Soc., vol. xii. (1856), p. 304.

FROCESTER-HILL SECTION.—*S. S. Buckman*, 1893.[1]

		Thickness in feet	inches
XXVI. *Opaliniforme*-Bed (15 *of Haresfield*)	1. Hard, pinkish, very little ironshot stone. "Bottom-Bed of Bugstone or Ragstone" of quarrymen.. ..	1	0
XXVII. *Aalensis*-Bed (16 *of Haresfield*)	2. Soft ironshot yellowish mudstone, attached to the base of bed 1 with a very uneven junction; *Rhynchonella cynocephala*, auctt., small and rare, *Canavarina folleata*, S.B. (xxx., 1, 2), ? *Cotteswoldia limatula*, S. B. (xxx., 5-7), *C. crinita* S.B. (xxxi., 3, 4), *C. superba*, S. B. (xxx., 1, 2), *C. costulata* (Ziet.) (fig. spec., xxxiii., 3, 4), *Pleydellia fluens*, S.B. (xxxi., 1, 2), *P. aalensis* (Ziet.) (fig. spec., xxx., 3-6), etc.	0	4
Moorei-Bed* (17 & 18 *of Haresfield*)	3. Soft yellowish ironshot mudstone, with softer marly streaks. Band of *Rhyn. cynocephala*, auctt. 7 inches from the top (*Rhyn. ? cynica*, S.B), and in the bottom 2 inches *Rhyn. ? cynoprosopa*, S.B., *Dumortieria subfasciata*, S. B. (xxx., 18) or lower, *D. munda*, S. B. (xliv., 10-12—or lower), *D. Moorei* (Lycett).. ..	0	10
	4. Yellow, very ironshot mudstone; *Rhyn. cynoprosopa*, S. B. at top, *Lytoceras* cf. *Leckenbyi*: (Lyc.) ..	0	7
	5. Yellowish, often blackish ironshot mudstone; *Cotteswoldia subcandida*, S. B. (xxx., 7, 8) or higher, *Lytoceras Leckenbyi* (Lycett), *Lytoceras* sp.	0	10
Dispansum-Bed	6. Very black-stained ironshot mudstone; *Chartronia binodata*, S. B. (Suppl. i., 11-15) evidently belongs here and was wrongly attributed to the *Dumortieria*-Zone	0	9
Struckmanni-Bed [*& Pedicum*-Bed]	7. Yellow ironshot mudstone, dark in places [*Pseudogrammoceras thrasu*, S. B., *P. Bingmanni* (Denckm.), *P.* cf. *pedicum*, S.B.	0	6
Striatulum-Bed	8. Soft marl, with blocks of hard sandrock, redeposited	0	1
	6. Lumps of sandrock in irony coatings, cemented together by marly stone, which contains *Grammoceras striatulum* (Sow.), etc.		

* The following type-specimens came from Frocester, and from this horizon :—*Dumortieria Moorei* (Lyc.), *Lytoceras Leckenbyi* (Lyc.), *Protocardia Hulli* (Wr.), *Opis carinata*, Wr., *Lima ornata*, Wr., *Cucullæa ferruginea*, Wr., *Astarte rugulosa*, Lyc., and *Trigonia Ramsayi*, Wr.

Returning to the Stroud Road, on the east side of the road above the main Frocester-Hill Quarry, is a smaller one,

1 "Many of the ammonites of beds 2 and 3 were obtained from the adjacent Coaley-Peak Section (where only the *Aalensis*- and *Moorei*-Beds are exposed), and are included here for the purposes of reference (see Monograph 'Inf. Ool. Amm.')." S. S. B. (*in litt.*).

also in the Lower Freestone. Continuing northwards, the remains of the "Nympsfield Tumulus," opened by the Cotteswold Club in 1862, will be seen on a slight rise in a field on the left, and then—also on the left—at the very commencement of Buckholt Wood, but invisible from the road, is another large quarry in the Lower Limestone and Lower Freestone. The Pea-Grit here, according to Witchell, "is represented by a freestone bed with ferruginous stains." ("Geology of Stroud," p. 43).

The wood which extends from the tumulus to the combe just before Pen Hill is generally known as "The Long Wood." On the 6-inch map it bears the names of Buckholt and Stanley Woods; and it is in the former—in the side of the lane leading down to Frocester Cottages—that the Buckholt-Wood Section of Mr S. S. Buckman is situated. He described this section in 1889, but has supplied me with details, which, combined with those already recorded, enable me to present the appended reading fully up-to-date:

Section at Buckholt Wood

		Thickness in feet	inches
Moorei-Beds	1. Brownish limestones with darker-brown grains; *Dumortieria subexcentrica*, S.B. (xliv., 7 & 8), *D. subundulata* (Branco) (xlv., 1 to 3), *D. exacta*, S.B. (xlv., 6 and 7), *D. sparsicosta*, Haug. (xlv., 17 to 20), *D. externicompta* (Branco), *Cotteswoldia bifax*, S. B. (Suppl., p. cxxxvi.) or above, *C. paucicostata*, S.B., *C. particostata*, S. B,, *C. egena*, S.B., *C. attrita*, S.B. (Suppl., xxiii., 1 to 14), *C. crinita*, S. B., *Pleydellia mactra* (Dumortier) (xxx., 3 to 7), *Rhynchonella cynocephala* (Richards), *Terebratula haresfieldensis*, Dav., *Belemnites* spp., *Pseudomelania procera* (Desl.), *Tancredia* sp.	1	9
Dumortieria-Beds	2. Yellowish, but more often dark-grey, almost black mudstone, with dark-brown grains. *Ammonites* scarce and badly preserved; *Dum. rhodanica*, Haug, *Rhyn. cynocephala* (Richards), *Terebratula haresfieldensis*, Dav., and varieties, etc.	2	0
	3. Reddish-yellow, somewhat sticky, gritty marl; in places numerous *Belemnites*	0	6
Dispansum-Beds	4. Dark-grey ironshot soft stone; *Phlyseogrammoceras dispansum* (Lycett) (common), *P. metallarium* (Dumortier), (xxxvi., 1 & 2), *Hammatoceras insigne* (Schübler), *Astarte* sp...	1	0
	5. Marl	0	2

SECTION AT BUCKHOLT WOOD—*continued*

		Thickness in feet	inches
Struckmanni-Beds	6. Light yellow soft stone; *Pseudogrammoceras doerntense* (Denckm.)	0	9
Pedicum-Beds	7. "Linseed-Bed." Brownish marl with numerous dark brown grains. *Pseudogrammoceras cotteswoldiæ*, S.B. (xxxv., 4 to 6: misprint bed 6 in explanation of plate)	0	7
Striatulum-Beds	8. Yellowish stone with brown grains; *Grammoceras striatulum* (Sowerby), abundant	0	6
	This bed lies above, and fills the interstices of the very uneven-topped		
Variabilis-Beds	9. Hard, blue-hearted sandstone; *Canavarella ? arenacea*, S.B. (xxviii., 20 & 21)	1	3
	10. Yellow micaceous sands		

At 4¼ miles from Stroud is a quarry in a field on the right-hand side of the road, which may be called the "Stanley-Wood Quarry."

STANLEY-WOOD QUARRY

III. *Clypeus*-Grit	1. Limestone, obscurely-oolitic, rather sandy-looking: seen	4	0
V. Horizon of Dundry Freestone	2. Limestone, shelly, ironstained; a few oysters adhering to its upper surface	0	4
VI. Upper *Trigonia*-Grit	3. Ragstone, shelly; crowded with *Trigonia costata*, Sow.	1	11
	4. Rubbly ragstone	0	2
	5. Ragstone, the median portion crowded with *Acanthothyris spinosa* (Schloth.), *Rhynchonella* spp.	1	10
	6. Parting	0	0½
	7. Ragstone, massive, shelly; usual fossils	3	2
	Non-sequence. Beds VII. to XXI. (incl.) wanting.		
XXII. Lower Freestone	8. Limestone, massive, top-portion slightly bored: seen	6	0

Workings on the same side of the road further along, and in Pen Wood, all show the Upper *Trigonia*-Grit resting upon the Lower Freestone—no beds in between.

By the path-side, close to the cottage at the foot of the northern slope of Pen Hill, is the site of the Pen-Wood Section of Mr Buckman. The section was only a temporary one, an excavation being made and then filled up. However, Messrs Buckman and Charles Upton obtained a number of fossils therefrom, and the former geologist has supplied me with the appended record of the beds which were revealed.[1]

1 "In the original section Beds 2 to 4 were called '*Opalinum*-Zone,' Bed 4 being '*Opalinum*-Zone, *Moorei*-Beds'; Beds 5 to 9 '*Dumortieria*- and *Dispansum*-Beds'; Beds 10 and 11 '*Striatulum*-Beds.' These details will explain the horizons given in the earlier part of the Monograph."—S. S. Buckman (*in litt.*)

PEN WOOD, NEAR STROUD.—S. S. BUCKMAN

(*Temporary artificial excavation*)

			Thickness in feet	inches
XXIV.	Lower Limestone	1. Limestone, in large blocks		
XXV.	*Scissum*-Beds	2. Limestone, hard, yellow sandy; *Lioceras striatum*, S. Buckman, *Tmetoceras regleyi* (Thiollière), *Montlivaltia* sp., *Volsella sowerbyana* (d'Orb.), all found near the top	4	0
XXVI.	*Opaliniforme*-Beds	3. Limestone, hard greyish-yellow, slightly oolitic	0	10
XXVII.	*Moorei*-Beds	4. Limestone, yellowish-brown with some darker grains; *Dumortieria declinans*, S.B. (xl., 10 to 12), *D. diphyes*, S. Buckman (xliii., 5 to 7), *D. exigua*, S.B. (xliii., 10 to 12), *D. rustica*, S.B. (xlv., 10 to 12), *D. Moorei* (Lycett) (Suppl., p. clxxxii.), etc.	0	4
		5. Softer darkish-brown oolitic rock; *Dumortieria* sp. (xlii., 1 and 2), *D. pene-exigua*, S.B. (xlii., 3 to 5), *D. lata*, S.B. (xliv., 1 to 3 or bed 4)	1	4
	Dumortieria-Beds	6. Marl, yellowish-brown oolitic; *Hudlestonia serridens* (Quenstedt), *Hudlestonia affinis* (Seebach) (xxxviii., 1 to 3), *Catuloceras aratum*, S.B. (xxxix., 1 to 3), *Dumortieria externicosta* (Branco), (xl., 1 and 2), *D. mutans*, S.B. (xl., 3 to 8), *D. prisca* S.B., *D. novata*, S.B. (Suppl., p. clxxiii.), *D. multicostata*, S B. (Suppl., p. clxxvi.), *D. rhodanica*, Haug, (*D. tabulata*, *D. explanata*, *D. radians*, Suppl. xxii., 25 to 33), *D. Nicklesi*, Benecke, etc.	0	6
		7. Marl, indurated, yellowish-brown; *Phlyseogrammoceras dispansum* (Lycett) ..	0	4
	[? *Struckmanni*- & *Pedicum*-Bed]	8. [? Linseed-Bed]. Dark chocolate-coloured marl with dark granules ..	3	4
	Striatulum-Bed	9. Soft yellowish-brown stone	0	6
		10. Harder stone; *Haugia* aff. *illustris* (Denckmann) (xxvi., 3 or bed above)	0	10
		11. Marl	0	9
	Variabilis-Beds.	12. Blue-hearted nodule-shaped sandy stone	0	4
		13. Yellow sands		

Returning to the Stroud Road and proceeding towards Selsley Hill, Bown Hill—an outlier of Fullers' Earth capped with the basal Great-Oolite beds—is seen on the right. The broken ground over the wall on the right is where there was formerly a clay-pit for brick-making, but it has now been closed some twenty years. Mr Charles Upton washed some of the clay from here, and obtained a few specimens of *Cristellaria* and an ostracod.

Fig. 1.—LEIGH'S QUARRY, SELSLEY HILL

Fig. 2.—No. 4 QUARRY, SELSLEY HILL
(*C. Upton, photo.*)

SELSLEY HILL

Witchell thought that the thickness of the Inferior Oolite at Selsley Hill was about 150 feet.[1] This does not appear to be far wrong; but I should be inclined to say 160 feet. This total embraces the deposits detailed in the general section on pages 125-126. It is very difficult to arrive at estimates of the thicknesses of the Lower Limestone and Lower Freestone from details obtainable at Selsley Hill itself; but in a deeply-cut water-course which traverses the steep hill-side clothed by Pen Wood, a-sixth of a mile to the west of Selsley-Hill Farm, these beds are very fairly exposed, and it was here that the estimates of their thicknesses were obtained.

It is perhaps best to study the sequence of Inferior-Oolite beds at Selsley Hill in ascending order.

Ascending the hill from Dudbridge Station (see map, text-fig. 4), the first quarry to be noticed is on the Common on the right (No. 6), and is in the Lower Limestone. It is the "No. 6" of Edwin Witchell, who has described the geology of this hill in some detail.[2] The Lower Limestone is here noted for its "Dapple-Beds"—limestones with peculiar pebble-like inclusions of oolite, evidently the product of a pene-contemporaneous erosion. Since the Geologists' Association visited the quarry, it has been developed in a southerly direction, and an interesting fault, with

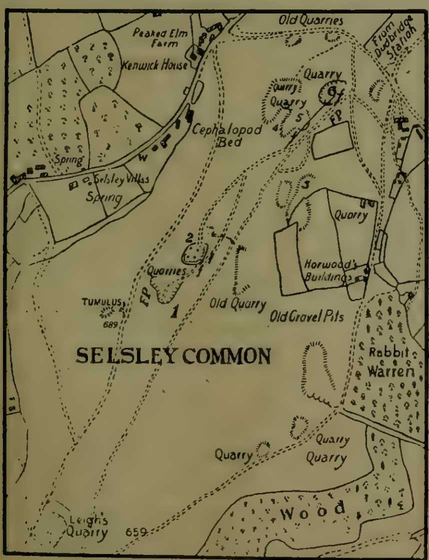


FIG. 4.—Map of Selsley Hill (3 inches = 1 mile) to show the positions of the quarries.

1 Proc. Cotteswold Nat. F.C., vol. ix., pt. 2 (for 1886-7), p. 99. 2 *Ibid.* pp. 96-107.

the Pea-Grit let down beyond, has been disclosed. The Pea-Grit here resembles its equivalent in the next quarry (No. 5), and yields *Terebratula Whitakeri*, *T. plicata*, J. Buckman, *T. pisolitica*, S. Buckman, *Rhynchonella subangulata*, Dav., etc.

In the next quarry (Nos. 4 and 5 of Witchell) the top-portion of the Lower Limestone is visible with Pea-Grit above. In the eastern portion of the southern face the Pea-Grit is let down by faulting some 4 feet, and this fault is probably a continuation of that noticed in the preceding quarry. A view of the western portion of the south face of the quarry is given in Plate XVIII., fig. 2, and details of the beds in the general record on page 126. Attention may be specially directed to the regular and worn aspect of the top-surface of the Lower Limestone, and to the probable occurrence of a slight non-sequence between the Limestone and the Pea-Grit—the Pea-Grit present being the top-portion of that subdivision.

About 300 yards further on up the trackway is quarry No. 2 of Witchell, in which is seen the top-portion of the Lower Freestone, the Oolite Marl, Upper Freestone and overlying Upper *Trigonia*-Grit: *but no Gryphite-*, *Buckmani-*, *or Lower-Trigonia*-Grits it should be noted. In the south-eastern corner a trough-fault will be noticed—the Upper *Trigonia*-Grit having been introduced in between the *Bradfordensis*-Beds, which therefore flank it. The Oolite Marl is very feebly developed here, and at its horizon the beds exhibit considerable variation, and are consequently difficult to measure accurately. The main feature is the large replacement of marl by limestone replete with a new *Rhynchonella*, *Rhyn. Witchelli*, Richardson, which is common here but comparatively rare elsewhere.

In the shallow quarry near the Tumulus (No. 1 of Witchell), the top of the Upper *Trigonia*-Grit can readily be found by means of the layer of oysters, and resting thereon is a bed of very distinctive lumps of limestone containing *Terebratula subsphæroidalis*, Upton, and a new species of *Rhynchonella*. Rubble of typical *Clypeus*-Grit succeeds.

The sequence from the Lower Freestone to the *Clypeus*-Grit is excellently seen in Leigh's Quarry (see map and Plate XVIII., fig. 1). The lower portion of the Upper *Trigonia*-Grit Witchell thought was Gryphite-Grit; but there are no "Intervening-Beds" here.

SEQUENCE AT SELSLEY HILL, NEAR STROUD.

(*Leigh's Quarry*)

			Thickness in feet	inches
II.	White Oolite	1. Débris of white oolitic limestone: seen	1	0
III.	*Clypeus*-Grit	2. Limestone, somewhat flaggy, broken up and mixed with some marl; *Terebratula globata*, auctt. non Sow., *T. globata* var. *birdlipensis*, Walker, *T. permaxillata*, S. Buckman, *Rhynchonella hampenensis*, S. Buckman, etc., *Amberleya hudlestoni*, Richardson, *Ceromya striata* (Sow.), *Limatula gibbosa* (Sow.), *Holectypus depressus* (Leske), etc.	5	0
		3. Limestone; *Berenicea* sp., *Bourguetia striata* (Sow.)	1	3
		4. Limestone, massive, top bored by *Lithophagi* in places; *Ter. globata*, auctt. very common, *Syncyclonema demissum* (Phillips); 2 ft. to 2 ft. 6 ins. ..	2	2
		5. Limestone, with a most irregular under surface resting upon lumps of limestone; *Pleuromya Goldfussi* (Lyc.), *Trigonia costata* (Sow.), common, *Holectypus depressus* (Leske), etc.	0	8
		6. Limestone, grey-brown, with a most irregular top; few fossils: 6 ins. to 1 ft.	0	9
		7. Limestone	0	7
		8. Limestone, rubbly, with few fossils ..	2	6
		Non-sequence. Beds IV. & V. wanting		
VI.	Upper *Trigonia*-Grit	9. Limestone, very shelly, with a layer of oysters on top	0	10
		10. Lumps of pale-brown, non-oolitic, and not very shelly limestone and shaly marl: average	0	6
		11. Ragstone; usual fossils	2	0
		12. Parting	0	1
		13. Limestone, rubbly; few fossils ..	0	6
		14. Ragstone; usual fossils (= Gryphite-Grit of Witchell)	2	1
		Non-sequence. Beds VII. to XIX. (incl.) wanting.		
XX.	Upper Freestone	15. Limestone, white, oolitic, top-bed conspicuously bored by annelids; *Trigonia costatula*, Lycett, *Nerinæa oppelensis*, Lycett: average	4	2
		16. Parting	0	1
XXI.	Oolite Marl	17. Limestone, rubbly, whitish; *Spiropora*, *Pentacrinus*-ossicles, *Rhynchonella granulata*, Upton, [*Acrosalenia Lycetti*, Wr., *Trochotiara depressa* (Ag.), *Hemipedina tetragramma*, Wr.] ..	1	3
		18. Parting; small sponges	0	0½
		19. Limestone; *Terebratula fimbria*, Sow., *Rhynchonella subobsoleta*, Dav., *Rhynchonella Witchelli*, Rich.: average ..	2	0

SEQUENCE AT SELSLEY HILL, NEAR STROUD—*continued*

			Thickness in feet	inches
		20. Marl; same fossils as in 19, and *Ter. submaxillata*, Morris, *Rhyn. granulata*, Upton: 1 to 4 inches	0	2
		(*This deposit alone—No. 20—is paralleled by Witchell with the Oolite Marl*).		
XXII.	Lower Freestone	21. Limestone, massive-bedded, white, oolitic: seen	13	0
		(*In Quarry No.* 4.)		
XXIII.	Pea-Grit	22. Limestone, rather flaggy, pisolitic; *Rhyn. subangulata*, Dav., etc.	3	0
		23. Brownish "marly" deposit, with numerous loose pisolite-spherules; *Pseudoglossothyris simplex* (J. Buckman), *Terebratula plicata*, J. Buckman, *Ter. pisolitica*, S. Buckman, *Ter. Whitakeri*, Walker, *Rhynchonella granulata*, Upton, *Rhyn. subangulata*, Dav., *Proboscina Jacquoti*, Haime, var. *expansa*, Gregory, *Rhyn. oolitica*, Dav., *Nerinæa oppelensis*, Lycett, *Stomechinus germinans*, Phil., *S. intermedius* (Ag.), *Pygaster semisulcatus*, Phil., *Nerinæa pisolitica*, Witchell, *Plagiostoma* sp., etc.	1	0
		24. Rubbly pisolitic rock; *Nerita costulata*, Deshayes, *Nerinæa pisolitica*, Witchell, *Ter. plicata*, J. Buckman, *Plagiostoma Lycetti*, auctt., *Acrosalenia Lycetti*, Wright		
		25. Brown marly layer, with pisolite-spherules: 1 to 3 inches	0	2
XXIV.	Lower Limestone (38 ft.)	26. Limestone, even top-surface, but uneven bottom; *Spiropora*, small *Ostreæ*, echinoid-radioles: 2 ft. to 2 ft. 8 ins.	2	0
		27. Parting	0	2
		28. Limestone; small gasteropods, *Nerinæa pisolitica*, Witchell, *Nerinæa* sp., *Pseudoglossothyris simplex* (J. Buckman): seen	17	0
		(*Not exposed: say* 18 *ft.* 4 *ins. of Lower Limestone, and* 1 *ft. of Scissum Beds*)	18	4
		(*Opening in the hillside near the cottages.*)		
XXV.	*Scissum*-Beds (7 ft.)	29. Limestone, coarsely oolitic: seen ..	5	0
		30. Limestone, hard, sandy; *Amusium personatum* (Goldf.)	1	0
		(*Just below, but a little more to the north*)		
XXVI.	*Opaliniforme*-Bed	31. Limestone, hard, with iron-grains, forming the cap to	1	0
	Cephalopod-Bed	Limestone, well ironshot, passing down into	1	0
		Marl, indurated, richly-ironshot; *Trichites* (fragments)	1	0
		Limestone, hardish, ironshot: seen ..	0	10

The position of the Cephalopod-Bed exposure will be seen upon reference to the map (text-fig. 4).

Between Selsley Hill and Nailsworth two long valleys run westwards into the hill-mass.

The first is the Woodchester Valley. There are no exposures of note in it now, but in times past

> "a landslip on the eastern side of the Woodchester Valley, one mile from Nailsworth, exposed the chocolate-coloured sandstone charged with *Lima Electra*, *Gervillia fornicata*, *Trigonia Ramsayi*, *Perna rugosa*, and *Turbo capitaneus*. Some shaly bands of the blue Lias marl beneath contained many specimens of *Posidonia* [*Posidonomya*] *Bronni*, a shell which is invariably found in the same position in France and Germany."[1]

Also a quarry in the building freestones "has produced many large testacea, including *Trichites nodosus*, Lyc., and *Perna quadrata*, Sow....."[2]

In the next valley, to the south, in "a deep lane cutting adjoining Nailsworth, on the way to the hamlet of Shortwood," Lycett found at the base of the Cotteswold Sands (to be exact, a few feet above the blue Upper-Lias clay) a very fossiliferous bed, apparently of *variabilis* date. It yielded a number of fossils at that time new to science, and most of them were described and named by Wright[3] and Lycett.[3] At the present time the road-cutting is quite overgrown, and nothing more than that it is in the bottom-portion of the Sands can be made out.

Mr S. S. Buckman, F.G.S., informs me that "many specimens of *Hildoceras semipolitum*, S. Buckm., came from a bluish sandy bed exposed in an excavation for the gasholder at Nailsworth.

The Freestones have been worked at a number of places up the Horsley Valley; but the sections call for no particular comment.

1 Lycett, "Cotteswold Hills" (1857), p. 23.
2 *Ibid.*, pp. 43-44.
3 The type-specimens of *Cypricardia brevis*, Wr., and *Protocardia Oppeli* (Wr.) came from "the fossiliferous nodules at the base of the Sands" here (Q.J.G.S., vol. xii. (1856), pp. 324-325) as well as that of *Natica oppelensis*, Lycett ("Cotteswold Hills," pl. i., fig. 4, and p. 123).

The Nailsworth and Rodborough-Hill Area.

On the Bath Road, about half-a-mile to the south of Nailsworth, is a large disused quarry, affording a view of these beds:

Bath-Road Quarry, Nailsworth

			Thickness in feet	inches
II.	White Oolite	1. Limestones, well oolitic, much broken up, but forming, nevertheless, a noticeable capping to the section; *Rhynchonella* sp., and *Terebralula globata*, auctt., rare: seen	5	0
III.	*Clypeus*-Grit	2. Limestone, hard, lumpy: usual fossils: average	0	8
		3. "Marl"; *Ter. globata*, auctt., common	0	1
		4. Limestone, regular bed, but rarely fossiliferous	0	7
		5. "Shale," or calcite	0	1
		6. Limestone, rubbly, especially at the base, where the usual pisolites are numerous; large specimens of *Ter. globata*, auctt., *Pleuromya Goldfussi* (Lycett), *Limatula gibbosa* (Sow.), *Ceromya striata* (Sow.), *Gresslya*, etc.: 10 ins. to 1 ft. 8 ins.	0	10
		7. Limestone, rubbly at the top and bottom; *Clypeus Ploti*, Klein, *Pholadomya* sp. and *Nerinæa Guisei*, Witchell, *Ter. globata*, auctt., etc.	3	10
		8. Limestone, hard, few fossils	1	1
		9. Shale	0	1
		Non-sequence. Beds IV. & V. wanting		
VI.	Upper *Trigonia*-Grit	10. Ragstone, very shelly, in three beds; usual fossils	6	0
		Non-sequence. Beds VII. to XXI. (incl.) wanting		
XXII.	Lower Freestone	11. Limestone, top-bed harder than the rest, and well bored: seen	15	0

It is easy to see in the capping limestones the equivalent of the *Anabacia*-Limestones, and it is not uninteresting to find them so well marked thus far north.

A somewhat similar section is to be seen a little over a quarter of a mile to the north-north-east (by the side of the Tetbury Lane); but the White Oolite (seen 3 feet 6 inches), *Clypeus*-Grit (8 ft. 2 ins.), and Upper *Trigonia*-Grit (5 ft. 4 ins.), are all more fossiliferous. The last-named subdivision rests upon the Lower Freestone, of which about 10 feet is seen. I think the Freestone here and at the Bath-Road Quarry is all Lower Freestone, because of the absence of *Nerinæa*, its massiveness, and suitability for working right up to the base of the "Grit."

At the Hazelwood Quarry, however, there appears to be a trace of the *Bradfordensis*-Beds.

HAZELWOOD QUARRY

		Thickness in feet	inches
III. *Clypeus*-Grit	1. Limestone, rubbly, grey-brown, with numerous soft yellowish pisolites; *Syncyclonema demissum* (Phillips), *Stomechinus intermedius* (Ag.), etc.	3	6
	2. Limestone, with rather a sandy feel; *Ter. subsphæroidalis*, Upton	0	8
	Non-sequence. Beds IV. & V. wanting		
VI. Upper *Trigonia*-Grit	3. Ragstone, massive: usual fossils. The upper surface is irregular, water-worn, and usually covered with oysters ..	3	0
	4. Ragstones..	2	4
	5. Parting of brown clayey matter: 1 to 2 inches	0	1
	6. Ragstone, shelly; looks like a cap to the Freestone	0	3
	Non-sequence. Beds VII. to XIX. (incl.) wanting		
XX. Upper Freestone	7. Freestones, hard, massive, top-bed very much bored, and covered with oysters; *Nerinæa* sp.: seen	5	0

Between Longfords Mill and Avening are two disused quarries by the road-side, and not far apart. They afford much the same section. In the western one there is this sequence:

QUARRY NEAR LONGFORDS MILL

		Thickness in feet	inches
VI. Upper *Trigonia*-Grit	1. Ragstone, very shelly, usual fossils ..		
	2. Rubbly deposit, made up of limestone-rubble and brown clayey marl ..	0	9
	Non-sequence. Beds VII. to XIX. (incl.) wanting.		
XX. Upper Freestone	3. Freestone, rather irregularly-bedded; *Terebratula fimbria*, Sow., *Rhynchonella Tatei*, and a few corals (spp. indet.)..	9	0
XXI. Oolite Marl	4. Brownish marly deposit: 2 to 6 inches	0	3
	5. Limestone, hard, obscurely-oolitic; *Ter. fimbria*, Sow., *Rhyn. Witchelli*, Rich.	1	6
XXII. Lower Freestone	6. Limestone, massive, formerly mined: seen	20	0

In the south bank of the road near Longfords Mill and Lake (Plate XX., fig. 2) the basement-beds of the Lower Freestone are exposed, and are separated from the Pea-Grit by a layer of brown shaly material, from which specimens of *Terebratula plicata*, J. Buckman, *Plagiostoma Lycetti*, auctt. were obtained. It was from the Pea-Grit here that Edwin Witchell procured many specimens of *Nerinæa*. "The section at Longfords Mill, Nailsworth," he wrote, "contains a bed of Pea-Grit, in which the grains are in a soft marly paste, overlying a bed of pisolitic limestone charged with several species of *Nerinæa*, the whole being about five feet thick."[1]

The other quarry, a little further on, affords much the same section; but the "Top-Beds" are exposed for a greater thickness, although somewhat difficult of access. There are some seven or eight feet of Upper *Trigonia*-Grit with the basal *Clypeus*-Grit beds above.

At Balls Green the Freestones are being worked by the United Stone Firms Ltd., in surface and underground workings —now, principally in the former. The Prospectus of the Firms states:

> "Until acquired by this Company these Quarries were held by Messrs Andrews and Provis, of Coleford, and Mr C. Essex, of Avening, near Stroud.
>
> The Stone is very little known to Architects and Surveyors, owing to the Quarries having been worked on a very small scale in the past, and almost entirely for local purposes.
>
> The Stone is of the Oolite formation, and resembles Portland in quality and appearance, so much so that the difference is hardly discernible. It is very considerably cheaper, and great hopes are entertained that when it is well-known it will be extensively used in London and the Provinces in preference to Portland.
>
> The possibilities of these Quarries are enormous. The beds of rock are entirely free from defects, and can be obtained in huge sizes, thus giving a splendid average cubical measurement for Random Block. It is very mild working when freshly quarried, but hardens very considerably and quickly when brought to the surface, and is very hard after a few weeks' exposure, when the moisture has evaporated.
>
> It is an excellent durable Stone for external and internal purposes, and weathers well. It is a particularly desirable Stone where cost is a consideration, as it can be supplied at a very low finished cost without any risk as to strength, quality and durability."

Commercially it is known as "Nailsworth Stone."

On the north side of the Nailsworth Valley is the old Scar Hill Quarry (Plate XX., fig. 1). Ascending the hill from the Railway Station, the Cotteswold Sands are seen in the left bank of the road. On the Common the Lower Limestone is exposed in a scarp above the road, and is capped by Pea-Grit, which is of the same general facies as at Longfords, containing amongst other fossils *Plicatula tuberculosa*, Morris and Lycett, *Rhynchonella subangulata*, Dav., *Ter.* *pisolitica*, S. Buckman, etc.

1 Quart. Journ. Geol. Soc., vol. xlii. (1886), p. 266; Proc. Cotteswold Nat. F.C., vol. ix., pt 1 (1885-86), pp. 21-37.

In the disused quarry on Scar Hill the Freestone has been mined, and, as usual, its top-bed is bored. Above it, is the Upper *Trigonia*-Grit, and then comes the *Clypeus*-Grit.

A number of geologists have investigated the Scar-Hill sections, and first amongst them was Lycett. He remarked that we find here "the entire marl group reduced to a thickness of four feet, destitute both of corals and Brachiopoda, but containing Gasteropoda and Conchifera, generally of same size."[1] He also noticed the sequence of Top-Beds, and apparently thought that the lower part of the Upper *Trigonia*-Grit was Gryphite-Grit, "but without the characteristic gryphite."[2] It must be borne in mind, however, that there is no Gryphite-, *Buckmani*-, or Lower *Trigonia*-Grit (nor any "Intervening Bed") at Scar Hill, and that fossils from the Inferior Oolite of Nailsworth must have come from the Upper *Trigonia*- or *Clypeus*-Grits, or from the Aalenian.[3]

Wright also identified the representative of the Oolite Marl at Scar-Hill, and repeated Lycett's observations concerning it, namely, that it "contains neither corals nor Brachiopods," and continues: "but is charged with long spiral univalves belonging to the genera *Chemnitzia* and *Nerinæa*, with a few conchifera and small Gasteropoda. The Nerinæa limestone is a fine argillaceous rock, close in texture, and feebly oolitic....."[4]

The late W. H. Hudleston gives a general section of "Nailsworth Hill and District" in his Monograph, "partly derived from observations, partly from other sources," and follows Lycett in his recognition of "Grit without Gryphites."[5]

The chief feature of the Scar-Hill section is undoubtedly the fossiliferous *Nerinæa*-Bed. Lycett obtained a large number of lamellibranchs from this bed and the underlying Freestones. They are now housed at Jermyn-Street Museum.

It will be unnecessary to detail the sequence observable at Scar Hill, because it can be much more satisfactorily made out in a large quarry in work on Culver Hill, Amberley.

1 "Cotteswold Hills" (1857), p. 49. 2 *Ibid.*, pp. 69-70. 3 Fossils are often found in old collections labelled "Inferior Oolite, Minchinhampton." As their matrix is usually a shelly white oolite, very similar to the shelly Great Oolite, and the locality given is "Minchinhampton," one is at first sight disposed to think that the Great Oolite is meant instead. 4 Quart. Journ. Geol. Soc., vol. xvi. (1859) pp. 12-13. 5 Monogr. Brit. Jurassic Gasteropoda—Gasteropoda of the Inferior Oolite, pp. 59-61.

CULVER HILL, AMBERLEY

			Thickness in feet	inches
II.	White Oolite	1. Limestone, whitish, and apparently some marl, but inaccessible: seen ..	3	0
III.	*Clypeus*-Grit	2. *More conspicuous deposit of marl and rubble; Terebratula globata*, auctt. non Sow., very common. (*Holectypus depressus* (Leske), at Scar Hill. This is the highest bed now visible at Scar Hill)	1	0
		3. Limestone, oolitic, thicker-bedded in the lower portion, passing up into whiter, thinner-bedded limestones; *Ter. globata*, auctt., non Sow., not uncommon in the massive beds: about	4	0
		4. Yellow, softish pisolitic marl and rubble; *Ter. globata*, common, *Clypeus Ploti*, Klein, *Pleuromya Goldfussi* (Lyc.), etc. (At Scar Hill, 1 ft. 2 ins. thick, and *Ter. globata* very common)	0	10
		5. Limestones, yellowish-grey massive (three main beds), but in places, at the top and bottom of the beds, rubbly. The lower portion is less fossiliferous. *Clypeus Ploti*, Klein, *Holectypus depressus* (Leske), etc.	6	0
		6. Parting	0	1
		Non-sequence. Beds IV. & V. wanting.		
		Limestone, shelly iron-speckled, coarsely oolitic, yellow and white-blotched; oysters on the top, bored	0	4
VI.	Upper *Trigonia*-Grit	Ragstones, shelly, in two massive beds; crowded with *Terebratula globata*, auctt. and *Rhynchonella* spp. and usual fossils	8	0
		Non-sequence Beds VII. to XIX. (incl.) wanting.		
XX.	Upper Freestone	Limestones in two beds, very hard, conchoidal fracture, top very even, water-worn and oyster-strewn, bored; topmost six inches of rock very shelly, and *Nerinæa* spp., corals frequent, *Astarte; Terebratula fimbria*, Sow., 3 inches from the base	3	0
XXI.	Oolite Marl	Well-marked parting above band of yellower oolitic limestone[1] joined on to the well-planed surface of Limestone	0	4
		that has, in the top-portions especially, *Nerinæa*, corals and lamellibranchs ..	1	4
XXII.	Lower Freestone	Limestones, well-oolitic, in massive beds: seen	12	0

The *Bradfordensis*-Beds here (*i.e.*, Upper Freestone and Oolite Marl), are again very fossiliferous, and would doubtless repay detailed working.

1 This adheres to the Upper Freestone at Scar Hill, where that deposit is 2 feet 10 inches thick, and the Oolite Marl 1 foot 10 inches.

Rodborough Hill

At Rodborough Hill the general sequence of beds is as follows:

				Thickness in feet
U. Inf. O.	Top-Beds	I.	Rubbly Beds	$14\frac{1}{2}$ (I.–III.)
		II.	White Oolite	
		III.	*Clypeus*-Grit	
		IV.	Upper Coral-Bed: max. ..	$2\frac{1}{6}$
			Non-sequence. Bed V. wanting	
		VI.	Upper *Trigonia*-Grit	6
			Non-sequence. Beds VII. to XII. (incl.) wanting	
	Intervening-Beds	XIII.	*Buckmani*-Grit	About 3 (XIII.–XIV.)
		XIV.	Lower *Trigonia*-Grit	
			Non-sequence. Beds XV. to XIX. (incl.) wanting	
L. Inf. O.	Freestone-Beds proper	XX.	Upper Freestone	14
		XXI.	Oolite Marl	7
		XXII.	Lower Freestone	79
	Pea-Grit series	XXIII.	Pea-Grit	13
		XXIV.	Lower Limestone ..	44 (XXIV.–XXV.)
		XXV.	*Scissum*-Beds	
		XXVI.	*Opaliniforme*-Bed	? 1
			Cephalopod-Bed	
			Cotteswold Sands	
			Upper-Lias clay	
			Marlstone	

Of the Inferior-Oolite subdivisions, the lowest now seen is the Lower Limestone. The top-portion of this rock, with the Pea-Grit, and basal portion of the Lower Freestone, is exposed in a long disused quarry(1)* close to the Old Pound,[1] and it will be noticed that the Pea-Grit has greatly increased in thickness.

In the next quarry,(2) also now disused, the *Bradfordensis*-Beds are seen. The upper portion (said by Witchell to be 14 feet thick, and by Hudleston 20 feet) is comparable with the *Nerinæa*-Bed of Nailsworth; while the true equivalent of the Oolite Marl occurs below, and is 7 feet thick (*teste* Witchell). As Witchell wrote, the *Nerinæa*-Beds "contain *Nerinæa cotteswoldiæ* in great abundance. Several other species of *Nerinæa* occur; indeed it is almost impossible to fracture the rock without exposing the transverse sections of these shells; the outskirts of a coral-reef appear to have been their habitat."[2]

The top-portion of the Upper Freestone and the overlying Lower *Trigonia*-, *Buckmani*-, Upper *Trigonia*-, and *Clypeus*-Grits, but no Upper Coral-Bed, are excellently and best seen in

1 "Geology of Stroud," p. 43. 2 *Ibid.*, p. 49.
* These numbers refer to those on the map, fig. 5.

the now enclosed "Fort" Quarry.(3) It was from the Lower *Trigonia*-Grit here that Lycett and Wright obtained such a number of beautifully-preserved lamellibranchs, many of which were new. The *Buckmani*-Grit is the bed that immediately overlies the Lower *Trigonia*-Grit. It is 1 foot 9 inches thick, and has yielded *Terebratula Buckmani*, Dav.[1]

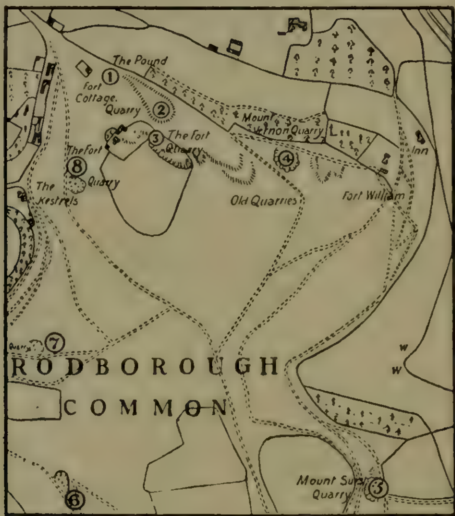


FIG 5.—Map of Rodborough Hill (3 inches = 1 mile) to show the positions of the quarries.

In his work on "The Cotteswold Hills,"[2] Lycett identified the present Lower *Trigonia*- and *Buckmani*-Grits with the Gryphite-Grit; but Dr Wright, two years later (1859), stated his opinion that the bottom foot of Lycett's "Gryphite Grit" was Lower *Trigonia*-Grit. Lycett, however, while admitting that Wright's description of this portion of the bed was correct, failed to see how it could be separated from the rest of his Gryphite-Grit at Rodborough, although he thought it might be possible where the subdivisions were thicker, and therefore the successive characteristic faunas more distinct.[3]

1 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), p. 72; see also S. S. Buckman, Quart. Journ. Geol. Soc., vol. li. (1895), pp. 394-395. 2 "Cotteswold Hills" (1857), p. 62. 3 Quart. Journ. Geol. Soc., vol. xvi. (1859), pp. 44-45.

At The-Fort Quarry there is a non-sequence between the Upper *Trigonia*- and *Clypeus*-Grits, for neither the Dundry Freestone nor Upper Coral-Bed are present. But the latter is developed a short distance away at the Mount-Vernon Quarry.[(4)]

It is unnecessary to append a detailed section of The-Fort Quarry, or of those at Mount Vernon and Mount Surat, for I have already given such in the Proceedings of the Club, and to them I have nothing to add.[1] For the sake of completeness, however, it will be as well to state that at The-Fort Quarry the *Clypeus*-Grit is very well developed. The lowest beds are brown and rather bare of fossils, as is generally the case in the Stroud district. But the higher beds are rubbly and fossiliferous, *Terebratula globata*, auctt., being very abundant along certain horizons.

The Lower *Trigonia*- and *Buckmani*-Grits are represented at the Mount-Vernon Quarry by deposits 1 foot 4 inches and 1 foot 7 inches thick respectively. Above them comes the Upper *Trigonia*-Grit (7 feet 10 inches), and this is overlaid by a very interesting development of the Upper Coral-Bed. The Upper Coral-Bed has yielded a number of most interesting fossils, including crowds of micro-organisms, which have been identified by Mr Charles Upton.[2] The *Clypeus*-Grit completes the section.

At the next quarry, the Mount Surat (or Montserrat), the Upper *Trigonia*-Grit rests directly upon the Upper Freestone: the Lower *Trigonia*- and *Buckmani*-Grits have disappeared,[3] neither is there any Upper Coral-Bed present.[(5)]

None of the Intervening-Beds are present along the south side of the deep Stroud-Sapperton Valley east of Rodborough Hill.

The Lower Freestone is exposed in a number of small quarries, and is especially well seen in the abandoned workings at the hamlet called "Wall's Quarry,"[4] and in the old quarry in the wood by the road-side near the house called "Hyde Brae," Chalford. At both these localities the Lower Freestone has been mined, and has typical Oolite Marl (at Wall's Quarry about 5 ft. thick, and at "Hyde Brae" from 8 to 10 ft. thick) parting it from the Upper Freestone. It should be noticed that

1 Vol. xvi., pt. 1 (1907), pp. 71-80. 2 *Idem.* p. 75. 3 See S. S. Buckman, Quart. Journ. Geol. Soc., vol. li. (1895), p. 394. 4 See Lycett's "Cotteswold Hills" (1857), p. 47.

the Oolite Marl is recognizable as a distinct deposit up this valley, and is *not* with difficulty separable from the Upper Freestone, as is the case at Rodborough Hill and the Frith, near Painswick. Upon the Upper Freestone, which at both localities is about 9 or 10 feet thick, reposes the Upper *Trigonia*-Grit. Hull, in the Geological Survey Memoir on the "Geology of Parts of Wiltshire and Gloucestershire," grouped together all the ragstone-beds between the *Clypeus*-Grit and the Upper Freestone, and called them "Lower Ragstone,"[1] applying the term "Upper Ragstone" to the *Clypeus*-Grit. Therefore, it will be understood that in his record of the Wall's-Quarry section, the term "Lower Ragstone" there means Upper *Trigonia*-Grit, for there are no Intervening-Beds present. The Upper *Trigonia*-Grit, from Wall's Quarry eastwards to the Sapperton Tunnel, maintains a thickness of between 8 and 10 feet. The precise thickness of the *Clypeus*-Grit has not been ascertained, but probably it measures somewhere about 15 to 20 feet.

The Fullers' Earth is seen in many small openings, and on the steep valley-side at Cowcomb is very tolerably exposed. It contains, throughout its course along this side of the valley, bands of impure limestone absolutely crowded with specimens of *Ostrea acuminata*.

1 *Loc. cit.*, p. 10.

THE NORTHERN END OF THE SOUTH COTTESWOLD, NAMELY RODBOROUGH AND SELSLEY HILLS, AS SEEN FROM FOLLY LANE, STROUD

(H. J. Comley, photo.)

(From Burrow's "Stroud Valley Illustrated.")

Fig. 1.—NAILSWORTH AND SCAR HILL

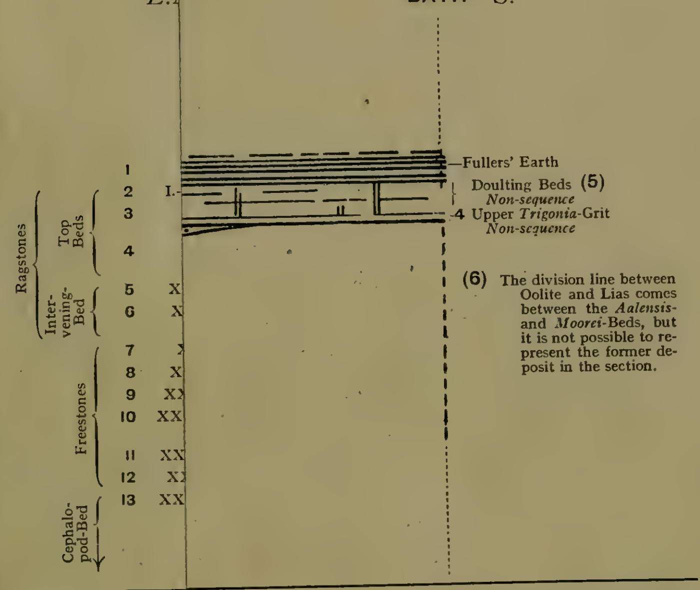
(Paul L. Smith, photo.)

(From Burrow's "Stroud Valley Illustrated.")

Fig 2.—LONGFORDS LAKE, NEAR NAILSWORTH

(Paul L. Smith, photo.)

HE SOUTH COTTESWOLDS



I.-III.—*Clypeu* 25′ (5) At the southern end of the South Cotteswolds, the Doulting Beds comprise the Rubbly Beds, *Anabacia*-Limestones and Doulting Stone. At the northern end, they have almost completely passed into the *Clypeus*-Grit.

IV.—Upper (4) Trace

V.—Dundr

[... es given in italics are ... ated thicknesses.]

VI.—Upper 5′

XIII.-XIV.—*Buckm* —

XX.—Upper —

XXI.—Oolite —

XXII.—Lower —

XXIII.—Pea-G —

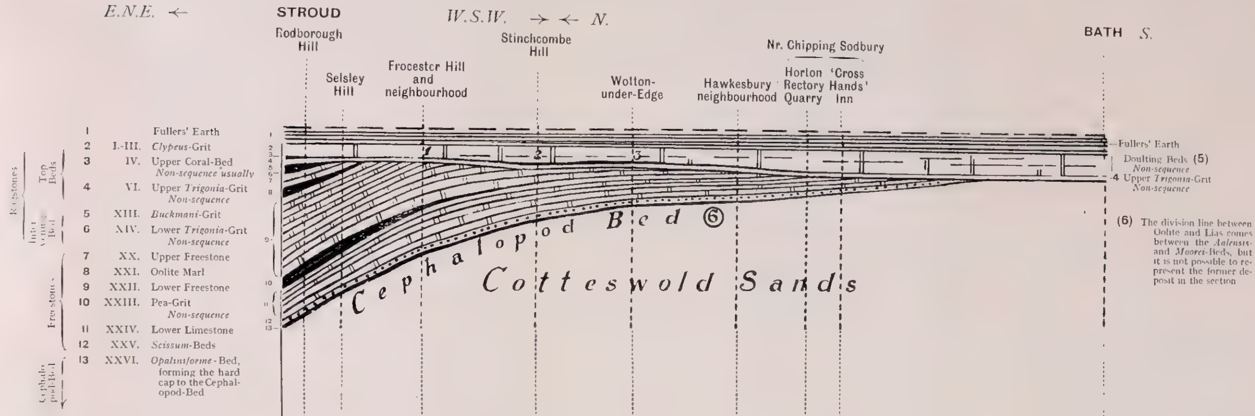
XXIV.—Lower —

XXV.—*Scissu* —

XXVI.—*Opalin* —

30′

SKETCH-SECTION, SHOWING THE RELATIONS OF THE INFERIOR-OOLITE BEDS OF THE SOUTH COTTESWOLDS TO THE DEPOSITS ABOVE AND BELOW THEM, ETC.



	Rodborough Hill	Selsley Hill	Frocester Hill	Stinchcombe Hill	Wotton-under-Edge	Hawkesbury	Horton Rectory Quarry	'Cross Hands' Inn	Bath
I. III *Clypeus*-Grit or Doulting Beds	*14'6"*	*15'2"*	*15'6"*	*17'*	*18'8"*	*19'10"*	*26'4"*		25' (5)
IV. - Upper Coral-Bed	2'2"	—		(2) 3"	(3) 10"		Rubble		(4) Trace
V. Dundry Freestone	—	—	(1) 4"	—	(3) 2"	Trace	2"		
VI.—Upper *Trigonia*-Grit	6'	6'1"	6'2"	4'	2'6"	4'10"	3'6"		5'
XIII.-XIV.—*Buckmani*- & L. *Trigonia*-Grits	3'	—	—	—	—	—	—	—	—
XX.—Upper Freestone	*14'*	8'3"	—	—	—	—	—	—	—
XXI.—Oolite Marl	7'	3'6"	—	—	—	—	—	—	—
XXII.—Lower Freestone	*79'*	*70'*	*45'*	*14'*	17'9"	—	—	—	—
XXIII.—Pea-Grit		10'	5"	9"	6"	—	—	—	—
XXIV.—Lower Limestone	*57'*	*38'*	*40'*	*25'10"*	*21'9"*	*27'2"*		12'	—
XXV. —*Scissum*-Beds		7'	7'8"	*8'*	*8'*	7'4"		2'	—
XXVI.—*Opaliniforme*-Bed		*2'*	1'11"	*1'2"*	1'	1'4"		1'	
Totals	182'8"	160'	118'	80'	63'	60'	45'		30'

[*Thicknesses given in italics are estimated thicknesses.*]

(5) At the southern end of the South Cotteswolds, the Doulting Beds comprise the Rubbly Beds, *Anabacia*-Limestones and Doulting Stone. At the northern end, they have almost completely passed into the *Clypeus*-Grit.

APPENDIX

REPORT (No. 2) ON THE PROGRESS MADE IN CONNECTION WITH THE FLORA OF GLOUCESTERSHIRE

By THE REV. H. J. RIDDELSDELL

The chief results of last year's work (1909) may most easily and serviceably be set forth, if regarded continuously with the report presented at the last annual meeting.

Considerable additional material, in lists embodying recent observations, and in extracts from old publications, has been received from Miss Roper, Mr E. M. Day of Minchinhampton, Mr H. H. Knight of Cheltenham, Miss K. B. Blackburn of Gloucester, Mr W. J. Greenwood of Cirencester, and others. The specimens sent by such workers have always been most acceptable.

A fresh source of information has been discovered: one which may become, under careful handling, of first rate service. It is the supply of local lists by Elementary Schools. Temple Guiting has already placed its 1909 list at our disposal. It was felt that a little encouragement and organisation would develop and improve this kind of material. A meeting was therefore held at Lydney in October, at which many Teachers from the Forest of Dean area were present. They were asked to allow such lists of plants as are usually made in their schools to be augmented and altered in such directions as would make them more available for the purposes of a County Flora. They received promises of assistance, in loan of books, identification of plants, and such ways; and very generally agreed to direct their already existing work to the end thus proposed to them. It is certain that interesting new records may be expected from this scheme, which should be extended also to other parts of the county. Foolscap sheets, with proper headings, are now being distributed among the Teachers. The great burden of work involved in carrying out this plan, and giving it the promise of success which it certainly shows, has happily fallen upon the shoulders of an expert—Mr F. Dixon, of Lydney.

There remains one thing to do: to impress upon all who thus co-operate with the Club (1) the necessity of careful discrimination in the matter of escaped plants: far too many things are accepted without question as natives; and (2) the great value of carefully chosen, carefully gathered and carefully dried specimens, to be submitted to botanical experts for identification.

One of the most interesting results of the year's work arises from the opening up of new or comparatively new parts of the county. Certain areas were visited, each for periods of several days: and lists (by no means complete, of course) were made, showing plants observed in each. A typical case of much interest is that of the parish of Arlingham, which was selected because of its clear definition and comparative isolation. Mr E. M. Day visited this area five or six times during the season, generally by himself, and made a very large list of plants, some 350 or more, all told, including **Rumex maritimus*, new to Gloucestershire (v.c. 34); and in fact gained a good idea of its botanical character. *Repeated visits to the very same area* provide the only possible means of getting at the real nature of the flora: each section of the area must be worked separately and carefully, and good notes taken of habitat, surroundings and the like. Mr Knight is also working this year at certain defined areas near Cheltenham, and valuable results may be looked for. Mr Coley is giving special attention to a part of district 6, as yet only slightly worked.

The usefulness of specially directed work may be illustrated from records made during stays of varying length at Coleford, Newent, Alvington, Amberley neighbourhood, Ford (near Temple Guiting), &c. The Forest of Dean Flora, as seen from the Coleford centre (district 4), presents much of interest. The actual woodland has nothing special beyond the trees; but clearings and rides in the wood, the grassy borders, and large open spaces like Serridge Green, are full of good things, *e.g.*, *Caltha palustris* var. *Guerangerii*, *Mœnchia erecta*, *Trifolium striatum*, *T. filiforme*, *Ornithopus perpusillus*, *Rubus fissus*, **Drosera rotundifolia*, (near Cinderford: specimen from the Forest of Dean in St. Brody's Herbarium) *Peplis Portula*, *Gnaphalium sylvaticum*, *Taraxacum erythrospermum*, *Mentha rotundifolia* and *Calamintha Nepeta*, †*Leonurus Cardiaca*, **Polygonum dumetorum* (found by Mr Knight), *P. Bistorta*, *Eleocharis acicularis* (Edge End), *Scirpus fluitans* (Broadmoor), **Eriophorum angustifolium* (Drybrook; also Pool Keynes in July, 1908), *Carex echinata* (Drybrook), *Festuca Myurus* in some quantity. All the above in West Gloucester, v.c. 34.

Around Newent (district 3) the best botanising occurs in the great woods (Queen's Wood, &c.), by the side of the Rivers Ell and Leadon, and on Chase End Hill (the tail end of the Malverns) and at Bromsberrow. Here are some of the plants seen:—**Papaver Lecoqii*, *P. Argemone*, *Radicula amphibia* (common in the Leadon), *Barbarea stricta* (rare by the Leadon), *Cardamine amara* (R. Leadon), *Brassica nigra* (R. Leadon), *Stellaria aquatica*, *S. neglecta* (common about Newent), **Sagina ciliata* (Chase End Hill), *Geranium pusillum*, *Acer campestre* var. *leiocarpon*, *Trigonella ornithopodioides* (Chase End Hill), *Medicago lupulina* var. † *Willdenowiana* (garden, Newent), *Trifolium striatum*, *Ornithopus perpusillus*, *Lathyrus montanus*, **Rubus opacus*, *R. Balfourianus*, **Sedum purpureum*, *Epilobium roseum*, *Galium Mollugo* var. *insubricum*, *G. uliginosum*, *Valerianella dentata* var. *mixta* (near Newent: A. G. Higgins, spn !), *Dipsacus pilosus* (river banks), *Filago germanica* and *minima*, *Hieracium sciaphilum* var: *amplifolium*, **Hypochæris glabra* (Chase End Hill), *Campanula patula* (Newent, Pauntley), *Samolus Valerandi*, *Myosotis scorpioides* var: *strigulosa*, *Antirrhinum Orontium* (A. G. Higgins, spn. !), *Plantago lanceolata* var. *sphærostachya*, *P. Coronopus* var. *pygmæa* (both on Chase End Hill), †*Urtica urens*, *Luzula Forsteri*, *Carex pallescens*, *C. strigosa*. All these are in v.c. 34.

Around Ford (district 7), a small village on the main road from Tewkesbury to Stow-on-the-Wold, there are a few woods (Hailes Wood, Guiting Wood, and narrow strips along the roads), much upland pasture and ploughland, some very rough undisturbed shallow soil (Bourton Downs, &c.), and some good streams (*e.g.*, the upper waters of the Windrush). Some records given here were made on long excursions from this centre, *e.g.*, to Mickleton, Dorsington, &c. (district 1) and to Colesborne. **Aquilegia vulgaris* (open ground of Bourton Downs), *Brassica arvensis* var. *orientalis*, *Geranium pratense fl. albo* (Toddington), *Lotus tenuis* (Bourton Downs, plenty), *Astragalus danicus*, *Hippocrepis comosa*, *Spiræa Filipendula* (common on low ground in district 1, below the Cotteswold escarpment, as well as on the hills in districts 1 and 7), **Rubus thyrsoideus* (districts 1 and 7), **R. Godroni* (Bourton Downs), and var. * *clivicola* (near Withington), * *R. hypoleucus* (Hailes), **R. pyramidalis*, * *R. anglosaxonicus* var. *curvidens* and var. * *raduloides*, **R. radula*, *R. echinatus*, **R. rosaceus* var. *infecundus*, *R. dasyphyllus*, **R. dumetorum* var. *ferox* and var. **diversifolius*, *R. saxatilis* (Guiting Wood), * *Rosa omissa*, *R. arvensis*, var. *gallicoides* (Campden), * *Epilobium montanum* × *obscurum*, *Pimpinella major* (Guiting Wood, Winchcombe, &c.), * *Galium verum* × *Mollugo*, * *G. erectum* and *G. asperum* (both Bourton Downs: Knight spns. !), *G. saxatile*, * *Valeriana officinalis* (Guiting Wood), *Gnaphalium sylvaticum*, *Senecio integrifolius* (Downs near Taddington, with *Anemone Pulsatilla*, *Thlaspi perfoliatum* and *Orchis ustulata*, fide J. M. Dixon), *Cnicus acaulis* var. *caulescens*, **C. arvensis* × *palustris* (near Ford), *H. sciaphilum* and var. **transiens*, **Campanula persicifolia* (on a piece of ground from which rabbits, &c., have been excluded by wiring: apparently native. Now recorded for both divisions of the county). *Monotropa* (very common) *Chenopodium hybridum* (garden weed, Campden), *Thesium humifusum*, *Typha latifolia* (Pebworth), **Sparganium neglectum*, *Zannichellia* (Dorsington), *Scirpus compressus* (near hill top, above Hailes Wood), **Carex remota* × *vulpina*, **C. pilulifera*, *Calamagrostis epigeios* (Guiting Wood, Knight, spn. !), *Catabrosa*, **Chara fragilis*, **C. hispida*, **C. vulgaris* (all three at Kempsford.) These occur in v.c. 33.

Finally, other records (for the past year, as a rule) are:—*Papaver Lecoqii* (Fairford, 33), **Fumaria Vaillantii* (Leckhampton, spn. in St. Brody's Herbarium; Kempsford, 33), *Radicula Nasturtium-aquaticum* var. *siifolia* (Frampton-on-Severn, 34), **Cardamine flexuosa* × *pratensis* (*C. Hayneana* Welw. This apparently, at Tidenham, 34). **Erophila præcox* (Fairford, 33), *Sisymbrium officinale* var. *leiocarpon* (Arlingham, 34), *Viola odorata* var. *subcarnea* (copses, &c., about Whelford and Kempsford; I am told, also frequent about Cheltenham, 33), *V. hirta* var. *inconcinna* and var. *propera* (Stroud Valley, 33), **Silene latifolia* × *maritima* (apparently this, Lancaut, 34), **Lychnis alba* × *dioica* (Road from Tidenham Chase to St. Briavels, 34). *Arenaria tenuifolia* (Lydney, railway ballast, type) var. *laxa* (on Minchinhampton Common: v.c. 34). **Sagina nodosa* (wet moor, Pool Keynes, 1908: found by Mr Rogers on Minchinhampton Common as *f. glandulosa*, 1909: v.c. 34), †*Hypericum hircinum* (railway, Kemble, 34), **Geranium pyrenaicum* (Minchinhampton Common, 34), *Erodium moschatum* (Box, Minchinhampton, 34, E. M. Day, spn !), *Medicago arabica* (Ballast, Lydney, 34), *Trifolium scabrum* (Ballast, Lydney; also Minchinhampton Common, W. M. Rogers, 34), *T. fragiferum* and *Lathyrus Nissolia* (both at Kempsford, 33), †*L. latifolius* (escape, railway, Cheltenham, 33), *Spiræa Filipendula* (Tutshill, 34), *Geum rivale* (Pool Keynes, 34, Miss Mallam) *Alchemilla vulgaris* var: *minor* (Common in 33 and 34), †*Poterium polygamum* (Lydney Dock, 34), *Rosa stylosa* var. *systyla* (Arlingham, 34), *Pyrus cordata* (Bird-sown on railway, Symonds' Yat 34), **Cratægus Oxyacantha* and **C. Oxyacantha* × *monogyna* (both at Kempsford, 33), †*Cotoneaster microphylla* (Tutshill, 34), *Parnassia* (Meadows by river, Fairford, 33: wet moor, *Pool Keynes, 34), *Epilobium palustre* (Guiting Wood, 33), *Apium inundatum* (deep water, Canal, Brimscombe; on mud, Tidenham Chase, 34), *Caucalis nodosa* (Tutshlll; sea marshes by Alvington, 34), *Galium Mollugo* var. *Bakeri* (Railway, near R.-Severn Bridge, 34: E. M. Day, spn !), *G. palustre* var. *Witheringii* (the usual form of the county), **Arctium majus* (Kempsford, 33), *Carduus pycnocephalus* var. *tenuiflorus* (Lydney, 34), * *Cnicus tuberosus* (Railway near Stonehouse Station, 33: spn! in Hbm. St Brody), †*C. arvensis* var. *vestitus* (Gloucester Docks, 33), *Serratula tinctoria* var. *alpina* (wet meadows, Fairford, 33), *Hieracium sabaudum* var. *calvatum* (Tutshill, 34), *H. cacuminatum* var. **barbareæfolium* (fide A. Ley: Top of Slad Valley, 33; E. M. Day), †*Symphytum asperrimum* (Hedge near Fairford, 33, small quantity) *Linaria vulgaris* var. *latifolia* (W. J. Greenwood, spn. ! near Sapperton, 33), *Scrophularia aquatica* var. *cinerea* (the only form I have seen in the county), *S. nodosa* (absent from the gravel of the Colne and Thames Junction, 33), **Orobanche hederæ* (Ampney, 33), *O. minor* (Kempsford, local, plenty, 33), **Thymus ovatus* (fide E. F. Linton: Minchinhampton Common, 34, W. Moyle Rogers), †*Teucrium Chamædrys* (Minchinhampton, 34, E. M. Day, spn. !); *Chenopodium polyspermum* (Garden, Kempsford, 33), *Rumex pulcher* (Kempsford Churchyard, Gloucester Docks, 33), *R. crispus* × *obtusifolius* (Quarry near Fairford, 33), *Euphorbia platyphyllos* (Railway, near Cirencester, 33, W. J. Greenwood). **E. Lathyrus* (native on Wainlode Hill, 33), *Hydrocharis Morsus-ranæ* (Brick-pits, Sandhurst, 33), *Orchis ustulata* (near Taddington, 33, J. M. Dixon; *Lydney Park, 34, Lightfoot in 1773. Also found by Mr Purchas near Symonds Yat: Mr Ley has the specimen). **Juncus effusus* × *inflexus* (Sandhurst, 33), **Sparganium erectum* (Kempsford, 33), *Acorus Calamus* (Canal side, Frampton-on-Severn, 34), *Lemna gibba* (Arlingham, 34), *Alisma lanceolatum* (plenty in Canal, Stroud Valley, *33 and *34), *A. ranunculoides* (Kempsford, canal, 33), *Zannichellia* (Fretherne, 34), *Carex disticha* (Elmore Back, 34), *C. arenaria* (Lydney, 34), *C. divulsa* (Arlingham, 34), *C. remota* × *vulpina* (Lydney Canal, 34), *C. gracilis* and var. *prolixa* (Sandhurst, 33), *C. pendula* (Sedbury Park, 34), *C. strigosa* (Gatcombe Wood, Reddings Enclosure, 34), **C. Pseudocyperus* (Brickpits, Sandhurst, 33), *Alopecurus bulbosus* (marshes by the Severn, Alvington, 34), †*Agrostis nigra* (Gloucester Docks, 33), *Holcus mollis* (Forest of Dean, 34), *Avena fatua* var. *pilosissima* (Welford, district 1, v.c. 33), **Molinia cœrulea* (wet meadow, Fairford, 33), *Catabrosa aquatica* (Lechlade, 33), **Poa palustris* var. *effusa* (Sandhurst, 33), *G. maritima* (Lancaut, 34), *Lolium perenne* var. *tenue* (Wood on cliff at Lydney and Tutshill, 34), **Tolypella glomerata* (canal above Stroud, 33).

* 'New County records,' *i.e.*, not in Top. Bot. or 1905 Supp.; or (in case of Rubus) not in W. M. Rogers's Handbook for the particular vice-county indicated. †Certainly introduced. Some others are possibly introduced.

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The following publications are in pamphlet form :—

Vol. I., pp. 1-100, 12 papers. Fossils of Oolites, Lycett, 4 papers; Geology of Grantham, Brodie; Geol. Isle of Wight, Wright; Roman Tesseræ, J. Buckman; etc. With 2 plates figuring several new species of fossils. 1847-1851 3/-

Vol. I., pp. 1-29. Report of First Meeting, 1847. Poison Gland, *Geophilus*, Wright; Fossils of Oolites, Lycett. 1/6

Vol. I., pp. 229-270. 7 Geological and Palæontological papers by T. Wright, John Lycett, P. B. Brodie, James Buckman. 1 plate of *Trigoniæ*, and woodcuts. 1853 2/6

Vol. II., pp. i-viii. and 55-130. 6 papers. Presidential Address; Inundations Antient Corinium, J. Buckman; Fossil Echinodermata, T. Wright, 3 papers; *Perna quadrata*, J. Lycett. 4 plates of Echinids, and woodcut of *Perna*. 1855 4/

On *Rhynchonella acuta*, John Jones. 1 plate, 8 pp. 1860 1/-

Presidential Address, 5 pp. 1856 1/-
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Vol. II., pp. 139-154. 4 papers. Lias of Barrow, Brodie; Sands of Cotteswold Hills, Lycett; *Cnicus tuberosus*, J. Buckman; Genus *Isodonta*, Lycett. 1859 2/-

Vol. II., pp. 155-197. 4 papers. Presidential Addresses, 1859, 1860. Upper Lias, Lycett; Inferior Oolite of Bath, W. V. Guise. 1860 1/6

Vol. III., pp. 1-50. 5 papers. Ammonites of Sands, Lycett; Lias and Sands, Witchell; Annual Address, 1861; Drifts of Severn, etc., Symonds; Geology of Churchdown, Smithe. 1861 2/6

Gryphæa incurva, John Jones, 6 quarto plates, no text. 4/-

Vol. III., pp. 97-194. 11 papers. Flint Implements, Jones; Lias Ammonites, Wright; Crosses, Pooley; Nympsfield Tumulus, J. Buckman; etc. One Plate of Flints. 1864 2/6

Vol. III., pp. 195-257. 6 papers. Rhætics at Garden Cliff, R. Etheridge; Crosses, Pooley; Deposit at Stroud Hill, E. Witchell; Lias Ammonites, Wright; etc. Plate of Aston Cross. 1865 4/-

The Jubilee Meeting of the Club. Reprint of Newspaper Report. 1896 1/-

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CONTENTS

PAPERS PUBLISHED

APPENDIX

*** The Council reserves to itself the decision as to the publication of any paper, and will not be able to publish any paper unless it is placed in the Secretary's hands within a month of its being read.

[*The Editor of the Proceedings of the Cotteswold Naturalists' Field Club is directed to make it known to the Public that the Authors alone are responsible for the facts and opinions contained in their respective Papers.*]

VOL. XVII. NOVEMBER, 1911 PART II.

PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB

(SESSION 1910—11)

EDITED BY THE HONORARY SECRETARY

PRICE, FIVE SHILLINGS AND THREEPENCE

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,, X.	(3 ,,) .	.	1890–1892	0	10	6	0	15	9
,, XI.	(3 ,,) .	.	1893–1894	0	10	6	0	15	9
,, XII.	(3 ,,) .	.	1895–1898	0	10	6	0	15	9
,, XIII.	(4 ,,) .	.	1899–1901	0	14	0	1	1	0
,, XIV.	(4 ,, with Supplem't†)		1901–1903	0	13	0	0	19	3
,, XV.	(3 ,,) .	.	1904–1906	0	10	6	0	15	9
,, XVI.	(3 ,,) .	.	1907–1909	0	10	6	0	15	9
,, XVII.	(2 parts published) .		1910–1911		7	0		10	6
	Cost of Set to date .	.		£9	8	6	£14	17	9

* The Supplement to Vol. IX., is 'The Origin of the Cotteswold Field Club, and an Epitome of the Proceedings from its formation to May, 1877,' by W. C. Lucy, F.G.S.

† The Supplement to Vol. XIV., is the 'Contents of Proceedings,' Vols. I.–XIV. 1847–1903. To Members, 2/6; to the Public, 3/6.

Vols. IV. and onwards are sold in separate parts, if required, at the price for each part—to Members, 3/6; to the Public, 5/3.

Vol. II. lacks the plate of Cirencester High Cross.

Copies of Vol. III., imperfect as regards plates of Crosses, will be sold at one-third reduction.

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OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

PRESIDENT

WILLIAM CROOKE, B.A., F.A.I.

HONORARY SECRETARY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

Vol. XVII. Part II.

1911

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1902—1904	C. Callaway, M.A., D.Sc., F.G.S.
1904—1906	Rev. Walter Butt, M.A.
1906—1908	R. W. Carles, C.M.G., F.L.S., F.R.G.S.
1908—1910	Rev. Walter Butt, M.A., J.P.
1910—	William Crooke, B.A., F.A.I.

LIST OF MEMBERS, APRIL, 1911

Honorary Members:

G. Embrey, F.I.C., F.C.S., Hill-close, 47 Park Road, Gloucester
George Maw, F.L.S., F.G.S., Benthall, Kenley, Surrey
C. Lloyd Morgan, LL.D., F.R.S., F.G.S., University College, Bristol
H. B. Woodward, F.R.S., F.G.S., 85 Coombe Road, Croydon

Members:

Ainsworth-Davis, Prof. J. R., M.A.	Royal Agricultural College, Cirencester
Bailey, Charles, M.Sc., F.L.S. ..	Haymesgarth, Cleeve Hill, Glos.
Baker, G. E. Ll., J.P.	Hardwicke Court, near Gloucester
Ball, A. J. Morton	The Green, Stroud
Bathurst, Right Hon. Earl, C.M.G.	Cirencester House, Cirencester
Baxter, Wynne E., J.P., D.L., F.G.S., F.R.M.S., F.R.Hist.S.	Granville Cottage, Stroud
*Bellows, William	Walden, Denmark Road, Gloucester
Birchall, J. D., J.P...	Bowden Hall, Gloucester
Bowly, Christopher, M.A.I. ..	Siddington House, Cirencester
Bretherton, F. H.	Belgrave House, Gloucester
Brown, Walter	Further Barton, Cirencester
Bruton, Henry Tew..	Newlyn, Gloucester
Bruton, H.W.	Bewick House, Gloucester
Bubb, Henry..	Ullen Wood, near Cheltenham
*Butt, Rev. Walter, M.A.	Oakwood, Chepstow
*Carles, W. R., C.M.G., F.L.S., F.R.G.S...	Silwood, The Park, Cheltenham
Chance, H. G., M.A...	Lynthorpe, Barnwood, Gloucester
Clark, Oscar, M.A., M.B., M.R.C.S.	Spa Road, Gloucester
Cockshott, A., M.A.	7 Pittville Crescent, Cheltenham
*Colchester-Wemyss, M. W., J.P.	Westbury Court, Newnham
Cole, R. M., M.R.C.S.	Northgate House, Gloucester
Coley, S. J.	High Street, Stroud
Collett, J. M., F.C.S.	Hillfield, Gloucester

Coomaraswamy, Ananda K., D.Sc. F.L.S., F.G.S., M.R.A.S. ..	c/o Messrs Thos. Cook & Son, Bombay, India
*Crooke, W., B.A., F.A.I.	Langton House, Charlton Kings, Cheltenham
Cullis, A. J.	21 Park Road, Gloucester
*Cullis, F. J., F.G.S.	Barnwood, Gloucester
Currie, G. M...	26 Lansdown Place, Cheltenham
Curtis, Charles	Cainscross House, Stroud
Daniels, J. S...	Lightpill, Stroud
Davies, Rev. C. H., M.A.	Bagendon Rectory, Cirencester
Dixon, J. M., B.A., LL.B.	Mickleton, Campden
*Drew, Joseph, M.B., F.G.S. ..	Montrose, Battledown, Cheltenham
Ducie, The Earl of, F.R.S., F.G.S.	Tortworth Court, Falfield, R.S.O.
*Duke, Lieut.-Col. J. C.	Gwynfa, Cheltenham
*Ellis, T. S., M.R.C.S.	9 Denmark Road, Gloucester
Finlay, D. E., M.B., B.S.	Wells Dene, Park Road, Gloucester
Foster, R. G., J.P.	Lennox House, Gloucester
Fowler, O. H., M.R.C.S.	Ashcroft House, Cirencester
Fulton, Sir E. M. H., C.S.I. ..	Elmhust, Suffolk Lawn, Cheltenham
*Garrett, J. H., M.D., F.L.S. ..	Municipal Offices, Cheltenham
Geidt, B. G.	Bayshill House, Cheltenham
*Gray, J. W., F.G.S.	6 Richmond Park Crescent, Bournemouth
Grosvenor, W. W., B.A., M.D. ..	Granville House, The Spa, Gloucester
Guise, Sir W.F G., Bart., J.P., D.L.	Elmore Court, near Gloucester
Haigh, Herbert	Coed Ithel, Llandogo, Mon.
Hannam-Clark, F.	12 Queen Street, Gloucester
Hartland, Ernest, M.A.	Hardwick Court, Chepstow
Hedley, G. W., M.A., F.C.S. ..	The College, Cheltenham
Hobbs, J. N.	Concord, Moorend Grove, Cheltenham
Hooker, C. Paget, L.R.C.P., L.R.C.S.	Dollar Ward House, Cirencester
Hooper, J. F...	Upton Hill, near Gloucester
Household, H. W., M.A.	Park Lawn, The Park, Cheltenham
Hume-Rothery, J. H., M.A., B.Sc..	The Pines, Tivoli Road, Cheltenham
Jones, John H.	Barrow Hill, Churchdown, Cheltenham
Keeling, G. W., J.P.	10 Lansdown Terrace, Cheltenham
Knight, H. H., M.A.	The Lodge, All Saints' Villas, Cheltenham
Knowles, H.	Egerton House, Spa Road, Gloucester
Little, E. P.	Amberley Court, near Stroud
McAldowie, A. M., M.D., F.R.S.E.	Glengarriff, Leckhampton Road, Cheltenham
Margetson, W.	Bright Side, Stroud
Marling, Sir William H., Bart., J.P., D.L.	Stanley Park, Stroud
Marling, W. J. Paley	Stanley Park, Stroud
Marling, S. S., J.P.	Stanley Park, Stroud
Meredith, W. L. F.G.S.	7 Midland Road, Gloucester
Milnes, G. P., A.M.I.C.E.	Whitehall, Stroud
Mitchinson, Right Rev. J., D.C.L., D.D.	College Gardens, Gloucester

Moreton, Lord	Sarsden, Chipping Norton, Oxon.
Newton, Surgeon-Major Isaac, I.M.S.	Broadlands, The Park, Cheltenham
Norris, H. E...	Cirencester
Paine, Alfred E. W...	The Poplars, Welford-on-Avon
*Paris, E. Talbot, Inter. B.Sc., F.C.S.	15 Montpellier Villas, Cheltenham
Pearce, F. T.	Lorraine House, Gloucester
Perkins, Vincent R.	Wotton-under-Edge
Phillips, J. G.	Barnwood Avenue, near Gloucester
*Prevost, E. W., M.A., Ph.D.,F.R.S.E.,	Weston, Ross
Price, M. P.	Tibberton Court, Gloucester
Price, W. R.	Pen Moel, Chepstow
*Richardson,L.,F.R.S.E.,F.L.S.,F.G.S.	10 Oxford Parade, Cheltenham
Rixon, W. A., J.P.	Turkdean Manor, Northleach, Glos.
*Sawyer, John, J.P., C.C.	Battledown, Cheltenham
*Scobell, Ven. E. C., M.A.	Upton St. Leonards, Gloucester
Scott, H. Harger, LL.B.	Berkeley House, Gloucester
Sewell, E. C.	The Beeches, Cirencester
Sinclair, The Ven. Archdeacon ..	The Greenway, Shurdington, near Cheltenham
Skinner, J. W.	The Edge, Stroud
Slater, A., J.P.	Garron Dene, Gloucester
Smith, A. E.	The Hollies, Nailsworth
Smithin, James A.	Lloyds Bank, Gloucester
Stanton, A. W.	22 Henrietta Street, Cavendish Square, London
Stanton, C. H., M.A., F.R.G.S. ..	Field Place, Stroud
Stanton, Walter John	Stratford Lodge, Stroud
Stephens, A. J.	Clovelly, Denmark Road, Gloucester
Taynton, H. J.	8 Clarence Street, Gloucester
Thiselton-Dyer, Sir William, K.C.M.G. C.I.E., LL.D., F.R.S.	The Ferns, Witcombe, near Gloucester
*Thompson, W.	Lansdown, Stroud
Tunbridge, E. W., B.Sc., F.G.S. ..	Rocklands, Edgbaston, Birmingham
*Upton, Charles	Homebush, Instow, N. Devon
Waller, F. W.	Horton Road, Gloucester
Washbourn, William	Blackfriars, Gloucester
Watson, Dep. Surgeon-Gen. G. A...	Hendre, Cheltenham
Weaver, Henry J., M.I.C.E.I., M.I.M.E., F.G.S.	Ashcroft, Churchdown, nr. Cheltenham
Wenden, J. G.	The Chantry, Dursley
*Wethered, E. B., J.P., F.G.S. ..	The Uplands, Cheltenham
*Winnington-Ingram, Rev. A. R. ..	Lassington Rectory, Gloucester
*Winwood, Rev. H. H., M.A., F.G.S.	11 Cavendish Crescent, Bath
*Witchell, E. Northam	Lansdown, Stroud
Witts, G. B., C.E., J.P., A.M.I.C.E.	Leckhampton, Cheltenham
Witts, Canon F. E. B., B.A. ..	Upper Slaughter Manor, Lower Slaughter, R.S.O., Glos.
Wood, Walter B.	Barnwood, Gloucester
Young, C. C. C.	Godfrey House, Cheltenham

*Signifies those who have contributed Papers printed in the "Proceedings" of the Club.

(*Any corrections in this List should be notified to the Hon. Secretary*).

LIST OF SOCIETIES, INSTITUTIONS, &c.,

To whom Copies of the Club's Publications are presented.

An asterisk denotes those from whom publications are received in exchange.

*The American Museum of Natural History, Central Park, 77th Street and 8th Avenue, New York City, U.S. America, c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*†Birmingham Nat. Hist. & Phil. Society, c/o The Librarian, Avebury House, 55 Newhall Street, Birmingham

*†The Bristol and Gloucestershire Archæological Society, c/o The Librarian, Eastgate, Gloucester.

*†The Bristol Naturalists' Society, c/o C. King Rudge, L.R.C.P., 145 White Ladies Road, Redland, Bristol.

The British Museum (Natural History), The Librarian, Cromwell Road, London, W.

The British Association, The Secretary, Burlington House, London, W.

The Cambridge University Library, c/o The Librarian, Cambridge.

The Geological Magazine, The Editor of, 13 Arundel Gardens, Notting Hill, W.

The Geological Society, c/o The Librarian, Burlington House, Piccadilly, London, W.

*The Geological Survey, c/o The Librarian, The School of Mines, Jermyn Street, London, S.W.

*†The Geologists' Association, c/o The Librarian, University College, Gower Street, London, W.C.

*The Glasgow Geological Society, c/o The Librarian, 207 Bath Street, Glasgow.

The Gloucester Municipal Library, Brunswick Road, Gloucester.

Nature, The Editor of, c/o Messrs Macmillan & Co., St. Martin's Street, London, W.C.

*†The North Staffordshire Field Club, c/o W. Wells-Bladen, Stone, Staffordshire.

The Royal Society, c/o The Librarian, Burlington House, Piccadilly, W.

The Smithsonian Institution (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

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*†The Warwickshire Naturalists' and Archæologists' Field Club, The Museum, Warwick

*†The Wiltshire Archæological and Natural History Society, The Museum, Devizes.

*†The Woolhope Naturalists' Field Club, c/o Hon Librarian, Woolhope Club, Free Library, Hereford.

Canon W. Bazeley, Hon. Librarian, Bristol and Gloucestershire Archæological Society, Matson Rectory, Gloucester.

†The Presidents and Secretaries of these Societies are considered as Ex-officio Members of the Club, and are cordially invited to the Meetings; Programmes of Meetings to be sent to them as invitations.

INCOME AND EXPENDITURE

INCOME

	£ s d	£ s d
Balance from last Account		22 15 1
Interest on Deposit Account	3 3	
Subscriptions, 1908, 2 at 15/-	1 10 0	
,, 1909, 5 at 15/-	3 15 0	
,, 1910, 106 at 15/-	79 10 0	
,, 1910, 5 at 10/-	2 10 0	
Entrance Fees	10 0 0	
Sale of Proceedings	5 5 6	
Archæological Society—Rent of Room	8 0 0	
Rev. Walter Butt (Contribution to cost of blocks)	1 0 0	
		111 13 9
		£134 8 10

T. S. ELLIS, *Hon. Treasurer.*
Gloucester, 1st April, 1911.

FOR THE YEAR 1910

EXPENDITURE

	£	s	d	£	s	d
Secretary's Expenses, including Entertainment of Guests, Proceedings, etc.	8	17	2			
Treasurer—Expenses	1	3	0			
—Cheque Book		5	0			
Bellows—Rent	12	0	0			
Custodian, etc.	1	3	11			
Municipal Schools—Rent	2	2	0			
Custodian		15	0			
Pitcher—Lantern		18	0			
Coffee House Co.—Refreshments	5	10	0			
Bellows—Printing	59	19	11			
Norman, Sawyer & Co.—Printing	10	12	6			
Stroud "Journal"—Blocks and Reprints ..	0	10	6			
Photochrom Co.—Blocks	7	5	0			
Lewis—Forms for "Flora"	0	11	6			
				111	13	6
BALANCE in hands of Hon. Secretary ..		7	0			
,, ,, Hon. Treasurer ..	22	8	4			
				22	15	4
				£134	8	10

Audited by me and found to be correct
H. KNOWLES,
Gloucester, April 3rd, 1911.

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to promote the preservation of all antiquities, and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member, he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club, not being a Field Meeting; one black ball in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (See Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Elected Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot), but the President shall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in the early part of each year, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Executive Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—All papers communicated to the Club shall be submitted to a Publication Committee, which shall consist of the President, Honorary Treasurer, Honorary Secretary, and two other Members appointed at the Annual Meeting. The decision of the Publication Committee shall be final. Any gentleman who favours the Club with Lectures on any subject shall be invited to furnish an abstract of the lecture for publication in the Proceedings of the Club.

13.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

AT THE

ANNUAL GENERAL MEETING

APRIL 4th, 1911

WILLIAM CROOKE, B.A., F.A.I.

President of the Folk-lore Society

IN THE CHAIR

The Minutes of the last Annual Meeting were read and confirmed.

The Hon. Treasurer presented his Financial Report, which was approved.

The Right Hon. Earl Bathurst, C.M.G., and Mr E. W. Tunbridge, B. Sc., F.G.S., were elected Members.

The President then delivered his

ANNUAL ADDRESS

During the past year, the sixty-third of its existence, the work of our Club has steadily maintained its interest and scientific value. It is true that, without any disparagement of the qualifications of individual Members, we are an association of amateur workers; and, as such, we cannot always pretend to attain the standard of the greater scientific societies, which largely consist of experts in various branches of knowledge. Occasionally, therefore, we admit in our Proceedings contributions which are intended to be suggestive of novel views, not always, perhaps, based on indisputable evidence—but not therefore the less interesting and suggestive. It is well for us to place such views on record, because with the rapid development of science, some obscure worker may one day gain immortality in the ranks of the leaders by being able to show that he anticipated some great discovery by some tentative interpretation of scientific facts.

Again, we constitute a Club, not a Society, a distinction of great importance, because it gives emphasis to the fact that it is not composed of a fortuitous aggregate of Members who seldom meet as a corporate body, and are interested in the annually published literature rather than in our Meetings and Excursions. On the contrary, our aim is to bring together in friendly co-operation and social intercourse, a number of gentlemen engaged in the investigation of the many problems of science and archæology for which the wealth of material found in our district provides such ample opportunity, in the hope that we may be able to supply some addition to the general stock of knowledge. This object is largely promoted by the visits to many places of interest in our neighbourhood, for which the arrangements have been so ably carried out by our excellent Honorary Secretary, Mr Richardson, and his understudy, Mr Paris, to both of whom I beg to express my acknowledgments for such generous assistance during the period while I have had the honour to occupy this Chair.

The most important work to which the Club is at present pledged is, of course, the preparation of the County Flora, which I am glad to say our late President, Rev. W. Butt, continues to supervise. Needless to say, the work could not be placed in abler hands. You have seen the progress report of this work, which indicates that a number of enthusiastic workers are engaged in the collection of the mass of specimens which must be classified before the final summarisation can be attempted. It is also a matter of congratulation that the work of investigation into the geological and palæontological records which our district so abundantly supplies is now being systematically prosecuted. We have had, during the year, important papers on the geology and palæontology of the Cotteswolds by Messrs Gray and Upton, besides the contributions which we are accustomed to receive from Messrs Richardson and Paris, all excellent examples of the work which can be usefully accomplished by a Field Club. After all, the collection and arrangement of the local facts in all the branches of geology, archaeology, and other sciences is the duty which most clearly presses upon us, and which is within the capacity of any of our Members. For the present, we may safely leave to the arm-chair philosopher the task of interpreting these facts from a comparative point of view. I venture to express the hope that the list of our Members now engaged on this most important work will soon be increased; and, in particular, that a staff of younger workers will be ready to take the place of the veterans when their time of service is over.

I admit, of course, that I have no pretensions to discuss the special problems to which our work is so largely devoted, and I naturally feel extreme diffidence in venturing to draw your attention to questions of another kind. At the same time, while our attention is specially, and rightly, directed to the world of nature, we are not neglectful of those investigations into man, his history and development, in which I am specially interested. Archaeology in all its branches falls within the scope of our work, and during the past year one of our Members Dr McAldowie, has favoured us with the results of his careful enquiry into problems connected with the prehistoric monuments which are so numerous within our district. I cannot, I must admit, follow in all its details the theories which he has advanced regarding the location of the Cotteswold barrows; and he will, I am sure, be prepared to admit that his work is still in the preliminary stage, and that much remains to be done before he will be in a position to lay before us the final results of his investigations. In his view, if I interpret it aright, one, or perhaps the main object of these monuments was to provide a kind of calendar to define and regularise the seasonal feasts and ceremonies of their builders. Without pressing the argument that these rude stones seldom furnish accurate data for gauging the position of the heavenly bodies, the real difficulty in accepting these views seems to me to lie in the fact that the primary object of these monuments was not astronomical, but sepulchral. This does not, of course, preclude the possibility that, as in the case of many races in various parts of the world, some attention may have been given to the position of the corpse, or that it may have been laid in the ground with the head or face turned towards the rising or the setting sun, or, as Professor Frazer supposes, with reference to the tribal totem.[1] The case of the great stone circles, like Stonehenge or Avebury, is different, and there is some reason to believe that these erections may have been used as primitive observatories and for the regulation of the seasonal feasts and other ceremonies which were so closely associated with the religious and social life of their builders. This view receives still further confirmation from the fact that recent excavations at Stonehenge, conducted by Professor Gowland[2] prove that the monument was erected at a date which closely corresponds with that assigned to it by Sir Norman Lockyer from astronomical data.

We must also be very cautious in assuming, as I think Dr McAldowie is inclined to do, that our barrows are in any way connected with the astronomical studies of the Babylonian or other Eastern races. If the evidence of archaeology is of any value, it certainly goes to show that the evolution of our culture is not due to the foreigner, but is mainly of indigenous growth. It has been suggested by Sir L. Gomme and others that the Druids, about whom we know so little save from the confused accounts of Roman writers, and whose ritual and customs are said not easily to conform with the so-called Aryan culture, were really the medicine men of the conquered and enslaved neolithic people, retained by their new masters to exercise priestly functions because they were supposed to be more familiar than the newcomers with the appropriate methods of controlling the local spooks and bogies. This we know to be the case in India and elsewhere. But there are strong arguments against this view, which have been stated by Canon McCulloch in a paper read before the Third International Congress for the History of Religions, held at Oxford three years ago. "There is," he urges, "no evidence to show that the Druids were the priests of a non-Celtic people, nor is it easy to see how the priests of a conquered race could ever have obtained such influence over their conquerors as the Druids certainly possessed. The case of conquering peoples who resort to priests or magicians of a subject race, because the latter possess more powerful magic, is not really analogous.

1 Frazer, *Totemism and Exogamy*, i, 454 seqq.; ii. 190.
2 See his paper read before the Society of Antiquaries on 19th December, 1901, and the Summary n *Man* (1902), ii. 7 seqq.

The Druids were not resorted to occasionally, but dominated the Celts always, in all departments of life." It has been urged that many Druidic beliefs, that of shape-shifting, for instance, practices like human sacrifice, functions like judging or demarcating boundaries, are opposed to Aryan sentiment and have their analogies among the non-Aryan tribes who serve the village communities in India. But the Druids were more than occasional officiants at Celtic rites, and the hostility shown to them by the Romans is inexplicable on the view that they resembled the pariah priests of India. It is clearly impossible to define certain rites as non-Aryan, because the Aryans, like other races, had a savage past, and inherited from their barbarous ancestors many beliefs and practices inconsistent with the higher culture which they afterwards attained. With the curious conservatism of backward races in matters of belief and ritual, such beliefs and rites would, even if they were often misunderstood or misinterpreted, tend to survive when the race had attained a higher culture.

Here I may remark that in Gloucestershire we have the distinction of possessing an unique Celtic God. Some years ago a temple was excavated at Lydney, which provided several inscriptions with a record of his name, and a mosaic which stood on the floor of his fane. One inscription has been supposed to identify this god, whom the Romano-British people knew by the name of Nodens, with the Latin god of war, Mars. A little bronze crescent found on the spot, representing the deity as a crowned, beardless personage, driving a four-horse chariot, has been compared with figures of the Sun god or of Neptune. Sir John Rhys, who has investigated the question with his usual learning, is inclined to think that Nodens was a god of water.[1] His name, which survives in Lydney, the modern designation of the place, seems to be identical with the Welsh Nüd, and the occurrence of the same root in the name of Ludgate, leads him to suggest that he once possessed a fane which stood on or near the spot now occupied by the Cathedral of St. Paul. Professor Anwyl, another great Welsh scholar, thinks that his name means the mist, as it survives with this signification in certain dialects of southern Wales. At any rate, whatever his title

1 Hibbert Lectures on *The Origin and Growth of Religion as illustrated in Celtic Heathendom*, 125 pp.: and see MacCullock, in Hastings, *Encyclopædia of Religion and Ethics*, iii. 287.

may mean or whatever may have been his attributes, we have the satisfaction to learn that he has not been recognised among the Continental Celts, and that his affinities are to be found in one of the many figures which are included in the Welsh or Irish Celtic pantheon.

But even if we are unable to trace survivals of neolithic beliefs in Druidism, the continuity of culture is so striking in this district that I venture now to direct your attention to some examples which illustrate it. The human mind, influenced though it may be by climatic and other forms of environment, works with remarkable uniformity. In addition to this, we have much evidence to show that in spite of the entry of foreign tribes, the racial type is remarkable persistent. Our veteran anthropologist, Dr John Beddoe, asserts that traces of palæolithic man can still be identified in Wales and Western England ; and he quotes examples of people of low stature, with broad cheek bones, receding foreheads, flat noses, narrow chins and protruding jaws, whom he identifies with this earlier race. To this, however, it may reasonably be objected that between palæolithic and neolithic man there is a vast geological and cultural gap. While palæolithic man possessed no ordinary artistic capacity, as is proved by the admirable engravings on bone or ivory of a contemporary and now extinct fauna, this power is almost entirely absent in their neolithic successors, whose pottery is generally ornamented in the geometrical type of decoration. The differences of material culture are still more apparent. The earlier race lived in caves, hunted for food animals no longer existent, and possessed only the very rudest flint implements, being apparently ignorant of the use of the bow. The neolithic folk had succeeded in domesticating many of the animals which we now possess, lived in rude huts or wind shelters, as the Australian Aborigines do now, had acquired the art of making pottery, and unusual skill in chipping and polishing the knives, daggers and spear heads which are found in abundance in this district.

For practical purposes we need not concern ourselves with palæolithic man, because we seem to have no evidence of his existence in this district. Mr W. J. Gray has, I am glad to say, collected much evidence about primitive man and his remains on the Cotteswolds, and has kindly supplied me with a note summarising the results of his enquiries. It would be unfair for me to anticipate the paper which he promises to read before us during the next Session. Sufficient to say that the only palæolithic implement which seems to be well attested, is a scraper found by Mr Shrubsole, of Reading, in a gravel pit at Moreton-in-the-Marsh, which may be included in the Cotteswold area as defined by Mr S. S. Buckman. I commend the search for remains of this period to those who are engaged in field work, because it would be a matter of much importance to prove that palæolithic man did not occupy this region, and, if so, to account for his absence.

While, however, we must reluctantly for the present dismiss any palæolithic ancestor of the present inhabitants, the evidence of the continuity of the population from neolithic days through the bronze and iron ages, seems indisputable.

In this connexion, I may remark that I have recently been in correspondence with Mr G. B. Witts, whose valuable handbook and archæological map of the district are familiar to us all. I have hopes that he may be induced to prepare under the patronage and with the aid of the Members of the Club, a new edition of these useful works. If we could arrange to combine with the archæological details a geological map of the county, marking all the more important sites where prehistoric remains have been found, with the Roman roads and other antiquities, and the more important village churches, it would be a work which I consider the Club might undertake with great advantage to its Members.

Among the antiquities of the neolithic and other ages, we possess no dolmens ; but we have many menhirs or standing stones, such as the Hoar and Whittle Stones near Lower Swell, the Tingle Stone at Avening, the Woeful Dane's Bottom near Minchinhampton, and the remains of a circle at Marshfield. We have at least thirty-four groups of long, and one hundred and twenty six round barrows, of which fourteen are of special importance. Then come the earthworks lining the scarp of the Cotteswolds from Bredon to the further south, outposts occupied by many races in succession, and from their position, obviously intended to repel the raids of Welsh tribes from the west. Besides these, we have prehistoric villages at Cam Long Down, Minchinhampton, Selsley, Stinchcombe, and Westridge Hills.

Much of the evidence of the life of our forefathers remains obscure, because the interments and their mobilier are our only sources of information. It is only the happy circumstance that these people believed that the dead in the other world were dependent upon their surviving relatives for the needs of life, which preserves this evidence for our use. The persistence of this belief from the prehistoric age down to the present is one of the links which connect us with these earlier people. When we lead the charger of a dead officer, with his boots, helmet and sword behind his coffin, we unconsciously record the permanence of this belief, because as late as the 17th century we have proof from Germany that the horse was actually killed with his owner to be at his service in the other life. Not long ago an Irish widow was found putting a bottle of whisky in the coffin of her dead husband for his refreshment, and as recently as 1865, when Lord Palmerston was buried, it is recorded that many ladies present took off their rings and flung them on his coffin. If they had been asked to explain the reason of this act, they would probably have said that it was merely a tribute of affection or respect for the dead statesman. But, in essence, it is a survival of the same belief which induced pre-historic men on the Cotteswolds to place food and flint implements in the grave of their chieftain.

The same persistence of custom is seen in the case of witchcraft. One of our most famous local legends tells of the Witch of Berkeley, who warned her friends to lay her in a stag's hide within a stone coffer bound with iron and lead; and if she so remained for three nights they might bury her. But as the chronicler tellls us: "Al was in vaine, for in the first two nightes which the psalmes were in soundinge, the Divells havinge easily broken the doores, as lightly brake the two utmost iron chaines; and on the third night about cock crowinge, the place shakinge, one with a terrible countenance and of a mighty tall stature, havinge broken open the cover of the chest commanded the dead body to arise, who answeringe that she could not by reason of the bonds; 'be thou loosed,' quoth hee, 'but to thy woe'; and presently all the barres being broken, he draweth her out of the Church, and setteth her upon a blacke horse, neighinge before the doore, and soe went away with loud soundinge cries heard four miles off."

Only last year the newspapers recorded the following notice which was issued to the people of Eckington, a village on the banks of the Avon, about seven miles from Worcester: "Whereas a certain M... J.. D...., wife of J.. D... of the village named, has been repeatedly slandered in common talk and gossip as a witch, together with other false and injurious accusations against her character, whereby she has suffered grievously in mind and body in the esteem and fellowship of her neighbours, any repetition of these offences will result in action being taken against the slanderer." Enquiries showed that the chief charge against this unfortunate person was that she had married a man some years her senior. A century or so ago she would have been tortured and probably executed. Archdeacon Scobell tells us that in the parish of Upton St. Leonards, quite recently, an old woman used to charm away thrush in children by an incantation, to which she very judiciously added the application of borax.

Even more interesting are the survivals of the seasonal feasts which are to be found in our district. In pagan Europe, human sacrifices were offered to the water spirits on Midsummer's Day to refresh the powers of Nature and stimulate them to perform their benign fertilising powers. We have the Greek tale of Andromeda which was probably based on some beliefs of this kind, and the legend appears in many parts of England. Here it is localised at Deerhurst, where the historian Sir Thomas Atkyns tells how a serpent of prodigious bigness poisoned the people and slew their cattle. A reward was offered for the destruction of the beast, and this was effected by a certain John Smith, a labourer, who laid out a quantity of milk for the monster, and when it was gorged slew it with his axe. When Sir Robert wrote his account in 1712, this very axe was said to be in the possession of a certain Mr Lane, who had married a widow in the Smith family.[1] It would be interesting to trace its subsequent history. But why was the

[1] For most of the following illustrations of folk-belief in the county, I am indebted to *County Folk-lore, Printed Extracts*, No. I., by E. S. Hartland, Folk-lore Society, 1892, and to the Gloucestershire volume in the *Gentleman's Magazine Library*, edited by Sir G. L. Gomme.

legend localised at Deerhurst? Mr Sidney Hartland[1] thinks that it may have arisen from a broken stone, roughly carved into something like a dragon's head, which projects from the wall of the tower of the Church over the west doorway. Or may we assume that there was some prehistoric cult of a dragon at Deerhurst, and a celebration of the Midsummer festival at which the dragon was supposed to claim a victim?

We have indications of similar cults of water spirit sat the sacred wells which are numerous in the district, many of which were, in the natural course of things taken over by Christianity. At Acton and Wick are wells dedicated to the Blessed Virgin. One at Bagendon is famous for curing sore eyes, and another at Pucklechurch has the same reputation. At the well in the parish of Barnsley, young men used to meet on St. John's Eve for wrestling, singing and music, a fact which points to a periodical or seasonal propitiation of the water spirit.

The famous Cotteswold Games, which were held on 14th May, near Chipping Campden, are said to have been instituted in the time of James I. by a spirited public attorney of Burton-on-the-Heath in Warwickshire, named Robert Dover. Even if this be the case, the date and character of these celebrations suggest that they originally represented a seasonal feast, perhaps sporadically performed from the earliest times and reorganised at the time of the Stuarts. One survival of them is found in the assemblage at Cooper's Hill on Ascension Monday, when cheeses are rolled down the hill. I hope it is not rash to connect this with the customs which have been so fully investigated by Dr Frazer,[2] in which wheels with lights attached to them were rolled down hills as a mimetic charm to produce sunshine, the wheel with its lights typifying the orb of the sun. In the same way, it was, or is still, the custom to roll three cheeses round Randwick Church on May Day. They were then carried in triumph, cut up on the village green, and distributed among the villagers. Another mimetic charm, apparently with the same object, is that which used to be done at Pauntley, near Newent, on Twelfth Day, when the farmer's servants assembled in a field sown with grain, lit twelve piles

1 *The Legend of Perseus*, iii. 54 seq.
2 *The Golden Bough*, 2nd ed. iii. 242 seqq.

of straw, apparently representing the twelve months of the year, and drank cider to the health of their master round the largest fire, this rite being followed by a dinner. The fires, like the bonfires so commonly lit in various parts of the country, were possibly intended to revive and stimulate the heat of the sun. Another class of these seasonal feasts is found in the Wakes, which used to be held at May Hill and Leckhampton, where they were possibly associated with some important barrow, barrows and dolmens being well recognised scenes of such rites with the object of enhancing the fertility of men, cattle and crops, because the spirit of the dead hero buried there was supposed to promote fertility, and in particular to enter women and thus relieve them from the affliction of barrenness.

We have, again, the curious observance at St Briavels, where bread and cheese were distributed to the people after the service on Whitsunday. This was said to be connected in some way with the rights of cutting and taking wood in Hudnolls, a privilege won from a certain Earl of Hereford, then lord of the Forest of Dean, by his lady, who underwent the same ordeal as that by which Lady Godiva obtained the privileges for the citizens of Coventry.

The Forest of Dean, secluded from the march of civilisation, naturally abounds in primitive customs and observances, I may note that at the Mine Court, in taking the oath, it was the rule that the witness touched the book of the Gospels with a stick of holly. The object of this is said to have been to prevent the sacred volume being soiled by the dirty hands of the witnesses. But we may reasonably suspect that the custom has its root in a primitive custom of divination by using a branch of a sacred tree ; and we know that in ancient times the holly tree was highly sacred.

It is also noteworthy that at Randwick, which seems to have retained many primitive observances, a sort of Saturnalia was held on the Monday after Low Sunday, when a mock mayor was elected. His Worship, after election, was carried in state, colours flying, drums beating, men, women and children shouting, to a horsepond where, seated on his chair, he was solemnly ducked. A song was sung and his worship then dowsed the company with water. On the analogy of a similar group of customs in other parts of the world, it may be suggested that the rite was originally a mimetic charm to produce rain and fructify the crops.

As an example of the large amount of such interesting material which can be collected by careful local enquiry, I may refer to a very valuable little book written by the Ven. Archdeacon E. C. Scobell, entitled "Parish Gleanings in Upton St. Leonards." We have to thank the Archdeacon for his kindness in communicating some of the interesting facts which he has collected, at a Meeting of the Club held during the past session. We read of the Cherry Fair, held on the first three Sundays after July 5th, Old Midsummer's Day, which seems to represent one of the primitive seasonal festivals held in various parts of the country at this time of the year: the fight, often ending in blood letting, between two neighbouring villages, in which we recognise the custom of shedding blood at this season to revive the fertilising powers of the earth. At Bristol Fair, held in the Winter, cakes in the form of a pig—the appropriate offering to the earth spirit—are sold. The periodical drumming by the parish band goes back to the old rite of expelling evil spirits by noise, which is a common feature of such observances. The influence of the moon on vegetation, trees and animals is recognised: pigs should be killed under a waxing moon, or the bacon will not "plim" or swell in the pot, wood cut at this time lasts longer, seeds then sown prosper, trees grafted are more productive—all instances of mimetic magic, the belief being that things rise and flourish with the waxing moon, sink and fail as it decreases in size. We meet survivals of the open field system, which had its roots in the organisation of the Aryan village community: and there is a "No Man's Land," a survival of the dedication of a patch of the virgin forest from which the trees were never removed, which served for a home for the ejected, vagrant spirits of the fell and wood who had to fly when disturbed by the woodman's axe or the plough share. The beating of the bounds reminds us of the old custom of making a sacred circle round the homestead to bar the entry of foreign malignant spirits. All these curious survivals of primitive rites and practices collected in a single parish remind us what a wealth of curious lore still remains ungarnered. We have in our district many other localities, less influenced by the progress of culture from which even more interesting information may be collected.

Of course, the tentative explanations which I have suggested of these local rites may be upset by some historical or other local evidence which some Members of this Club, now that their attention has been excited and the scientific interest of such enquiries illustrated, may be able to supply. The suggestion that they may be survivals of early custom is rendered more probable by other analogies. We are told that when some one tried to build a Church below the slope on the Churchdown Hill, the Devil every night removed the materials to the summit, where it became eventually necessary to build the sacred edifice. The same story is told of the Church at Bisley, and of many others in different parts of the country. The underlying meaning of the legend is obviously to explain why such Churches are built on inaccessible and otherwise apparently unsatisfactory sites ; the real object being to erect the Christian place of worship on a place already the scene of pagan rites. In the same connexion I may note that the Churches at Notgrove, Nether Swell, Condicote and Wyck Risington occupy the sites of Roman buildings, just as the Guild Hall at Gloucester is built on the ground once occupied by the Roman Prætorium.

Lastly, I may ask whether we have any fairies now in our district. We have good reason to believe that they were once found there. Gervase of Tilbury, an Anglo-Italian writer of the late 12th or early 13th century, tells us that in a hunting forest in Gloucestershire, which may have been the Forest of Dean, and which was full of boars, deer and other game, there was a glade, and in it a hillock rising to the height of a man. Knights and other hunters were wont, when fatigued with heat and thirst, to ascend the hillock and there seek relief. It had to be done by each man singly, all comrades being left at a distance. The adventurous sportsman would then say : "I thirst" and immediately a cupbearer would appear at his side in a splendid dress and with a jovial countenance, and would offer him a drinking horn adorned with gold and gems, and containing liquor of some unknown but most delicious flavour. Then he presented to him a napkin and departed, waiting neither for recompense nor enquiry. One time a sordid knight appropriated the horn and, contrary to good manners, kept it. But the Earl of Gloucester confiscated it and gave it to King Henry I. The story raises many interesting points of history and tradition, for a review of which I must refer you to an excellent paper by Mr Sidney Hartland, entitled "The Archæology of Tradition," read before the Bristol and Gloucester Archæological Society in 1904.

Now when we compare this account of the inmates of this mound, we cannot help being reminded of the fairies so admirably described in that delightful book by Mr J. G. Campbell, "The Superstitions of the Highlands and Islands of Scotland," where the fairy belief forms a part of the living folk-lore of the people. They live in mounds distinguished from the surrounding scenery by a peculiarly green appearance and rounded form. In short, they resemble the pit dwellings occupied by the Lapps and other northern races. They have a community of their own. Men have entered their mounds and found them spinning, weaving, cooking, enjoying singing and music. They have occasional splendid feasts in which mortal men have shared. Such visitors become insensible to the passage of time and have spent years or even ages with them. They are connected with the stone age by the fact that their weapons are little flint arrows, and they sometimes leave behind them a little black stone, which when soaked in water cures sick people and cattle. They often abduct babies and leave their own mis-shapen offspring in their place. They know little of surgery and have to employ human midwives. Many a Howdie has been called to a Brugh, and finds on coming home that her stay had been incredibly longer or shorter than she imagined. But no one was ever the better after such an adventure, and when she gets her fee in gold, it often turns into dry leaves when she gets home.

From such facts, which form quite a literature of their own, it has been suspected that the fairies represent the surviving tradition of a small-sized, furtive, thievish, mischievous people, who play sundry tricks on mankind, just as we may suppose the degraded survivors of an earlier race, hating and fearing their conquerors, may have done. The real flaw in the theory, and it is a serious one, is that though the fairy underground dwellings may reasonably be compared with similar habitations used by the Lapps or other northern races, there is no evidence to show that the pit dwellings of England go back to the neolithic period, and the evidence of the finding of pigmy remains in English barrows or other places of habitation or interment is scanty. Perhaps our district may one day supply the link which will connect the fairies with the neolithic peoples.

To sum up this desultory account of some of the directions in which a study of the popular beliefs and usages of our district usefully supplement our knowledge of our prehistoric ancestors. To those whose tastes lie in the investigation of the physical, rather than the psychical side of Nature, such topics may seem frivolous and destitute of any practical value. But for the examination of the evolution of human culture it is now almost a commonplace to recognise that the study of the beliefs and practices of backward races supplies the only available clue to the interpretation of those archaic usuages, the meaning of which is no longer apparent. The mobilier of an interment in a barrow would possess little meaning so long as it cannot be compared with the customs of living savage and barbaric races. Hence anthropology, and in particular that branch of it which attempts to deal with peasant beliefs and survivals, is an indispensable handmaid to archæology, and archæology so far as it seeks to classify the remains of primitive man, is largely indebted to both geology and palæontology. It is the geologist to whom we look for information on the age of the gravels or other strata in which human remains are embedded, while the palæontologist teaches us how to interpret the nature of the osteological fragments found in association with human remains, and how to identify the fauna contemporaneous with them. Within the limits of a Club like ours there is ample room for the co-operation of workers in these allied sciences.

The moral of what I have tried to say is this.—The beliefs and usages of our peasantry, now unhappily obsolescent and rapidly disappearing before the Board School and the pseudo-culture which is encouraged by an unreflective age, are an asset of great value for the study of the evolution of human culture. Treated by the comparative method, that is to say, in relation to the usages and beliefs of living backward races in other parts of the world, they open up new lines of enquiry into the past history of mankind, and explain much in human psychology and belief which would otherwise be unintelligible to us. They are like the fossils embedded in the strata of our rocks, each of which has a life history of its own. If what I have said this afternoon leads any Members of the Club to appreciate the interest and importance of the collection of such facts, my object in addressing you will have been fully attained.

Mr Crooke then left the Chair.

The Hon. Secretary then called upon the Rev. H. H. Winwood to propose the President for the Coming year.

Mr Winwood reminded the Members that as late President of the Anthropological Section of the British Association and President of the Folk Lore Society, Mr Crooke was eminently qualified to deal with the subject of the Address the Club had been favoured with, and expressed the belief that it would influence the future work of some of its Members. He proposed the re-election of Mr Crooke as President—a proposition that was unanimously agreed to.

Mr Crooke returned thanks, and said it would be his aim to further the best interests of the Club.

The Rev. H. H. Winwood and Messrs Christopher Bowly, M. W. Colchester Wemyss, W. R. Carles and Charles Upton were re-elected Vice-Presidents: Dr Charles Callaway and the Rev. Walter Butt having resigned.

Mr J. H. Jones was elected Hon. Treasurer; Mr J. G. Phillips, Hon. Librarian; Mr L. Richardson, Hon Secretary; and Mr E. T. Paris, Hon. Assistant Secretary. The Rev. Walter Butt and Messrs W. Thompson. G. M. Currie and J. M. Dixon were elected as representatives of the Members on the Council.

Rule 12 was read and adopted.

The places and dates for Field Meetings were then decided upon as follows:—Edge Hill, May 16th; Charlton Kings, May 27th; Knightsford Bridge, June 13th; Cirencester (Royal Agric. College), July 1st; Brecon, July 4th to 6th; Ledbury, Eastnor and the South Malverns, September 12th.

ORDINARY WINTER MEETINGS

TUESDAY, November 15th, 1910

WILLIAM CROOKE, F.A.I., President, in the Chair

The Minutes of the last Meeting were read and confirmed.

Exhibits.—The Rev. A. R. Winnington-Ingram exhibited specimens of ores from Cornwall. These were handed round, and the exhibitor made some explanatory remarks. The tin ore came from the Botallac mine, which is 1,050 feet deep, and runs for one-third of a mile under the sea. The mine has been worked between 600 and 700 years, and is considered to be very dangerous, because the old workings are full of water, many of them are unknown, and the workmen are likely at any time to run a new passage into an old one, and so be all drowned. The ore is crushed with stamps, washed, and then roasted. After this process it is called black tin, and is worth £86 5*s* a ton. It is then sent to Penzance to be smelted, after which operation it is worth £150 a ton. Specimens of serpentine, uranium, etc. were also shown. The exhibitor said that according to the report of a French expert, radium can be extracted from the uranium from rocks beyond the Botallac mine, and Mr Winnington-Ingram was told that a French syndicate intends finding money to work it. Radium is worth £600,000 an ounce.

Mr Richardson exhibited a very large Nautilus (*N. cf. lineolatus*, Foord and Crick), from the base of the Pea-Grit at Huddingknoll Hill, The Edge, near Stroud. It had been given him by Miss H. M. Hutton to do what he thought best with, and he had presented it to the Gloucester Museum in Miss Hutton's name.

Mr Richardson also said that the Members of the Club would be interested to hear that the fine collection of Lias fossils from Alderton and Dumbleton Hill, which was made by the late Mrs Hutton, and concerning which Dr Thomas Wright had written a "report" that was published in volume iii. of the "Proceedings" of their Club, had been presented to the Cheltenham Town Museum. Mr Paris and he were arranging it, and they had the assistance of several British Museum officials, as a number of the specimens had not hitherto been recorded from this country. He was preparing a paper descriptive of this collection, and there would be several appendices by specialists.

POLECATS NEAR CHEPSTOW

The Rev. Walter Butt made an interesting statement with reference to two polecats he saw in his wood the previous evening. Such animals, said he, had become very rare. About a month ago, as people were coming out of Church at Tutshill, near Chepstow, a gentleman called out that he had just seen a polecat. The speaker did not attach much very importance to the remark, but a week or two afterwards a gardener told him that he had seen what he believed to be two polecats go up a cedar tree. The previous evening he (Mr Butt) went into his wood, and whilst looking for a rabbit, he saw two polecats go up a beech tree and stop there.

The following papers were then communicated :—

1. "PARISH LORE." By *the Ven. Archdeacon Scobell, M.A.*
2. "THE 'STONE CIRCLES' ON THE BLACKHEDGE ESTATE, LECKHAMPTON." By *L. Richardson.*[1]

[1] See Proc. Cheltenham Nat. Sci. Soc. for 1911.

The following were elected Members of the Club :—

Henry Tew Bruton, Gloucester ; Henry J. Weaver, M.I.C.E.I., M.I.M.E., F.G.S., Gloucester ; Sir E. M. H. Fulton, C.S.I., Cheltenham ; B. G. Geidt, Cheltenham ; The Venerable Archdeacon Sinclair, Shurdington, near Cheltenham.

TUESDAY, December 6th, 1910

WILLIAM CROOKE, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read and confirmed.

Mr H. W. Household, M.A. was elected a Member.

A Lecture, illustrated with lantern-views, was then given on :—

"CHARNWOOD FOREST AND ITS BURIED LANDSCAPE." By *Prof. W. W. Watts, Sc.D., M.Sc., F.R.S., Pres. G.S.*

In the discussion which followed, Mr L. Richardson and the Rev. H. H. Winwood took part.

TUESDAY, February 14th, 1911

WILLIAM CROOKE, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read and confirmed.

The following communications were made :—

1. "A REVISED LIST OF THE LAND AND FRESHWATER MOLLUSCA OF GLOUCESTERSHIRE." By *Charles Upton.*
2. "AN ASTRONOMICAL STUDY OF THE LONG BARROWS OF THE COTTESWOLDS, WITH SPECIAL REFERENCE TO THE MERIDIAN." By *A. M. McAldowie, M.D., F.R.S.E.*

TUESDAY, March 14th, 1911

WILLIAM CROOKE, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read and confirmed.

The following communications were then made :—

1. "THE COTTESWOLDS, SEVERN VALLEY AND MALVERNS DURING THE GLACIAL EPOCH." By *J. W. Gray, F.G.S.*
2. "THE INFERIOR OOLITE AND CONTIGUOUS DEPOSITS OF THE CHIPPING NORTON DISTRICT." By *L. Richardson, F.G.S.*
3. "NOTES ON SOME SPECIES OF GERVILLIA FROM THE LOWER AND MIDDLE JURASSIC ROCKS OF GLOUCESTERSHIRE." By *E. T. Paris, F.C.S.*

EXCURSIONS

EXCURSION TO YATE AND WICK ROCKS

TUESDAY, May 10th, 1910

Directors: B. A. BAKER, F.G.S. *and* L. RICHARDSON

(*Report by* THE DIRECTORS)

The weather, with the exception of one short interlude of cold rain as the Members were approaching Wick, was most favourable for this Excursion, and, as on so many previous occasions, the opening field-work for the year proved thoroughly enjoyable. Most of the Members travelled from Gloucester by the 10.10 *a.m.* train, arriving at Yate at 11.12 *a.m.* A brake was awaiting them, and they drove to the workings for gypsum and celestite (or celestine) near Goose Green Farm, distant about three-quarters of a mile to the north of Yate Church.

Here, Mr Baker, F.G.S., of Bristol, pointed out that they were inside the Bristol coalfield. The ridge to the east of them was formed by the outcrop of the hard Carboniferous Limestone; beneath where they stood was the Millstone-Grit, with a comparatively thin covering of Keuper Marl on top; while away to the west stretched the Coal Measures. While the Coal Measures and underlying rocks belong to the Palæozoic and Archæan Groups, the Keuper Marls, Rhætic, Lias and the Oolites of the Cotteswold escarpment to the east appertain to the Neozoic Group. The Coal Measures were formed under somewhat lagoon-like conditions, which were terminated by intense crust-crumplings. Some areas were upheaved and others depressed, and for a very long period indeed the disturbed strata were subjected to denudation. Valleys were scooped out of the soft rocks; but the harder rocks formed hills, so that a land-relief of hill and valley was ultimately produced. In time, this land-surface was lowered and the Keuper waters submerged all except the higher hills. From the waters of the Keuper sea were precipitated the layers of gypsum and celestite which constitute so valuable commercial assets in the Bristol district. Rhætic, Lias and Oolites were deposited sequentially above, and in these rocks is chronicled the history of the transition from the inland sea conditions of Keuper times to the coral-reef-encumbered seas of the Oolite epoch. The Oolite of the Cotteswold Hills and the Lias of the vale once extended much further west, as is obvious from outlying patches; but they are being gradually removed, and as they are removed the old land-surface of Palæozoic rocks is revealed once more and modified. Celestite is specially well seen in the Bristol district, occurring as thin beds and irregular deposits in the Triassic marls, especially near the boundary between the red marls and the tea-green marls. It is worked for commercial purposes at many places, especially in the Yate and Wickwar district. Starting from the Golden Valley, near Bitton, the exposures have been followed through Wapley, Yate and Sodbury, near the south end of the Wickwar tunnel, and Cowslip to Ashworthy. The mineral also occurs near Charfield, to the north of the Carboniferous Limestone ridge, which forms the edge of the Bristol coalfield. In all these places the celestite is found in pockets. Often the deposit will run across several fields, but not continuously, as there may be several breaks, and while from one excavation several thousand tons may be obtained, the next may yield only a small quantity. Some of the excavations show two or more beds at different depths, separated by marl, and sometimes introduced between the beds of the underlying Palæozoic series. Generally near the surface will be found isolated celestite masses, then may come an irregular bed of the mineral; this may be followed by a deposit of marl, and lower again, another bed of celestite. The beds are not continuous, but sometimes thin out, or break off suddenly, but commence again further on at the same level. The deposits vary in character. In some the celestite forms a mixture of angular and subangular masses of irregular shape and varying size; in other cases the fragments are rounded. There occur also large geodal masses, sometimes weighing several hundredweight, and containing beautiful crystals. The crystals vary much in size, some being small, while others associated with them may reach a length of three to three-and-a-half inches.

After lunch at the Portcullis Hotel, Chipping Sodbury, the Members drove to Wick Rocks and, by kind permission of Mr W. Machell, the Managing Director of the West of England Ochre and Oxide Co. Ltd., inspected the Ochre Mines at Gatheram.

Ochre is a form of hematite, only more earthy, and there are two principal kinds—yellow and red. The ochre here occurs in the Keuper deposits and is worked in adits driven along the dip of the beds. It is ground and treated in mills, and is largely employed in the manufacture of paints, etc.

The Members were much impressed at the picturesqueness of the Wick Rocks, and it was explained that the scenery is due to the presence of Carboniferous rocks, which here occur as an inlier in the Neozoic rocks.[1]

A number of specimens were obtained from the Limestone, and then the Members drove to Mangotsfield, and caught the 5.5 p.m. train for Gloucester.

HALF-DAY EXCURSION TO CHARLTON COMMON, NEAR CHELTENHAM

SATURDAY, May 28th. 1910

Director: L. RICHARDSON

(*Report by* L. RICHARDSON)

The Members met at the tram-terminus at the foot of Leckhampton Hill at 3 *p.m.*, and walked up to the house called "Daisybank." Here Mr Richardson said it was unnecessary to describe the detailed structure of this hill-mass, because it had been done so often of recent years, and was set forth in print in the Club's "Proceedings."[2] Briefly, however, the vale-land was clay, Lower Lias; this Lower-Lias clay gradually gave place at the foot of the hill to the sandy beds of the Middle Lias (of which the topmost portion was the hard Marlstone), while above the Middle Lias came the Upper Lias. In the South Cotteswolds nearly all the Upper Lias was sand (Cotteswold Sands), while here it was clay. But the top-portion of the clay at Leckhampton was somewhat sandy, and for that reason had been dug in the opening near to where they were standing for mixing with the "stronger" clay of the vale to make a suitable earth for use at the Cotswold Potteries. [3] A very plastic clay was required for pottery-making, and the ordinary blue Lias clay by itself was no good for the purpose. Above the Upper Lias comes the Inferior Oolite, which, as the Members knew well enough, was full of fossils at certain horizons.

1 An account of "The Geology of the Wick Rocks Valley," by Prof. C. Lloyd Morgan, will be found in the Proc. Bristol Nat. Soc., vol. vi., pp. 183-188.

2 Proc. Cotteswold Nat. F. C., vol. xv., pt. 3 (1906), pp. 182-189.

3 Proc. Cheltenham Nat. Sci. Soc., n.s., vol i., pt. 4 (1910), pp. 263-264.

Walking along at the foot of the steep side of the common, the Members saw a gravel-pit, in which the top-gravel is made up principally of angular fragments of oolite, which have become detached from the cliff-head, and have fallen down; but the main portion is "granular." Mr Richardson said that if in imagination they restored the angular *debris* to the cliff-head, and removed the "granular" gravel from its foot, he thought they would have a cliff very much steeper than any that could have been produced by the ordinary processes of denudation such as are at present at work in the district. He suggested that the over-steepening of the scarp of Inferior-Oolite rocks took place in the Glacial Period, and that the processes which over-steepened the Inferior-Oolite scarp were analogous to those which steepened the head walls of some of the Welsh cwms. He thought that the resemblances as regards certain features here and in Wales permitted such a comparison being suggested. This comparison he had made in a paper about to appear in their "Proceedings."[1]

Fine views were obtained from May Hill northwards, prominent points being Hay Bluff, the Woolhope Hills, the high ground above Wenlock Edge, the Clee Hills, and, in the far distance, resembling a tumulus, the Wrekin.

Mr Charles Bailey noted the following plants:—Horse-shoe Vetch (*Hippocrepis comosa*), Columbine (*Aquilegia vulgaris*), Thyme-leaved sand-wort (*Arenaria serpyllifolia*), and Hairy rock-cress (*Arabis hirsuta*), all on the Common.

The Members then walked down Sandy Lane, boarded brakes at the entrance to Southfield Farm, and drove to Mr Carles's residence in the Park. Passing over the Banbury Line, the extensive deposit of sand attracted attention. Mr Richardson had, earlier in the afternoon, informed the Members that the sand could not have been derived from the hills because there was no deposit in those hills sufficiently extensive, and what deposit there was on Cleeve Hill was made up of finer grains than the deposit in the vale. The sand of the vale deposit was composed of relatively coarse grains, and its probable source was much farther north. It had probably been introduced into this district in the late Glacial Period.

After tea, Mr W. Crooke, F.A.I., the President, thanked Mr and Mrs Carles, on behalf of the Club, for their very kind hospitality, and assured them that it was very much appreciated.

EXCURSION TO THE NORTHLEACH DISTRICT.

TUESDAY, JUNE 7th, 1910

Directors: L. RICHARDSON *and* JOHN SAWYER

(*Report by the* DIRECTORS)

The Members left the G.W.R. Station, Cheltenham, in brakes at 10.30 *a.m.*, and drove direct to Northleach. Here, before lunch, a visit was paid to the Church. To the few Members who had not previously seen it, the Church was a pleasing surprise. It is entirely built in the Perpendicular style, is of noble proportions, and has a south porch of unusual beauty. Whether there was an earlier Church in the town is doubtful. Domesday Book records a priest as among the inhabitants, but says nothing of a Church. There is evidence of the existence of a Church of earlier date in the adjoining parish of Eastington, and it may be that this was the Church for Northleach as well. It may be, too, that the font in the Church is of earlier date than

1 Proc. Cotteswold Nat. F. C., vol. xvii., pt. 1 (1910), pp. 40-43.

the Church itself. It certainly looks older, and the ornamentation—a bowl supported by eight angels, with eight angels at the base of the pedestal—is not characteristic of fifteenth-century work.

Luncheon was served at the Wheatsheaf Hotel, and at the close of the meal, Mr J. Sawyer (who had previously described the Church), was invited by the President to make some observations on the archæology of the neighbourhood. In reply, Mr Sawyer gave the following outline of the English settlement on the Cotteswolds, with special reference to the wool-trade :—

The English Settlement

The English conquest of the Cotteswolds dates from 577, when the King of Cirencester, with the Kings of Gloucester and Bath, fell beneath the sword of the West-Saxon invaders on the famous battlefield at Dyrham. In the far-spreading uplands the new-comers saw their future home. Fast on their heels came their kindred whom they had left behind on the shores of the Baltic, and in a few years the Cotteswolds were peopled by a new race, speaking a new tongue, the tongue which is spoken here to-day. Sometimes a family lived by itself, with its farm and household servants, and owned and cultivated land around the house. Sometimes two or three or more families related to each other joined together in one settlement, forming, indeed, a small village. But their communities were never large. Their occupation, for they were agriculturists, pure and simple, forbade it, and so did their racial instinct, and the sparseness of town life on the Cotteswolds to-day has been largely determined by the customs of our ancestors of thirteen hundred years ago. This love of privacy was the origin and cause of another marked feature of Cotteswold rural life. Many of the main roads in Gloucestershire have existed from Roman or even British times, and were excellent highways when the English settlement began. Yet, as anyone accustomed to travel on our main roads must have noticed, the towns or villages alongside the roads are few and far between. From Gloucester to Cirencester, the Roman road, known as the Ermine Street, passes through only one village (Birdlip), and that is a modern outgrowth in a parish whose centre (Cowley) is two miles away. The ancient road which connects the Ermine-street at Birdlip with the Foss Way at Stow-on-the-Wold, except near Stow, also passes through only one village (Andoversford), and that consists of a few houses which have sprung up around a railway station in a corner of the parish of Dowdeswell. The Foss Way, which runs through the county from Bath to Moreton-in-Marsh, cuts through only one centre of life, the town of Cirencester, and that because Cirencester was a town—was, in fact a city, before the English came. Northleach itself, though close to the Foss Way, has only one house on its edge—the abandoned county prison !

The thoroughness of the English conquest of the Cotteswolds is evidenced by the names of places. Such well-known English affixes as "ham," "ton," "worth," "ley," "field," are common throughout the Cotteswold area ; and an analytical study of Cotteswold place-names reveals the striking fact that nearly ninety per cent. of them are of distinctively English origin. A few places take their names from rivers. Coln Rogers, Coln St. Dennis, Coln St. Aldwyns obviously take their names from the river Coln ; North and South Cerney are upon the banks of the Churn ; Windrush is simply the name of the river which flows through it ; Northleach, Eastleach Turville, Eastleach Martin and Southrop, which in early times was called Southleach, are four parishes on the little river Leach. Why these names should be exceptions to the general rule is uncertain. Two explanations may be offered. One is that these places were occupied and named before the English came, and the old names were adopted by the new settlers, just as were Cirencester and Gloucester, and other towns whose history dates from the Roman times. Or it may be that they were not a part of the land occupied by the early English settlers, and received their names before occupation began. After the partition of the conquered land among the original settlers, the land that was left over became the common land of the nation, and in course of time was used for the maintenance of the Crown, or for kingly gifts to notable men or to religious houses. So large, indeed, were the possessions of the Church at the time of the Domesday Survey, that they amounted to fully one-third of the profitable land in the county.

The Wool Trade

Agriculture on the Cotteswolds in pre-Norman and Norman times was almost entirely arable, and cereals were the only crops. Hence it is that in the Domesday Book the figures relating to land are confined to the value of land for arable purposes. Permanent pasture was of such small extent and of so little value that its existence finds no place in the great record. Live stock there was, of course, and, as the chronicler quaintly says of the Survey which the Conqueror ordered after his "deep speech" with his Witan at Gloucester, "not an ox, nor a cow, nor a pig was left that was not set down in his writ." But stock was not bred for profit. Cattle were kept as beasts of burden and for milk, and sheep were bred for their wool, but beef and mutton were too dear to be common articles of food. In the thirteenth century a great impetus was given to the breeding of sheep on the Cotteswolds by the foreign demand for English wool. In the products of wool, the Continental manufacturers were far more skilful than those at home, and as their trade developed, they had to come to England for their raw material. To improve woollen manufactures in England, weavers, dyers and fullers were brought from Flanders, and to handicap the foreigner—and also to put money into the royal coffers—monarch after monarch levied a heavy export duty on wool. In the reign of Charles II. an Act was passed which decreed that all dead bodies should be buried in woollen shrouds, an enactment which remained on the statute book for more than a hundred years. As a natural consequence of this development of sheep breeding, pasturage was by degrees substituted for tillage, and hence the ridge and furrow which characterize much of the grass land upon the Cotteswolds to-day.

The heyday of the Cotteswold wool trade was in the fourteenth and fifteenth centuries. The same period was the heyday of Northleach prosperity. Situated in the centre of a great wool-growing district, it was the mart to which the wool from thousands of sheep was annually sent. From there it went by pack-horse to ports at the mouth of the Thames, whence it was taken across the Channel to Calais and distributed to Continental towns. The breeders of sheep made much money; the woolstaplers made more. Stowell House and Park, hard by Northleach, were for a long time owned by the Tame family, who made their wealth by wool, and many another family became rich by their enterprise in the same lucrative trade. Acting on the apostolic injunction, "Be diligent in business, fervent in spirit, serving the Lord," they gave of their wealth for the spiritual benefit of their neighbours. They are commemorated by their brasses, their connection with the wool trade illustrated by their furred gowns, with their feet resting on woolpacks, sheep and pairs of shears. Other days, other ways; the mundane glories of the Cotteswold wool mart have gone; but to the munificence of the great woolstaplers of the past, Northleach, Fairford and Campden owe three of the finest fifteenth century Churches in the land.

Norbury Camp

A discussion followed on various points in the address, and then the party drove to Norbury Camp, which is reached by a turning from the Foss Way near the Isolation Hospital. The camp is a very extensive one and is said to be Roman, but is probably British. A slight flat-topped rise, about three-quarters of a mile in length by, on an average, a quarter of a mile in width, has been scarped all round and the edge surmounted by a low bank. These earthworks are well seen in a ploughed field on the north side of the road at the western end, and in a grass field on the southern. From a quarry in the Great Oolite situated on the north side of the road between the camp and the Foss Way, a large number of crinoid remains were obtained.

Geology and Water Supply

The up-and-down road to Turkdean was then followed. The adapted and beautified Leygore Farm was much admired, and the Hon. Secretary pointed out that whilst the lower part of the road and the ornamental sheet of water are in the Inferior Oolite, the Fullers'-Earth Clay crops out in the bank and may be easily located by means of boggy ground, springs and artificial openings for obtaining clay for puddling purposes. It is also to be seen in the road-side, and the reservoir at the head of the little valley derives its supply from where Great Oolite and Fullers'-Earth Clay meet. Having topped the next rise, the deep Turkdean valley came into view. From the road near the little freestone quarry, the Hon Secretary pointed out the main physiographic features.

The general geology of this part of the Cotteswolds is extremely simple. The Great Oolite caps the high ground and the prevalent and almost horizontal arrangement of its beds accounts for the levelness of the high ground. Below comes the Fullers' Earth. It throws out the water that has soaked through the great Oolite limestone as springs, and springs from this source, or the small depth from which the water held up by the clay can be reached, accounts for the location of most of the Cotteswold villages and farms in this neighbourhood. Compton Abdale, Hampnett, Farmington, Turkdean, Hazleton, Salperton and Notgrove all obtain their main water-supply from this level. When water from the Fullers' Earth runs over the outcrop of the clay it sinks into the porous Inferior Oolite, and continues to percolate downwards until stopped by a clay-bed. The next clay deposit is the Upper Lias, and when the water comes to it, it runs along the top of the clay in the direction of the prevalent dip. Earth movements have modified what may be called the original prevalent dip. The water becomes carbonated and therefore dissolves the limestone, the subterranean dissolution of which tends to cause "sagging" at the surface and a "solution valley" results. Mr Richardson holds that many of the Cotteswold valleys have been mainly formed in this way. In Carboniferous Limestone districts, such as Derbyshire and the Mendip Hills, long caverns are the rule, because Carboniferous Limestone is much harder and therefore would not give rise to "sagging."

Ascending a beautiful avenue, the party arrived in Turkdean, and spent too short a time in the village, seeing the spring, the outside of the Church—in which some Norman work is embedded—and Mr Rixon's house.

Botany

While looking for crinoid fossils in the Great Oolite Quarry, a rubbish heap was found by Mr Charles Bailey to be decorated with a luxuriant growth of an alien plant, made conspicuous by its numerous white flowers —the whitlow-pepperwort (*Lepidium Draba*, Linn.). Mr Bailey states that although included in the genus *Lepidium* in the British lists, it has quite as much affinity with *Senebiera*, or swine's cresses, and some good systematists have founded a new genus upon it, viz., *Cardaria*. A certain historic interest attaches to this plant, as it has completed the one-hundredth anniversary of its introduction into this country, for it was one of the legacies left by the unsuccessful attempt made by the British against the French in 1809, in connection with the unfortunate Walcheren expedition. A land force of forty thousand British troops under Lord Chatham, supported by a naval force under Strachan, landed on the island of Walcheren at the mouth of the Schelde, and bombarded and captured Flushing; they failed to take

Antwerp, and were finally driven from Zeeland with great loss. The broken-down fever-stricken British troops ultimately disembarked at Ramsgate. The straw and litter upon which they had slept were afterwards thrown into a disused chalk-pit belonging to a Mr Thompson ; other refuse was mixed with it, and in due time it was employed to manure the neighbouring fields. Wherever the material was used, a plentiful crop of the plant followed, so much so that in Kent it became known as "Thompson's weed" or "Thompson's curse." From Ramsgate it spread over the Isle of Thanet, and at the present day its head-quarters may be said to be the edges of the cliffs and the road-sides about Margate and Broadstairs, where it forms a conspicuous feature of the vegetation. When once it had taken hold of the soil, it became a terrible pest ; its roots were many feet in length, and soon choked the drain-pipes of the fields. Considering the immense numbers of seeds of alien plants which are annually turned out from the straw and other materials, now being used for packing the articles of commerce which reach Great Britain and Ireland from all the countries of the world, the surprise is that so few of them make any permanent impression upon the constituents of the native vegetation. But *Cardaria Draba* was one of the few plants which had come to stay ; and it has reached the Cotteswolds. It is gradually spreading all over the country, but nowhere with the same prodigality as in the Isle of Thanet. It is found in almost every European country, in Siberia, and western Asia as far as India, and in the African countries bordered by the Mediterranean.

HALF-DAY EXCURSION TO CRANHAM & PRINKNASH PARK NEAR GLOUCESTER

SATURDAY, July 2nd, 1910

(*Report by* W. THOMPSON)

The second Half-day Field Meeting of this Club was held in the neighbourhood of Cranham. There was a large muster of Members in spite of the stormy afternoon. Cheltenham, Gloucester and Stroud were well represented, and the Members were fully compensated for the unpleasant journey they had. The first place they visited was the Potteries at Cranham, an industry that has made the little secluded village famous for many centuries.

The manufacture and drying of flower-pots and other earthenware utensils was inspected, and the various processes, including glazing of the inside of pans, fully explained.[1] Then leaving the Potteries, the Members, at the invitation of Mr John Herbert, paid a visit to "The Old House," which Mr Herbert occupies. The quaint rooms, the low ceilings, the old-fashioned open fire-places with their andirons or fire-dogs, the circular staircases, the bedrooms with their scrupulously clean white walls, were all in turn a source of interest to the visitors, who expressed their appreciation of the kindness of Mr Herbert in inviting them to his romantic domicile. An inscription over the doorway was deciphered as "G. R., 1727."

Returning to the carriages at the top of the hill, the party drove to Prinknash Park, to which they had been invited by Mr T. Dyer Edwardes. Mr Dyer Edwardes first conducted the Members through his beautiful gardens, and then, after entertaining them to tea, gave them a description of the house and its history.[2] It appears that Abbot Parker resided here in 1526,

1 A detailed description of the Potteries is given in the "Proceedings" of the Cheltenham Natural Science Society for 1910 (pp. 252-253).
2 See "Country Life" for September, 1908.

at which time the house was attached to the Abbey at Gloucester. Elizabeth of York is said to have lodged here, and in 1535, King Henry VIII., with Anne Boleyn his Queen, visited the house. There is also good reason to believe that Charles I. dined and probably slept here during the siege of Gloucester, and that Prince Rupert also made it a house of call. The chapel,

FIG. 1.—View of the Cranham Potteries
(*R. J. Webb, photogr.*)

the drawing-room with its beautiful tapestry, the library, the billiard-room were next inspected, the articles of historic or archæological interest were pointed out and described by the genial host. The President of the Club (Mr W. Crooke) conveyed to Mr Dyer Edwardes the cordial thanks of the Club for the hospitable reception he had given them, after which the Members dispersed to the various centres from which they had come.

Photo. C. Law.

Fig. 1.—QUEEN ELEANOR'S CROSS, NORTHAMPTON

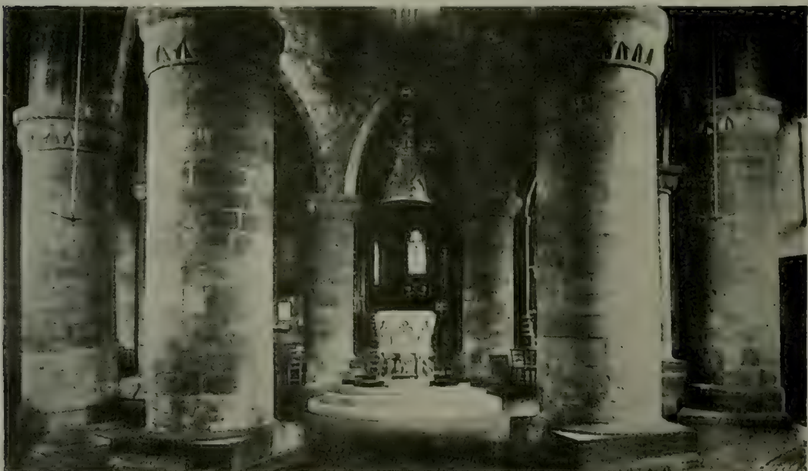

Photo. C. Law.

Fig. 2.—INTERIOR OF ST. SEPULCHRE'S CHURCH, NORTHAMPTON

(From Burrow's "Borough" Guide, Northampton.)

EXCURSION TO NORTHAMPTON

TUESDAY, July 12th to THURSDAY, July 14th, 1910

Directors : H. N. DIXON, M.A., F.L.S. *and* L. RICHARDSON

(*Report by* L. RICHARDSON)

Very fine weather favoured this Excursion, those present being the Rev. Walter Butt (*Vice-President*), Mr L. Richardson (*Hon. Secretary*), Lieut.-Col. J. C. Duke, Surgeon-Major I. Newton, Messrs F. H. Bretherton, G. M. Currie, J. M. Dixon, O. H. Fowler, H. Haigh, F. T. Pearce, J. W. Skinner and A. E. Smith.

Most of the Members arrived at Northampton (*via* Birmingham and Rugby) at 1.25 *p.m.* on the Tuesday and proceeded to the George Hotel, which was the Headquarters. After lunch they left in a brake and proceeded in a westerly direction through the suburb called St. James' End.

The first halt was at Watkins's Brickyard, close to the Duston Road.

Here Mr Richardson gave a brief outline of the geology of the district.[1]

From New Duston the Members drove across country to Hunsbury Hill to see "Danes Camp." This camp is similar to many others in other parts of the country and consists of an area of about four acres, enclosed by a couple of banks with an intervening ditch fifty to sixty feet wide and fifteen feet deep. Although known as "Danes Camp," some think that the Danes had nothing to do with it. Until 1882, little was known about it; but in that year the ironstone was worked inside and around the camp. The working of the ironstone revealed a multitude of archæological treasures—"numerous iron weapons and implements, bronze scabbards, bronze ornaments, stone and bone articles, vessels of hand-made pottery, remains of more than four hundred pots of different forms and sizes, portions of more than a hundred querns, or millstones for grinding corn by hand, spindle whorls, bones of man, the red deer, the roe deer, the short-horned ox, the goat, the horse, the pig, the dog, etc." "The whole of the finds," says Mr T. J. George, "belong to the late Celtic period, or pre-historic iron age." Most of the "finds" are in the Northampton Museum, where there is also a truly remarkable collection of flint implements from the neighbourhood.

The next stop was at Eleanor's Cross (Pl. XXII., fig. 1). This beautiful cross is one of the three remaining crosses of a number that were erected between 1291 and 1294 by Edward I. to mark the resting-places of the body of his Queen on its journey from Harby, in Nottinghamshire (where she died in 1290), to Westminster. The other two remaining crosses are at Waltham, in Hertfordshire, and Geddington, in Northamptonshire.

Passing up Bridge Street, St. John's Hospital was noticed. It is now used as a Roman Catholic place of worship, but was originally erected and endowed in 1138, by the then Archdeacon of Northampton, for the reception and maintenance of the infirm poor.

On Wednesday, the hotel was left at 9.30 *a.m.* and the Members drove to Earls Barton, visiting Abington Park on the way in order to see Garrick's Mulberry-tree (Plate XXIV).

1 As the detailed geology of the district has not been fully worked out, the account of this portion of the work accomplished on the excursion is postponed.

Fig. 1.—Tower of Earls Barton Church

The next stop was at Earls Barton Church, which is famous throughout the land for its Saxon tower (fig. 1). "The simple ornament it bears was evidently intended to represent timber, and from the position of the tower and its arrangement, it was clearly used as a retreat from danger in the lawless period in which it was erected." Norman, Early English and Perpendicular work is found in the body of the Church.

After lunch in Wellington, the Members drove to the Irthlingborough Iron Works (Messrs Thomas Butlin & Co., Ltd.), where they were received by one of the Directors and were conducted over the works.

The iron-ore is obtained from the Northampton Sands (Inferior Oolite) and is technically known as "brown hematite."

A booklet concerning the works was presented to each of the Members, and therefrom the following information is extracted.

The metallic yield of the ore varies, but the average works out at approximately 36½ per cent.

The ore varies considerably, so Messrs Butlin mix the different kinds, which are of different chemical composition, in the blast furnaces, thereby obtaining a uniform result.

After the ore has been smelted it is run into the pig-beds. These, as usual, are situated immediately in front of the blast furnaces, "but at the further extremity and beyond the entrance to the last 'sow,' the feeding channel is extended in the shape of an arc, having three races in the sand, and these races open upon the ladle-pit, where are placed three ladles, having a capacity of 4 tons, 3¾ tons and 3½ tons respectively. Upon the furnace being tapped, the metal runs down the channel and commences to fill the furthest 'sow,' but as the head of metal increases, it also, whilst filling the pig moulds, commences simultaneously to fill the ladles. As these are filled they are lifted one by one by a steam travelling crane on to a bogie and are taken into the foundry, where the metal is cast in the usual way. To get the cast-iron into a suitable composition for direct casting required a long investigation into the chemical composition of the ore, so as to arrive at the proper fluxes to be used for smelting. This painstaking task has devolved upon Mr W. H. Butlin, and the result has been very satisfactory, not only in the quality of the iron, but also in the slag produced, for which there is now a great demand for paving purposes and road-repairing, etc.

"Owing to the circumstance that the Northamptonshire district is deficient in hard rocks suitable for road making, Messrs Butlin & Company's slag is very largely used. The cinder, as it runs from the furnace, is moulded into rectangular blocks of about 13 cwts. in side-tipping, cast-iron bogies, which cool rapidly. The blocks, when subsequently cooled, are roughly broken by hand and passed through a Blake rock-breaker with drum seizing sieves, which reduces the bulk up to road metal, or railway ballast size, the finer chippings finding a use as ballast in making granolithic slabs. A considerable quantity has also been used in decorative moulded work by the North British Hotel at the Waverley Station in Edinburgh. As good iron is accompanied with good slag, the quality of the slag is regarded during scientific experiments as an index to the character of the iron."

The return drive to Northampton was *via* Castle Ashby, a short halt being made here in order to see the Castle, which is the seat of the Marquis of Northampton, and the Church. The lettered balustrades round the roof of the Castle are unique.

Thursday morning was devoted to seeing Brixworth Church, and the Churches of St. Peter's and the Holy Sepulchre in Northampton.

Brixworth Church, of the interior of which a photograph is given in fig. 2, is not, as reputed, an old Roman basilica, but an early Christian basilica,

FIG. 2.—Interior of Brixworth Church

and was in all probability founded about 680 A.D. Roman materials were largely used in the building, all the openings being built in Roman brick.

Returning to Northampton, the Members next saw St. Peter's Church, which is very rich in Norman work, and especially interesting to geologists as the burial-place of William Smith (see also Plate XXVI. in this part of the Proceedings). Near the Church is an imposing Elizabethan structure called "Cromwell House," and also the site of Northampton Castle.

The last Church visited was that of the Holy Sepulchre—one of the four remaining round churches in the kingdom. It dates from about 1100 (Pl. XXII., fig. 2).

Most of the Members left Northampton by the 3 o'clock train.

EXTENSION.—July 15th—WANSFORD, WITTERING AND BARNACK

(*Report by the* Rev. Walter Butt)

In company with another Member of the Club, Mr J. M. Dixon, I took the train for Wansford, accompanied thither and throughout the afternoon by Mr H. N. Dixon, F.L.S., the Hon. Secretary of the Northamptonshire Natural History Society. I would that more of our Members had availed themselves of Mr H. N. Dixon's kind offer to conduct them to Barnack. The line to Wansford lay through the rich, lush meadows of the Valley of the Nene, and we were never out of sight of one or more church spires. Never have I seen in the course of one afternoon so many or so decidedly graceful ones. At Wansford Church we saw a very fine Norman font with somewhat unusual sculptures on it, and a rare billet-moulding. Apparently, the base had been itself a font of much earlier date. The font is well figured in Bond's "Fonts and Font Covers," which was published by H. Frowde in 1908. We then went on to Wittering, an out-of-the-way place, and seemingly little visited. And this is a pity, for the Church is of extreme interest. There is much Saxon work in it, both outside and within. The imposts on the pillars carrying the chancel-arch are unique. Their size and thickness are quite cyclopæan in character. From Wittering we walked on to Barnack, and led by Mr Dixon, found many rare plants—some especially so.

Among the less common plants, we collected *Carex fulva, Lithospermum officinale, Schœnus nigricaus, Menyanthes trifoliata, Anagallis tenella, Hydrocotyle vulgaris, Cnicus palustris, Antennaria dioica, Echium vulgare,* etc. And among the quite rare plants of Britain, we found *Anemone pulsatilla,* of course in fruit, not in flower, *Epipactris palustris, Legousia secularia, Trifolium ochroleucon,* in probably its western-most station. It is found

Fig. 3.—The "Hills and Holes," Barnack. (Old quarries where the "Barnack Rag" was once worked.)

in but 11 of the 112 Vice-Counties of England. *Brachypodium pinnatum*, *Aceras anthropophora*, the "man" orchid, a very scarce British plant, were other "finds," and to end with the greatest "find" of all, *Apera interrupta* a grass which is only recorded in five Vice-Counties.

And so, over the "Hills and Holes," (fig. 3) whence stone for very many centuries has been got for some of the most notable buildings of the Midlands and further away still, we reached Barnack (fig. 4). Well, we had seen on the previous day Earls Barton, and during the previous morning, Brixworth; so perhaps I was a little disappointed. But the sight of it, and the two previously named Churches, with the but-just-left Wittering, was an experience of a very unusual kind, and most illuminating.

FIG. 4.—The Tower of Barnack Church.

EXCURSION TO THE FOREST OF DEAN

TUESDAY, September 13th, 1910

Directors: L. RICHARDSON *and* R. WILLIAMS
(*Report by* L. RICHARDSON *and* JOHN SAWYER)

The Members met at Monmouth—a town on the borderland of England and Wales, and associated with both Kingdoms. An English town, put (as also was the county of Monmouth) into English territory by Act of Parliament in the reign of Henry VIII., it is in a Welsh diocese; English for the purposes of the Sunday Closing Act, it is Welsh for Intermediate Education; English in language, it is surrounded by places with Welsh names. Old things and new jostle each other in delightful fashion. The militia barracks enfold a part of the castle which was founded by William Fitz-Osbern, one of the Norman Conqueror's regents in England during his absence in Normandy, and in which Henry V. first saw the light; from the western countryside all traffic to the town still passes through the gate on Monnow Bridge, where toll for man, beast and merchandise was demanded for many centuries; half-timbered, gabled houses, in quaint, narrow streets are lit with the electric light; and the study of Geoffrey of Monmouth, the monkish historian of the twelfth century, is near neighbour to two large Secondary schools, both of which owe their existence to the munificence of one William Jones, a native of Newland, a village near, who, after amassing a fortune in London, richly endowed in Monmouth "one free Grammar School, for the instruction and education of boys and youths in the Latin tongue and other more polite literature and erudition." Then, who that knows his Shakespeare does not call to mind some passages in *King Henry V.* "Ay, he was porn at Monmouth,' says the Welshman Fluellen, speaking of the hero of Agincourt; "what call you the town's name where Alexander the pig [great] was porn? . . . I think it is in Macedon where Alexander is porn? I tell you, captain—if you look in the maps of the 'orld, I warrant you shall find in the comparisons between Macedon and Monmouth that the situations, look you, is both alike. There is a river in Macedon and there is also, moreover, a river at Monmouth; it is called Wye at Monmouth, but it is out of my prains what is the name of the other river; but 'tis all one, 'tis alike as my fingers is to my fingers, and there is salmons in both." Then, speaking to the King, Fluellen says, "If your Majesty is remembered of it, the Welshmen did goot service in a garden where leeks did grow, wearing leeks in their Monmouth caps; which your majesty knows, to this hour is an honourable padge of the service; and I do believe your majesty takes no scorn to wear the leek upon Saint Tavy's day." "I wear it for a memorable honour," replies the King, "for I am Welsh, you know, good countryman." To which Fluellen replies, "All the water in the Wye cannot wash your majesty's Welsh plood out of your pody, I can tell you; Got bless it and preserve it, as long as it pleases His grace, and his majesty too." Unlike Henry V., Monmouth folk do not consider it an honour to be Welsh; they prefer to be considered English. Monmouth caps have long since gone out of fashion, though the name is still preserved in Capper's Town, the straggling parish on the western side of the Monnow's bridge. [J. S.]

Leaving Monmouth the party drove down the Wye Valley to the Redbrook Tinplate works, the property of the Redbrook Tinplate Co. Ltd. (who have offices in Liverpool and London).

"The manufacture of tinplates in Great Britain was first started by Major Hanbury, at Pontypool, in 1720, and a large number of works were soon opened in Monmouthshire and the neighbouring counties."

The Redbrook works are among the oldest tinplate works, and date back to about 1824. Previous to that date they were copper works, but on the introduction of steel, charcoal iron was displaced, and part of the works was converted into tinplate mills. Tinplates and sheet iron are produced; but the chief feature of the works is the exceptionally thin class of tin and black "taggers," which are largely used in Germany for making buttons and tags for shoe-laces, as well as for air-tight tobacco and cigarette tins. The raw material for these works consists of long flat steel bars. These are cut by a machine into more or less square pieces,and then heated and rolled out into large flat plates, and are dealt with in such a way that eventually a great number of very thin plates are derived from what appears to be but one. These are cut to the requisite size and polished by being put through a bright steel roller. Such plates are put on the market as black "taggers." To make a "tinplate" the black tagger is run through a bath of melted tin, and re-emerges from between two closely set rollers a fully-coated tinplate. To rub off any greasy matter that may be adhering, the tinplates are then thrust by hand in and out of mealy material, being finally polished by rubbing by hand. The steel required comes from South Wales, as does the coal; most of the tin is from Australia, although a little comes from Cornwall. There is a large Tinplate Works at Lydney.

Mr R. Beaumont Thomas, M.I.Mech.E., in a highly interesting paper on "The Manufacture of Tinplates" (Proc. Inst. Mech. Engineers, July, 1906, pp. 499-541) states (p. 501), "The chief use to which tinplates are put to-day is that of casing petroleum, and it is estimated that out of the total exports of 7,099,020 cwts, in 1905, 2,300,000 cwts. were used for this purpose. Other uses to which they are put are the manufacture of dairy utensils and the canning of food, such as beef in America, salmon in Canada and the United States, oysters and lobsters on the American Continent, sardines and peas and other vegetables in France, Spain, Italy and Portugal, pine-apples in Mauritius and Singapore, milk in Switzerland, and many other articles. In addition, it is well known that the introduction of stamping machinery has led to tinplates being more largely used for an increasing variety of purposes, such as the packing of biscuits, cakes, tobacco, sweets, etc. Terne plates are largely used in America for roofing purposes, and in the Manchester district for packing dry goods."

From Redbrook the drive was continued to Newland, where the famous oak was seen. Five feet from the ground it has a girth of 41 feet, and is thus one of the largest trees in the Kingdom. Thence the party went to the little town of Coleford and lunched at the Angel Hotel, after which they drove to St. Briavels. On the way they looked at an old iron-working in the Millstone Grit (a bed which underlies the Coal Measures), and also some quarries in the Mountain Limestone, the bottom bed of the Carboniferous system. Here Mr Richardson gave an outline of the geology of the district. [L.R.]

Reaching St. Briavels, some time was spent in an inspection of its ancient castle, which is perched on the edge of a hill a short distance north of Tintern. Its early history is closely interwoven with that of other fortresses in the near neighbourhood, while its fate in later times differs from that of all its neighbours. Goodrich to the north, and Raglan to the west, are majestic in their ruin; behind the latter are Grosmont, Skenfrith and Llantilio, forming the celebrated "Trilateral" of Monmouthshire. Chepstow, a few miles south, stands in solitary grandeur, as indeed it has always done; for its one purpose was to guard the passage of the Wye on the great road from Gloucester to South Wales made by the engineers of the Second Roman

Legion before the first century had come to a close. All these strongholds date from the great castle-building period which began with William I. and went on into the reign of Stephen. Their existence seems to indicate that in this limited section of the Welsh marches, the natives of the Principality were very troublesome until the first Edward had brought them into subjection to the English throne. Yet it was not patriotism alone that moved them to fight. Originally intended for self-protection, these Norman fortresses speedily became means of oppression. "I am monarch of all I survey" was the attitude of their owners in the days of feudal strength; and as Matthew Paris, the monkish historian of the early half of the thirteenth century, styles castles "nests of devils and dens of thieves," we may safely infer that it was not with favouring eye that Welshmen looked on the strong walls of Monmouth and Raglan, Goodrich, St. Briavels and Chepstow. In later times these buildings became the stately homes of the rich and the powerful, and of Raglan there is still preserved an account of the mode of living at the time of the Cromwellian civil war. Royalty again and again honoured the lords of these castles with their company. In connection with one of several visits paid to St. Briavel's castle by King John, it is on record that two tuns of wine were sent there, for the use of his majesty and his followers after the pleasures of the chase in the forest. King Charles went to the magnificent establishment at Raglan three times in the year before the battle at the Cotswold town of Stow-on-the-Wold brought the civil war to a close. From this time the ruin of nearly all the castles may be dated, for it was a creed of Cromwell to destroy buildings which could shelter his foes. St. Briavels is an exception, for to-day a portion of it is habitable, and is now the residence of the Hon. Mrs Campbell, by, whose kindness it was now visited. Probably its preservation is due to the fact that in early days it came into use as a court-room for the administration of miners' laws, and also as a manor court.

For a long period St. Briavels castle was used as a prison, and as such was visited by John Howard, who records that he found in it three prisoners who for trifling debts but heavy costs had been confined there for long periods. On the splay of one of the windows are some rudely scratched inscriptions by prisoneers in the seventeenth century, one of which runs:

MY GLAS IS ROON: TIS TIME 'TWAS GONE
FOR I HAVE LIVED A GRET SPACE
AND I AM WEARY OF THE PLACE.

In its chequered history, however, there is no story more pathetic than that of Anne, Countess of Warwick, daughter of the 14th Earl, who by inheritance became possessor of the castle. After the death of her husband on the field of Barnet, his estates were confiscated, and for the purpose of securing the property to the brothers of the royal victor on Tewkesbury's battlefield, an Act of Parliament solemnly ordained that the Countess should be treated as naturally dead. Sixteen years later, when Henry VII. was on the throne, this Act was annulled by another, as "against all reason, conscience, and the course of nature, and as being contrary to the laws of God and man." But no sooner was the unfortunate Countess in the possession of her vast estates than she was called upon by the King to show by what right she held them, and, probably to secure peace, she granted the whole to the King and his heirs male for ever.

The Mine Court attached to the castle dates from the year 1300 at the latest, for it is mentioned in the Miners' Laws of that period. Cases tried in it were not determined by any written law of the realm, but according to the custom of the court itself and the miners' laws. Three witnesses were required to prove a case, a custom which is hoary with age, and probably dates from the times of the Druids. The Oath was taken by touching the four Gospels with a stick of holly, apparently from a desire not to soil the Holy Book, and the same stick was always used. During the examination the parties had to wear their working caps—a striking contrast to the custom in our law courts to-day. The Mine Court held at the castle has ceased for many years, but the Manor Court is still occasionally held there by the Steward, who receives presentments of encroachments or other matters of a like nature, and the cases are tried by a jury of twelve men.

Close to the castle is the church of St. Briavels, an interesting structure, for it contains work belonging to all the great styles of church architecture. The earliest portions are portions of the south wall and the piers of the south arcade, which apparently date from the closing years of the twelfth century. The monuments are few, probably because of lawless acts in days gone by, of which there is documentary evidence, while solid evidence is attested by the use of a twelfth century coffin lid, with an incised cross, as a breast-stone in the chimney of a local inn.

On the way from St. Briavels down the hill to Monmouth, the party had spread before them a stretch of the beauties of the Wye Valley.

Photo. A. J. Lumbert.

THE GATEWAY, ST. BRIAVELS CASTLE

(Reproduced, with permission, from "A Week's Holiday in the Forest of Dean.")

GARRICK'S MULBERRY TREE, ABINGTON PARK

(*C. Law, photo.*)

A REVISED LIST OF THE LAND AND FRESH-WATER MOLLUSCA OF GLOUCESTERSHIRE

BY

CHARLES UPTON

(*Read February 14th* 1911)

[Plate XXV.]

It is nearly half a century since any essay appeared in the Proceedings of the Club concerning the Land and Fresh-water Mollusca of the county. In vol. iii. (pp. 63-72), there is a list, with notes, by the late John Jones, but since that paper was published the nomenclature has undergone revision and a number of additional species have been found to occur within the county. It therefore seemed desirable that the Proceedings should contain a revised census, showing as nearly as possible the state of our knowledge at the present time.

In the following list I have given—except in the case of very common forms—Jones' record, from his paper, the names used by him, where they differ from those now in use, being placed within square brackets, while in a few other instances, where other records have been quoted, the name of the recorder, or the authority, has been placed in round brackets. In all cases where no authority for the record is given, the species or variety has been taken by myself.

Three species enumerated by Jones, namely, *Zonites excavatus*, *Vertigo alpestris*, and *Planorbis glaber*, I have omitted altogether, as I think he was in error, possibly owing to wrong identification, none of these forms having yet, I believe, been found in the county.

In "Science Gossip" for the year 1891 (p. 125), Mr E. H. Robertson mentions *Pupa* (*Vertigo*) *substriata* and *Zonites excavatus* as occurring near Painswick. I venture to suggest that the name *Vertigo pygmæa* should be substituted for that of *Pupa substriata*.

A paper by Mr W. Harcourt-Bath was published in "The Zoologist" for 1909,[1] in which, among a number of terrestrial mollusca stated to exist in the Cotteswolds, are mentioned *Testacella scutulum*, *Milax gagates*, *Vitrea rogersi* and *Succinea oblonga*. The authority which the author gives for his list is "The Flora and Fauna of Gloucestershire," by Witchell and Strugnell. With the possible exception of *V. rogersi*, the records as regards the species mentioned are probably wrong. *Testacella scutulum* has been found in a few places, usually in nursery gardens, having in all probability been introduced from abroad, in soil with plants; it would not therefore be a matter for surprise if it should eventually turn up in the neighbourhood of Gloucester or Cheltenham. *Succinea oblonga* is much less likely to be found, as the conditions under which it lives in other places do not occur in this county.

Of the Estuarine shells mentioned in Jones' list, all but *Rissoa ulvæ* and *R. barleei*—now known as *Paludestrina stagnalis* Brasier, and var. *barleei* Jeffreys—have been omitted. These two forms live in brackish water, and are by many malacologists classed with the Land and Fresh-water Mollusca, whereas the other species mentioned, although spending a considerable portion of their lives out of the water, never wander away from the reach of salt water.

There are about 154 recognised species (omitting varieties) of Land and Fresh-water Mollusca existing in the British Islands. Of these, some ten forms have been introduced within recent years. Several of the introduced forms, although occurring in a number of localities, only flourish under more or less artificial conditions, for example, *Opeas goodalli* Miller, lives only in hot-houses and appears to have a partiality for pine-beds: and *Physa acuta* Draparnaud, occurs only in the *Victoria Regia* tank at the Royal Horticultural Society's Garden, Regent's Park, and a few other similar places. *Planorbis dilatatus* was first found in Lancashire, having been

1 *The Zoologist*, 4th ser., vol. xiii., February, 1909.

accidentally introduced in cotton-bales, but it appears to be well established and spreading rapidly. *Helicella elegans*, on the other hand, although it appears to thrive in one small spot near Dover, refuses to live elsewhere. None of these emigrants are likely to be found in the county, at any rate for many years to come. Of the remaining 144 species, 102 have already been taken in the county, and it is not improbable that further search may result in some six to eight additional forms eventually being found.

The *Pisidiæ* are very difficult to determine, and there are very few conchologists who will venture to identify them with certainty. The list, so far as regards that genus, must therefore be understood to be provisional only, although I believe that so far as it goes it is correct, and that if any alteration be found necessary, it will be by way of additional species.

The only other form which appears to call for special remark is *Vivipara contecta var. inflata* Villa. This remarkably fine shell has not been found anywhere in England except in the Thames and Severn Canal near Chalford, where I was fortunate enough to find a number of examples. The shells were submitted to Mr John W. Taylor, of Leeds, the author of the "Monograph of the Land and Fresh-water Mollusca of the British Isles," who identified them with the Italian variety named above.

In the subjoined list I have used a good many varietal names. The advisability of using varietal names may possibly be questioned; they are, however, of general use among conchologists, and certainly have their uses in facilitating reference to the very many forms which are known. All varietal names have not the same weight, but all those varieties which are enumerated below have, I consider, sufficiently well-defined characters in common to justify the use of the names. I do not pretend that the names which I have used are exhaustive, and it is very probable that a conchologist who carried subdivision to an extreme limit would considerably extend the list. It is, of course, open to any person who prefers not to use varietal names to disregard them.

GASTROPODA

TESTACELLIDÆ

Testacella maugei, Ferussac. West Gloucestershire (" Journal of Conchology "),

T. haliotidea, Draparnaud. In gardens in Gloucester (Jones); Cheltenham (C. A. Witchell).

LIMACIDÆ

Limax maximus, Linné [*L. cinereus*]. Common everywhere in cellars and damp outhouses, under water butts, etc.

L. flavus, L. Common in similar situations to last species.

L. arborum, Bouchard-Chantereaux. On trunks of beeches at Randwick; Slad; Shepscombe, etc.

Agriolimax agrestis (L.) [*Limax agrestis*]. Common everywhere in fields and gardens.

A. lævis (Müller) [*Limax brunneus*]. Under stones, etc. between Cooper's Hill and Birdlip (Jones).

Milax sowerbyi, Ferussac. Under stones and rubbish in gardens.

ZONITIDÆ

Vitrina pellucida (Müller). Under decaying leaves in beech woods—most commonly met with in winter.

V. crystallina (Müller). [*Zonites crystallinus*]. Common amongst decaying leaves in beech woods.

V. lucida (Drap). West Gloucestershire (" Journal of Conchology ").

V. cellaria (Müller). [*Zonites cellarius*]. Common everywhere in damp places, under stones, etc.

V. alliaria (Miller). [*Zonites alliarius*]. Not uncommon with last species.

V. nitidula (Drap). [*Zonites nitidulus*]. " Amongst moss and decaying wood at Over, between Newent Canal and the River Leadon." (Jones). Generally, although sparingly distributed in moist places, but abundant in the garden of Tower House, Stroud.

V. pura (Alder). [*Zonites purus*]. Tortworth (Jones). Sparingly under decaying leaves in shady places, Stroud.

V. pura, var. nitidosa (Gray). This is a pearly white variety, and in Stroud district is more abundant than the type. Under decaying holly leaves near Brown's Hill House, Stroud; and near Swift's Hill.

V. radiatula (Alder). [*Zonites radiatulus*]. Not generally common, but fairly abundant in a small bog near Elcombe, Stroud.

Zonitoides nitidus (Müller). [*Zonites nitidus*]. Weston Birt (Jones); Canal Bank near Chalford and Sharpness in very wet places; in bog at Elcombe.

Euconulus fulvus (Müller). [*Helix fulva*]. Birdlip, among decaying beech leaves (Jones). Toadsmoor; Worgan's Wood, Slad; Randwick and other localities in damp places in moss and under dead leaves.

ARIONIDÆ

Arion ater (L.) [*Arion empiricorum*]. Common everywhere.

A. ater, var. brunnea (Roebuck). Chalford; Slad Valley

A. ater, var. bicolor (Roebuck). Frampton Mansell, by side of canal.

A ater, var. alba (L.) One specimen seen by the wall of the Manse, Slad.

A. subfuscus (Drap). West Gloucestershire. ("Journal of Conchology").

A. minimus (Simroth). West Gloucestershire. ("Journal of Conchology").

A. hortensis (Fer.) Common in gardens at Stroud.

A. circumscriptus (Johnston). East and West Gloucestershire. ("Journal of Conchology").

ENDODONTIDÆ

Punctum pygmæum (Drap). [*Helix pygmæa*]. Over, near Gloucester, in moss, etc (Jones); Randwick Wood and Frocester Hill, on decaying leaves.

Sphyradium edentulum (Drap). [*Pupa edentula*]. Amongst dead leaves, Birdlip, Witcomb, etc. (Jones); Rodborough (E. J. Elliott).

Pyramidula rupestris (Drap). Very abundant under the top stones of the dry walls on the hills around Stroud. It is strange that so abundant a shell should have been overlooked by Jones.

P. rotundata (Müller). [*Helix rotundata*]. Abundant under stones everywhere.

P. rotundata, var. turtoni (Fleming). Under stones at Swift's Hill, Stroud.

HELICIDÆ

Helicella virgata (Da Costa). [*Helix virgata*]. Open hill-sides, banks and roadsides everywhere.

H. virgata, var. maculata (Moquin-Tandon). Frequently occurs with type. Common by the roadside from Stroud to Slad.

H. virgata, var. lutescens (Moquin-Tandon). With type and equally common.

H. virgata, var. albicans (Grateloup). Common with type.

H. itala (L.) [*Helix ericetorum*]. Common on the sunny slopes of the Hills throughout the Cotteswolds—particularly abundant and large on and near Pitchcombe Common.

H. itala, var. leucozona (Moquin-Tandon). Occasionally with type.

H. itala, var. hyalozonata (Cockerell). Cranham.

H. itala, var. alba (Taylor). Pitchcombe.

H. caperata (Montagu). [*Helix caperata*]. On grass and short herbage on sunny hillsides and roadsides—generally distributed.

H. caperata, var. ornata, Picard. Locally common with type. Plentiful by roadside from Stroud to Slad.

H. caperata var. fulva, Moquin-Tandon. Slad Road and Swifts Hill.

H. caperata, var. lutescens, Pascal. Slad Road. Very fine examples on border of ploughed field at Randwick.

H. cantiana (Montagu). [*Helix cantiana*]. Hedgerows at Evesham (Jones) ; side of road leading from Painswick Road to Pitchcombe Common under bushes and tall herbage.

H. cantiana, var. albida, Cockerell. Not uncommon at Pitchcombe with type.

Hygromia fusca (Montagu). [*Helix fusca*]. Amongst burdocks and brambles near the Roman Villa at Witcombe (Jones).

H. granulata (Alder). [*Helix sericea*]. On banks of canal near Sapperton and on Yellow Iris near the canal, Chalford (Jones); bog near Woodlands, Stroud; side of Cainscross Brewery Pond; Kingstanley; and near Nailsworth—usually in very wet places.

H. granulata, var. cornea, Jeffreys. Kingstanley; and Horsley.

H. hispida (L.). [*Helix hispida var concinna*]. Under stones and dead leaves. Common everywhere. Large examples on beech trunks in Randwick Wood.

H. rufescens, var. hispidosa, Mousson. [*Helix hispida*]. Common with last, but prefers damper situations.

H. hispida, var. albo-cincta, Taylor. By side of canal near Chalford; in garden of Tower House, Stroud.

H. hispida, var. albida, Jeffreys. Occasionally with type.

H. hispida, var. nana, Jeffreys. On grass on Swift's Hill.

H. rufescens (Pennant). [*Helix rufescens*]. In beech woods; under stones and rubbish; common.

H. rufescens, var. rubens, Moquin-Tandon. With type everywhere.

H. rufescens, var. albo-cincta, Cockerell. Not uncommon with type, but somewhat more local.

H. rufescens, var. albida, Moquin-Tandon. Not uncommon with type, but more abundant by roadsides—generally distributed.

Acanthinula aculeata (Müller). [*Helix aculeata*]. Over, near Gloucester, in moss and upon decaying willow twigs (Jones); Tortworth, in moss—rare (Jones; Hockley Hill, Elmore (V. W. G. in Jones); Worgan's Wood, Slad, on dead wet beech leaves; also Randwick Wood and Frocester Hill under similar conditions—common. The rarity stated by Jones is, I think, more apparent than real, the shell being frequently covered with dirt and easily overlooked.

Vallonia pulchella (Müller). [*Helix pulchella*]. Over, near Gloucester, and Lassington in moss (Jones); amongst decaying beech leaves of Cotteswold Woods (Jones); in very wet moss in small bog at Elcombe, near Stroud.

V. costata (Müller). [*Helix pulchella*—ribbed variety]. In moss by Newent Canal at Over and Lassington (Jones).

Under ivy on wall-tops by canal at Frampton Mansell, where it is abundant. Also in similar situations by Stroud Cemetery, and in the garden of Tower House, Stroud.

[With regard to the last two species, I have almost invariably found the first-named in wet, and the latter in dry situations].

Helicigona lapicida (L.). [*Helix lapicida*]. Common on beech trees in all the Cotteswold woods and on limestone rocks in the Forest of Dean.

H. lapicida, var. approaching **albina, Menke.** Frith Wood, Stroud and Cranham. Very rare.

H. arbustorum (L.). [*Helix arbustorum*]. Amongst rank and moist herbage from the Severn to the Cotteswolds (Jones). Very widely distributed on limestone soils, but almost always on Nettles.

H. arbustorum, var. fuscescens, Duchassaing and Michelotti. Usually with the type.

H. arbustorum, var. cincta, Taylor. On nettles at Chedworth.

H. arbustorum, var. luteofasciata, Duch. and Mich. On nettles at Brimscombe.

H. arbustorum, var. flavescens, Moquin-Tandon. On nettles at Chedworth and Shepscombe.

Helix aspersa, Müller. Gardens and hedgerows everywhere.

H. aspersa, var. flammea, Picard. On wall by side of canal, Chalford. In garden of Tower House, Stroud. See pl. xxv., fig. 2).

H. aspersa, var. albescens, Picard. Occasionally by roadsides on the hills.

H. aspersa, var. albo-fasciata, Jeffreys. Abundant everywhere with the type.

H. aspersa, var. zonata, Moquin-Tandon. Occasionally on the Cotteswold Hills.

H. aspersa, var. exalbida, Menke. This is a very striking and somewhat scarce form, and although it is fairly widely distributed on the limestone, it is never abundant. I have collected it in a lane below Stroud Cemetery and at the Slad near Stroud. See pl. XXV., fig. 1.

H. pomatia, L. Birdlip Wood ; Witcombe ; Miserdine ; Colesbourne ; Rendcomb (Jones) ; Chedworth ; Longfords.

H. nemoralis, L. Hedgerows and gardens—common.

H. nemoralis, var. conica, Pascal. Slad Road, Stroud.

H. nemoralis, var. compressa, Terver. Slad Road, Stroud

H. nemoralis, var. bimarginata, Moquin-Tandon. Generally found with the type in Stroud district, and almost equally abundant.

H. nemoralis, var. rubella, Moquin-Tandon.

H. nemoralis, var. libellula, Risso.

These two so-called varieties commonly occur with the type, that is, the five-banded form. They are also frequently found in colonies on the shady banks of disused quarries on the Hills where the type very rarely occurs.

H. nemoralis, var. castanea, Moquin-Tandon. Most commonly found in gardens.

H. hortensis, Müller. [*H. nemoralis* vars *hortensis* and *hybrida*]. Hedgerows and clumps of brambles and rank weeds in disused quarries—generally distributed. Jones states that this form, which he considered a variety of *H. nemoralis,*—was abundant with that species. This, however, does not agree with my observations. Occasionally they occur in association, but it is the exception rather than the rule.

H. hortensis, var. roseolabiata, Taylor. Found occasionally with the type.

H. hortensis, var. fuscolabiata, Von Martens. This variety is that which is referred to in Jones' paper as '*H. nemoralis* var. *hybrida*.' Abundant at Tortworth (Jones) ; Thrupp, near Stroud—very scarce.

H. hortensis, var. luteolabiata, L. E. Adams. Frocester Hill. Not common.

H. hortensis, var. albina, Moquin-Tandon. A rather local variety but common by the roadside from Salmons-Spring Brewery to Rock Mill, Stroud.

H. hortensis, var. lutea, Moquin-Tandon. Common with the type.

H. hortensis, var. arenicola, Macgillivray. With the var. albina, as above, and occasionally wherever the type is found.

ENIDÆ

Ena montana (Drap). [*Bulimus Lackhamensis*]. Found in most of the beech woods on the Cotteswold Hills, but must be sought for on warm wet days in Spring and Autumn on the trunks of the trees.

E. montana, var. albina, Moquin-Tandon. This very rare variety has been taken near Birdlip by a Member of the Conchological Society, but no captures have been recorded of late years.

E. obscura (Müller). [*Bulimus obscurus*]. Common with the last species and also in quarries and road-side banks—generally distributed.

E. obscura, var. albina, Moquin-Tandon. Worgan's Wood, Stroud—rare.

STENOGYRIDÆ

Cochlicopa lubrica (Müller). [*Zua lubrica*]. Under stones. In moss in very damp places—generally distributed.

C. lubrica, var. lubricoides, Ferussac. Fairly common under dead leaves in lane adjoining The Grove House, Stroud.

Azeca tridens (Pulteney). Found with *C. lubrica* (Jones). Generally occurs in "colonies." Buckholt Wood and Frocester Hill under decaying leaves; in small bog in Cranham Wood; and on Railway bank, Chalford.

Cæcilioides acicula (Müller). [*Achatina acicula*]. Barnwood at the roots of grass (Jones). At the edge of a disused quarry on Kilminster Farm, Stroud. At the Heavens, near Stroud and at an old quarry on the Hill near Thrupp—in each instance in the soil under the turf.

VERTIGINIDÆ

Jaminia secale, Draparnaud. [*Pupa secale*]. In old quarries and bare places on the Hills. Widely distributed and abundant.

J. anglica (Ferussac). In a small bog in Cranham Wood. This is a scarce and very local shell, and has not hitherto been found so far south in England.

J. cylindracea (Da Costa). [*Pupa umbilicata*]. On stone walls at Lassington (Jones). Common under ivy, etc. on the tops of walls throughout the Stroud district.

J. cylindracea, var. rufilabris, Jackson. On wall-top, adjoining Thrupp Wood, Stroud.

J. cylindracea, var. curta, Westerlund. In moss growing on a wall near Frampton Mansell.

J. muscorum (L.) [*Pupa muscorum*]. From grub-eaten boughs of an ash-tree (Jones). Amongst small plants growing on the tops of walls at Frampton Mansell and near the Stroud Cemetery. Under stones by the roadside at Pitchcombe.

J. muscorum, var. edentula, Clessin. On the top of marlstone wall near Stinchcombe. On wall top at Bull's Cross, near Painswick.

Vertigo antivertigo (Drap). [*Pupa antivertigo*]. From Over, near Gloucester, between the Canal and Leadon ; and near Sharpness (Jones).

V. pygmæa (Drap). [*Pupa pygmæa*]. Same locality as last (Jones). Common amongst stones in a field adjoining Horns Lane, Stroud.

V. pusilla, Müller. [*Pupa pusilla*]. In damp moss on Upper Lias at Birdlip ; Coopers Hill ; and near Sharpness Point (Jones).

CLAUSILIIDÆ

Balea perversa (Linné). [*Balea fragilis*]. Matson, under loose bark of horse-chestnut trees (Jones). On beech-tree stems at Painswick and Randwick (E. J. Elliott).

Clausilia laminata (Montagu). On beech-trees. Common in most of the beech woods.

C. laminata, var pellucida, Jeffreys. Frith Wood, Stroud occasionally. Fairly common in Saltridge Wood, near Shepscombe.

C. laminata, var. albina, Moquin-Tandon. Frith Wood, Stroud ; Randwick ; Toadsmoor ; Worgan's Wood. Occurs rarely wherever the type is found.

C. bidentata (Ström). [*Clausilia nigricans*]. Abundant on beech-trees and under stones. Generally distributed.

C. rolphii, Leach. [*Clausilia plicatula*]. Birdlip, in wood at the base of the oolitic formation amongst or near to patches of *Chrysosplenium* (Jones). In a small bog at Cranham.

SUCCINEIDÆ

Succinea putris (Linne). Common on plants by the side of ponds, streams and canals.

S. putris, var. albida, Mörch. In moss in small bog near Elcombe, Stroud.

S. elegans, Risso. By side of canal at Brimscombe and Chalford. Very fine examples by the canal at Sharpness.

S. elegans, var. pfeifferi, Rossmässler. [*S. putris* var *pfeifferi*]. On banks of canal at Over (Jones).

AURICULIDÆ

Carychium minimum, Müller. Extremely abundant among decaying beech-leaves in woods on the Cotteswolds. Also in moss in small bog near Elcombe.

LIMNÆIDÆ

Ancylus fluviatilis, Müller. Severn, at Wainlode Cliff; and at Wotton (in brook). Canal at Sharpness Point (Jones). Common in most stony streams.

A. fluviatilia, var. albida, Jeffreys. Plentiful in the River Frome near Brimscombe station to the exclusion of the type.

Acroloxus lacustris (L.) [*Ancylus oblongus*]. In old fish-pond of Great House at Churchdown (Jones). In the canal at Sharpness.

Limnæa auricularia (L.) [*Limnæus auricularius*]. Combe Hill Canal (Jones); canal between Stroud and Chalford.

L. auricularia, var. albida, Jeffreys. Canal at Chalford.

L. pereger (Müller). In nearly all ponds, ditches and canals.

L. pereger, var. ovata, Draparnaud. In the canal from Stroud to Chalford; in pond at Gainey's Leaze, Stroud. This is the largest and commonest form in the Stroud district.

L. pereger, var. oblonga, Jeffreys. In Roman Bath or tank at Chedworth Villa.

L. pereger, var. maritima, Jeffreys. In the canal at Sharpness.

L. palustris (Müller) Maisemore Ham, near Gloucester; Fairford and Cirencester districts (Jones). Very abundant in the canal at Chalford.

L. truncatula (Müller). In most brooks and ditches. Usually found out of the water on the partly dried mud.

L. stagnalis (L.) Maisemore-Ham ditch; Combe Hill and Newent Canals; Kempsford; Siddington (Jones); canal, Chalford. See Pl. xxv., fig. 5.

L. stagnalis, var. labiata, Jeffreys. Canal at Chalford. See pl. xxv., fig. 6.

Planorbis corneus (L.) Ditch at Maisemore Ham; Combe-Hill Canal (Jones). Abundant and large in canal above Chalford.

P. var. albina, Moquin-Tandon. Common in the Summer of 1908 at Chalford with the type. Two specimens of this variety were taken showing spiral colour bands.

P. albus, Müller. Newent Canal, Over near Gloucester (Jones).; Cainscross Brewery pond (common); Chamber's Pond, Stroud; canal, Stonehouse; canal, Sharpness.

P. crista (L.) [*P. nautileus*]. Near Witcomb's Mill, Barnwood (Jones); Chambers' Pond, Stroud.

P. carinatus, Müller. Maisemore-Ham ditch; Newent Canal (Jones); canal, Chalford.

P. umbilicatus, Müller. [*P. marginatus*]. Maisemore Ham; Newent Canal (Jones). Pond, Hempstead; Thames and Severn Canal throughout its length.

P. vortex (L.) In ponds, ditches and canals everywhere.

P. spirorbis (L.) Podgmead, Hempstead (Jones); Thames Head, near Kemble.

P. contortus (L.) Maisemore Ham; Newent Canal, Over (Jones). Ditch at Hempstead; canal at Thrupp, near Stroud and Stonehouse; canal, Sharpness.

P. fontanus (Lightfoot). [*P. nitidus*]. Pond at Barnwood (Jones); Damsels Mill pond, Painswick; canal, Sharpness; Chamber's Mill pond, Stroud.

PHYSIDÆ

Physa fontinalis (L.) In clear ponds, streams and canals. Generally distributed.

Aplecta hypnorum (L.) [*Physa hypnorum*]. Hempstead, in pond in the field leading to Podgmead. Over, near Gloucester, in a ditch near the Butts (Jones); Thames Head, near Kemble.

PALUDESTRINIDÆ

Paludestrina Jenkinsii, Smith. Canal at Sharpness (a few specimens). This form is somewhat local, but where it does occur, it is usually found in myriads. Probably it is a recent introduction to the neighbourhood.

P. stagnalis (Brasier). [*Rissoa ulvæ*]. Brackish water ditches at Shirehampton (Jones). This is a commoner form than the last, but like it, usually occurs in shoals.

P. stagnalis, var. barleei, Jeffreys. Shirehampton with type (Jones).

Bithynia tentaculata (L.) Common throughout the county in canals and streams.

B. Leachii (Sheppard). Canal, Stonehouse; canal, Sharpness. Common.

B. leachii, var. albida, Rimmer. In canal near Chalford to the entire exclusion of the type form.

VIVIPARIDÆ

Vivipara vivipara (L.) [*Paludina vivipara*]. Canal at Cirencester and near Stroud (Jones). Very common in the canal near Chalford.

V. vivipara, var. efasciata, Pickering. One specimen in the canal near Stroud Gas-Works.

V. contecta (Millet). [*Paludina Listeri*]. Newent canal at Over; Combe-Hill canal (Jones).

V. contecta var. inflata. Villa. Canal near Chalford. See pl. xxv., figs. 3, 4.

VALVATIDÆ

Valvata piscinalis (Müller). Robins' Wood Hill reservoirs; River Poplar, etc. (Jones); Newent Canal, Barbers Bridge (common); Cainscross Brewery pond; canal at Stonehouse.

V. cristata, Müller. Newent Canal at Over; Ditches at Maisemore Ham (Jones); canal, Sharpness; canal, Stonehouse; Vatch Mill pond, Stroud.

POMATIIDÆ

Pomatias elegans (Müller). [*Cyclostoma elegans*]. Common in hedgerows in the limestone districts, also on the hillsides amongst herbage.

P. elegans, var. pallida, Moquin-Tandon. Common with the type.

ACICULIDÆ

Acicula lineata (Drap). Amongst decaying leaves in a damp spot in Worgan's Wood, near the Slad, Stroud.

A. lineata, var. alba, Jeffreys. With the type, and in about equal numbers.

NERITIDÆ

Neritina fluviatilis (L.) The Severn at Wainlode (Jones); canal, Sharpness.

PELECYPODA

DRIESSENSIIDÆ

Driessensia polymorpha (Pallas). [*Driessena polymorpha*]. Berkeley Canal throughout its length.

UNIONIDÆ

Unio pictorum (L.) Newent Canal, Over; Berkeley Canal, near Stonebench—Rare (Jones); Stroudwater Canal near Stroud.

U. tumidus, Retzius. Severn at Wainlode and all the canals (Jones). Chalford, in the canal.

U. margaritifer. L. Near Ross, in the Wye (Jones).

Anodonta cygnæa (L.) Common in the Severn and in all the canals.

A. cygnæa (L.) var. anatina. Canal at Chalford.

A. cygnæa, var. pallida, Jeffreys. Canal at Kempsford.

CYRENIDÆ

Sphærium rivicola (Leach). [*Cyclas rivicola*]. Newent and Berkeley Canals; Combe-Hill Canal; Severn at Wainlode (Jones); Stroudwater Canal near Stroud; Berkeley Canal, Sharpness.

S. corneum (L.) [*Cyclas cornea*]. Brooks, ditches, ponds and canals everywhere.

S. corneum, var. flavescens, Macgillivray. Canal near Chalford.

S. lacustre (Müller). [*Cyclas caliculata*]. Pond in Bristol Road near Gloucester; Fisher's Mill pond, Barton St. Mary (Jones). Canal, Chalford.

S. pallidum, Gray. Canal, Sharpness—rare.

Pisidium obtusale, Pfeiffer. Near the Wilderness, Mitcheldean (Jones).

P. pusillum (Gmelin). Common in most ponds, ditches and canals.

P. pulchellum, Jenyns. Streams and canals and clear ponds—Common (Jones).

P. subtruncatum, Malm. East and West Gloucestershire ("Journal of Conchology").

P. amnicum (Müller). Canals and streams—Generally distributed.

Photo. C. Upton.

LAND AND FRESH WATER GASTROPODA

EXPLANATION OF PLATE XXV.

Fig. 1. **Helix aspersa**, var. **exalbida**, Menke.
Slad, near Stroud.

Fig. 2. **H. aspersa** var. **flammea**, Picard.
Chalford, near Stroud.

Figs. 3 and 4. **Vivipara contecta**, var. **inflata**, Villa
Thames and Severn Canal near Chalford.

Fig. 5. **Limnea stagnalis** (L.). Type form for comparison with next.
Thames and Severn Canal, Chalford.

Fig. 6. **L. stagnalis**, var. **labiata**, Jeffreys.
Thames and Severn Canal, Chalford.

All the figures are natural size.

Photo. P. Simms.

WILLIAM SMITH'S STONE, CHURCHILL, OXON.

(*By permission of Percy Simms, Photographer, Chipping-Norton.*)

THE INFERIOR OOLITE AND CONTIGUOUS DEPOSITS OF THE CHIPPING-NORTON DISTRICT OXFORDSHIRE

BY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

Plates [XXVI.-XXVII.]

CONTENTS

I.—INTRODUCTION

In this paper it is purposed giving a detailed description of the Inferior Oolite and contiguous deposits of the Chipping Norton district. The extent of this district, for the purpose of the present communication, is shown in the map, fig. 1, page 196.

In this district the beds that are present between the Cornbrash and Upper Lias, are, in descending order :—

(1). The Forest-Marble series ;
(2). The Great Oolite, with
(3). The Stonesfield slate at the base ;
(4). The Neæran Beds ;
(5). The Chipping-Norton Limestone ; and
(6). Certain of the Top-Beds of the Inferior Oolite.

More minute subdivisions of these beds have been made, and those that have been recognised in groups 4, 5 and 6 are detailed in Table I., on page 201.

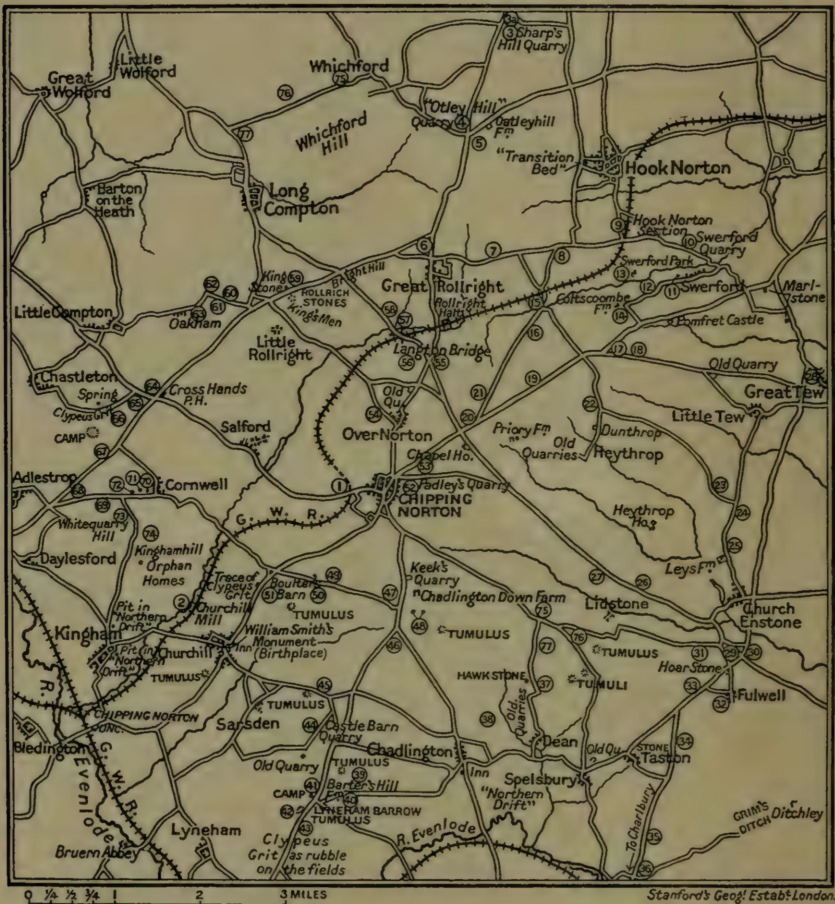

Fig. 1.—Map of the Chipping-Norton District. Scale: ½ inch = 1 mile.
(The numbers on the map correspond to those given in the text, and are intended to facilitate the location of the sections.)

As most workers in the Oolites are aware, the determination of the true sequence of deposits in the Chipping-Norton district, and the question of their correct allocation, whether to the Great Oolite or to the Inferior Oolite, are matters that have engaged the attention of many geologists. A thick mass of limestone, called the "Chipping-Norton Limestone," is the most prominent rock-subdivision in the district, spreading over a wide extent of country. Attention has been mainly directed to this Limestone, and the desire to settle the question whether it should be grouped with the Inferior Oolite or with the Great Oolite, appears to have outweighed the inclination to study the sub- and super-jacent deposits, with a view to seeing how far they would contribute information towards arriving at a conclusion with regard to the precise date of the relatively-barren intervening deposit (*i.e.*, the Chipping-Norton Limestone).

PREVIOUS WORKERS.—Amongst those who have worked on the Oolites of this district are Prof. E. Hull,[1] A. H. Green,[2] Prof. J. W. Judd,[3] John Phillips,[4] W. H. Hudleston,[5] T. Beesley[6] J. Windoes,[7] Mr H. B. Woodward,[8] and Mr E. A. Walford;[9] but of these, Walford, Hudleston and Judd have made the most important contributions to our knowledge.

Mr H. B. Woodward has summarized very well indeed all the information that had been obtained up to and inclusive of the year 1894, and he inserted some additional observations. Since then, however, Mr E. A. Walford, F.G.S., has published a most valuable contribution, in which he has detailed the sequence of a number of most interesting, fossiliferous deposits, which he calls "Neæran Beds."[10] More recently, Mr J. A. Douglas has contributed an article, of the nature of a résumé, on the geology of the Oxford-Banbury district to the Jubilee Volume of the Geologists' Association;[11] but no new facts are recorded therein, and Mr E. A. Walford's latest contribution is unfortunately overlooked.

1 "The Geology of the Country around Cheltenham" (1857), pp. 47, 48, 59, 60. Mem. Geol. Surv.
2 "The Geology of the Country around Banbury" (1864), p. 12. Mem. Geol. Surv.
3 "The Geology of Rutland, etc." (1875), pp. 17-24. Mem. Geol. Surv.
4 "The Geology of Oxford, etc. (1871), pp. 144, 164, 245, etc.
5 Proc. Geol. Assoc., vol. v., No. 7 (1878), pp. 378-379: "Monogr. Brit. Jur. Gasteropoda—Part 1, Gasteropoda of the Inferior Oolite," pp. 70-71. Pal. Soc.
6 Proc. Geol. Assoc., vol. v., No. 4 (1877), pp. 165-185.
7 Mr Windoes was an active local collector. See Foss. Trig. (Pal. Soc.) Lycett, Appendix revised by E. A. Walford.
8 "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)," vol. iv. (1894), pp. 146-164. Mem. Geol. Surv.
9 Foss Trig., Lycett, as above; Quart. Journ. Geol. Soc., vol. xxxix. (1883), pp. 224-245; *ibid.*, vol. xli. (1885), pp. 53-47; Rep. Brit. Assoc. (1895), p. 414; Proc. Geol. Assoc., vol. xiv., pt. 5 (1895), pp. 184-185.
10 "On some New Oolitic Strata in North Oxfordshire" (1906), pp. 1-32. Buckingham Advertiser Office.
11 "Geology in the Field." pt. 1 (1909), pp. 192-209.

GEOGRAPHICAL EXTENT OF THE ROCKS DESCRIBED.—The sketch-map given above (figure 1) does not show the geographical distribution of the several formations present in the district. It is only intended to indicate precisely the positions of the sections to which reference is made—the numbers in the text corresponding to those on the map. For the geology, and for seeing the approximate geographical distribution of the rocks, the Geological Survey Maps must be consulted ; but it should be noted that on the two quarter-sheets, 45 N.W. and 45 S.W., the equivalent beds between the *Clypeus*-Grit and typical Great Oolite are not similarly coloured, for reasons that need not be entered into here, as they have already been fully explained elsewhere.[1] Also, here and there, patches of higher beds than any originally suspected, such as of Forest Marble and Cornbrash, have been discovered ;[2] but considering the time at which the cartography was done, the small scale Ordnance Survey maps available, and the knowledge possessed, it is extraordinary that it was done as well as it was.

The LOWER LIAS floors the Vale of Moreton, the Evenlode Valley and the broad ends of the little valleys that run into the upland from the vale.

(1) The *Capricornus*-Beds were exposed when the tunnel at Chipping Norton (No. 1 on the map) was made :[3]
(2) In a temporary excavation near Churchill Mill (2—L.R., 1904) :
(3) The *Armatus*-Beds or thereabouts were seen in the railway-cutting near Charlbury :[4] while
(4) Lower Lias, of uncertain date, was laid bare in the railway-cutting at Ascott-under-Wychwood.[5]

The MIDDLE LIAS succeeds the Lower, and admits of the usual dual division into (*a*) a lower, sandy, shaly, clay portion, and (*b*) an upper or Rock-Bed (Marlstone) portion.

The sandy beds of the Middle Lias can be easily located by means of their usually-attendant gorse-bushes ; and the Marlstone, on the vale side, by the platforms—such as "Wichford Hill"—to which it gives rise. Around Hook Norton, the red, light level-land, and the numerous long workings, indicate clearly enough the presence and geographical extent of this Marlstone ; while its ferruginous character is emphasized by the presence of continuously smoking furnaces (figs. 2 and 3).

1 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), pp. 146-147.
2 Proc. Geol. Assoc., vol. v., No. 4 (1877), p. 177.
3 *Ibid.*, pp. 180-185.
4 E. Hull, "The Geology of the Country around Woodstock" (1859), p. 9. Mem. Geol. Surv.
5 W. S. Horton, "The Geologist," vol. iii. (1860), p. 251.

It is unnecessary to say anything more in this paper about

FIG. 1.—Blast Furnace at Hook Norton

the Marlstone beyond that it is of the usual Midland type, that is, it is rich red, ferruginous, and frequently replete with specimens of *Rhynchonella tetrahedra* (Sow.) and other fossils;

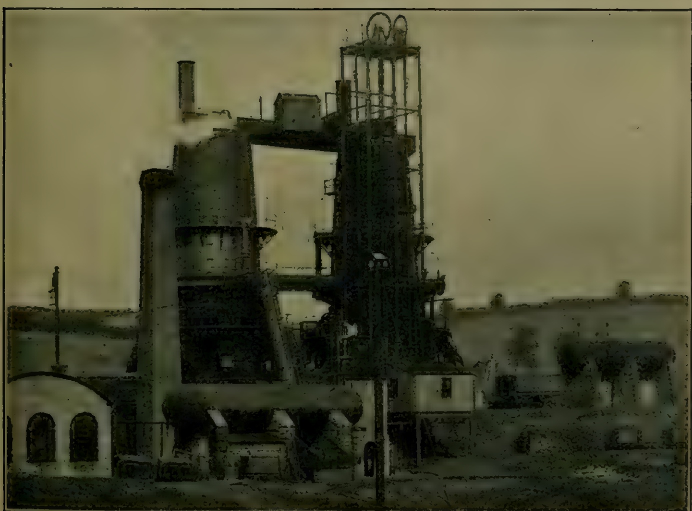

FIG. 2.—Another Blast Furnace at Hook Norton

but it may be as well to redirect attention to Prof. Hull's interesting discovery of conglomerate Marlstone "in a quarry south of Daylesford House," where the pebbles "consist of pieces of slate and sandstone, often of the character of trappean ash, while all the fragments have a Silurian aspect."[1] The quarry is now overgrown.

The Upper Lias in this district is clay from top to bottom. It is thickest in the railway-cutting at Hook Norton (30 to 40 feet), and thinnest in the south-eastern portion of the district, being at Fawler (just outside the area under consideration) only 12 feet thick. The clay in the Hook-Norton Cutting is mainly of *subcarinati*, *fibulati* and *brauniani* hemeræ ; that at Fawler, Mr S. S. Buckman informs me "speaking from memory, of *fibulati* and perhaps *subcarinati* hemeræ : there are signs of *falciferi*, but they look like remanié." (*in litt.*, April 11th, 1911.)

Speaking approximately, the *Scissum*-Beds (*vide* Table I.) rest directly upon the Upper-Lias clay in the north-western half of the district, and the *Clypeus*-Grit—with or without the intervention of a thin layer of conglomerate—immediately thereon in the south-eastern portion.

There is therefore a great non-sequence in the Chipping-Norton district between the Upper Lias and the immediately superincumbent Inferior-Oolite beds, and it is greatest where the *Clypeus*-Grit rests directly upon the Upper Lias. The lower limit of the Inferior Oolite is thus sharply-defined. Such, however, is not the case with regard to the upper limit, for the component layers of the Neæran Beds, which have been already referred to, have an irregular geographical extent and are overlaid by various members of the succeeding, unquestionable Great-Oolite beds. The line of demarcation between the Great Oolite proper and the Neæran Beds is therefore often none too definite, and the reason, doubtless, is—as Mr Woodward has remarked—mainly because the Chipping-Norton Limestone, Neæran Beds, etc., were flexured previous to the deposition of the higher beds.

1 "The Geology of the Country around Cheltenham" (1857), p. 20. Mem. Geol. Surv.

II.—Subdivisions recognizable in the Inferior Oolite and Contiguous Deposits of the District.

The subdivisions that are recognizable in the rocks under consideration are shown in the following table :—

TABLE I.—SUBDIVISIONS OF THE NEÆRAN BEDS, CHIPPING-NORTON LIMESTONE AND INFERIOR OOLITE SERIES IN THE CHIPPING-NORTON DISTRICT

Rhynchonella- and *Ostrea*-Bed.

"Great Oolite." — Neæran Beds (Walford)[1]:

3. Clay
4. *Ostrea*-Clay
5. Neæran Slates (*teste* Walford). Roe-stone (*teste* Walford).
6. Bituminous Clay
11. *Viviparus*-Marl
12. Upper *Nerinæa*-Bed
13. *Cyathopora-bourgeti*-Bed
14. Lower *Nerinæa*-Bed
15. *Astarte-oxoniensis*-Limestone
16. *Exelissa*-Limestone
18. *Perna*-Bed
19 and 20. Reddish sand and clays with *Placunopsis socialis.*

			Chipping Norton Area		Swerford Area	Fulwell Area
				Non-sequence		
"Great Oolite."		*Fuscæ* / *?Zigzag*	Chipping Norton Limestone	Limestone / Knotty Bed / Limestone	Swerford Beds / *Trigonia-signata*-Bed or "Old Man" / Hook-Norton Beds	Chipping Norton Limestone
				Non-sequence		
"Inferior Oolite."		*Schlœnbachi* and late *Truellei*	i-iii. *Clypeus*-Grit			
	Aalenian			*Non-sequence*	Conglomerate	*Clypeus*-Grit
	Aalenian	*Murchisonæ*	xxiii.–xxiv. *Amusium-personatum*-Limestones			Conglomeratic limestone
	Aalenian	*Scissi*	xxv. *Scissum*-Beds		*Scissum*-Beds	
				Non-sequence	*Non-sequence*	
Upper Lias.	Toarcian		Blue clay	Blue clay	Blue clay with lime-stone-nodules, 30 to 40 feet in the Hook Norton railway cutting	Blue clay, 12 feet at Fawler
Upper Lias.	Toarcian		Marlstone	Marlstone	Marlstone	Marlstone

[1](*The geographical distribution of these deposits is too complicated to indicate in this table.*)

(xxv.) *Scissum*-Beds (*scissi* hemera).—These beds precisely resemble, palæontologically and lithologically, their equivalents in the Cotteswold Hills, that is, they are, brown, sandy, calcareous limestones with the usual fossils, such as, *Rhynchonella cynocephala* (Rich.), *R. subdecorata* Dav., *Volsella sowerbyana* (d'Orb.), *Pholadomya fidicula* Sow., *Montlivaltia* cf. *lens* E. & H[1]., belemnites, and, in the Hook-Norton railway-cutting, ammonites—*Lioceras opalinum*, *L. thompsoni*, *Hammatoceras* aff. *newtoni*, etc.

1 The form eferred to by R. F. Tomes as occurring in " the beds of the Inferior Oolite, near their junction with the Upper Lias." Proc. Geol. Assoc., vol. vi., No. 4 (1879), p. 154.

(xxiv.-xxiii) *Amusium-personatum*-Limestones (*Murchisonæ, s. l.*).—At Cornwell (70 on map), above the *Scissum*-Beds, are sandy limestones, frequently full of this noticeable little pecten, which must doubtless be correlated with the *A.-personatum*-containing limestones of the North Cotteswolds, Ebrington and Bredon Hills, etc.

Conglomerate-Beds.—The precise time of formation of a conglomerate-bed is often difficult to determine, and each example must be considered separately. Thus the Conglomerate-Bed at Fawler may be of *Truellei* date, and that in the Hook-Norton Cutting of late *Schlœnbachi.*

(iii-i.) *Clypeus*-Grit (late *Truellei* and *Schlœnbachi*).—Over the south-western half of the district, the *Clypeus*-Grit precisely resembles, both as regards faunal and lithic characters, its equivalent in the North Cotteswolds, but to the north-east, it attenuates, and in the Hook-Norton cutting the loose, shelly conglomerate referred to above, occupies its stratigraphical position.

Fullers' Earth.—Above the *Clypeus*-Grit is the stratigraphical position of the Fullers' Earth—in Dorset and Somerset a great mass of clay. A bed of rock called the "Fullers' Earth Rock" is prominent in the Fullers' Earth of Somerset, and separates the clay into two parts—an Upper Fullers' Earth and a Lower Fullers' Earth. The median rock-bed is of *subcontracti* hemera, and this is also the date of a portion of the Great Oolite at Minchinhampton Common; of a portion of that exposed in the railway-cutting at Stony Furlong, near Chedworth, and of a portion of the Oxfordshire Great Oolite proper. Hence the deposit between the *Clypeus*-Grit or its equivalent and the rock of *subcontracti* date in the Cotteswold Hills and Oxfordshire corresponds, as regards stratigraphical position, to the Lower Fullers' Earth of Somerset.[1]

In Dorset and Somerset, portions of the Lower Fullers' Earth are sometimes clays, and at others limestones. In other words, limestones sometimes replace a greater or less portion of the clays of *zigzag* and *fuscæ* hemeræ. In the neighbourhood of Bath the deposit of *zigzag* hemera is clay and presumably so is that of *fuscæ* date. When the Fullers'-Earth clay is

1 Proc. Geol. Assoc., vol. xxii. (1911), pp. 111 and 115.

traced through the Cotteswold Hills, it is found to attenuate considerably as clay, and in the neighbourhood of Stow-on-the-Wold to be largely replaced by limestone again.

As far as can be seen, this replacement is effected in the local Fullers' Earth of the Stow district, from near the base, upwards. Thus, in the railway-cutting about half-a-mile to the south-west of Harford Bridge, between Notgrove and Stow, there is the following section :[1]—

SECTION IN RAILWAY-CUTTING NEAR HARFORD BRIDGE, BETWEEN NOTGROVE AND BOURTON

			Thickness in feet	ins.
Gt. Oolite.		Limestone, generally white, rather coarsely-oolitic : seen about	8	0
"Fullers' Earth"	1.	Clay, greenish, yellow-streaked, with buff-coloured layers of marl	0	5
		Marls, buff-coloured, with a harder layer at 6 inches from the top	2	0
	2.	Marls, bluish	1	2
	3.	Marls, buff-coloured and yellowish, with layers of clay and a number of limestone-bands, some of which are fissile and sandy, finely-micaceous, with annelid tracks and a bed about the middle full of specimens of *Ostrea*, sp. : about	3	9
	4.	Clay, very tough, yellowish : perhaps about ..	1	0
	5.	Clays, bluish, marly : about .. .. .. (At the base of these clays is a course of water-worn pebbles, often coated with *Serpulæ*, *Ostrea* and Polyzoa).	15	0
	6.	"Red sand, derived from the decomposition of [the top-portion of] bed 4 [*i.e.*, my bed 7]."[2] ..	1	2
	C. N. L. 7.	Limestones, brownish sandy, with numerous specimens of *Ostrea* sp., plant-remains : about ..	6	6
	8.	Layer of marly material, with crushed oyster-shells, described by Walford as 'a dark blue clay,' and given by him as	1	0
Inf. Oolite.		*Clypeus*-Grit. Usual type : seen	5	0

From this section it will be seen that limestones have developed in the lower portion of the Fullers' Earth. There is clay below them, and I presume that it is this bed which is represented at Great Rissington, where it contains an *Ostrea*-Limestone.[3]

1 This section was first described and accurately interpreted by Mr E. A. Walford (Q. J. G. S., vol. xxxix. 1883, pp. 225-226). Subsequently, in 1887, it was noticed in greater detail by Mr S. S. Buckman (Proc. Cotteswold Nat. F.C., vol. ix., pt. 2, pp. 123 and 128). See also Mr Walford's paper "On Some New Oolitic Strata in North Oxfordshire" (1906), pp. 6 and 7.

2 Walford. "On Some New Oolitic Strata, etc." p. 6

Quart. Journ. Geol. Soc., vol. lxiii. (1907), pp. 440-441.

In a quarry near Lower Swell[1] bed 5 of the railway-cutting section appears to have become replaced by limestone ; while above are marls that weather into a tough greenish-brown clay, which seem to represent bed 1 in the railway-cutting, but may be beds 2, 3 and 4 as well. In the marls exposed in this quarry is a limestone-band, sometimes crowded with gastropods which, I think, is correlative with the Lower *Nerinæa*-Bed in the Neæran Beds of the Chipping-Norton district. If this is the case, then by the test of relative stratigraphical position, the lower two-thirds of the Lower Fullers' Earth would appear to be equivalent to the Chipping-Norton Limestone, and the upper third to the Neæran Beds. This, of course, is speaking approximately, and in the light of the knowledge at present possessed.

I once noticed in the quarry near Lower Swell a peculiar deposit of sand, which I assigned to a position between the Chipping-Norton Limestone and the clay-beds. Mr Walford noticed a similar deposit on top of the Limestones (bed 7) in the railway-cutting. A similar deposit occupies a like stratigraphical position in many of the quarries in the Chipping-Norton district.

Thus on stratigraphical grounds, it would appear that the Lower Fullers' Earth in the Chipping-Norton district is mainly represented by the Chipping-Norton Limestone, and the fact that this limestone at the Oakham Quarry (page 228) has yielded a specimen of *Oppelia*, probably *O. fusca*, shows that this is so.

Chipping-Norton Limestone.—This limestone spreads far and wide over the Chipping-Norton District, and has long been known for the occurrence in it, or in the immediately superincumbent clay-beds of the remains of the giant saurians of the genus *Cetiosaurus*.[2]

The name "Chipping-Norton Limestone" was first used by the late W. H. Hudleston in 1878,[3] and he evidently intended it to apply to the *whole* of the limestone that intervenes between the *Clypeus*-Grit and the present Neæran Beds, or Great Oolite deposits, as the case may be, in the neighbourhood of Chipping Norton, where it is extensively quarried for dry-walling or for mending the local roads.[4]

1 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), pp. 24 and 25.
2 Phillips, "Geology of Oxford, etc." (1871), pp. 164, 245 : Proc. Geol. Assoc., vol. v., No. 4 (1877), p. 185.
3 Proc. Geol. Assoc., vol. v., No. 7 (1878), p. 384.
4 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 149.

Lithically, the Chipping-Norton Limestone varies considerably. In the south-western half of the district it is a black-speckled, although otherwise pure white, limestone, only slightly arenaceous ; but eastwards it passes into much more arenaceous limestones and in places into actual sand-deposits.

About the middle of the Chipping-Norton Limestone, *in the south-western half of the district,* is a peculiar bed best described as a " Knotty-Bed."[1] This Knotty-Bed becomes very hard indeed and often replete with specimens of *Trigonia,* especially of *Trigonia signata, in the north-eastern portion of the district,* on which account Mr Walford has termed it the " *Trigonia-signata*-Bed."[2]

The limestone above the *Trigonia-signata*-Bed may pass, as in the Hook-Norton Cutting, into a white sand similar to that of the Lower Estuarines at Stow-nine-Churches and Duston, near Northampton ; while in the sandy-limestone portion, larger fragments of plants occur than further west. For these beds, which are equivalent to the Chipping-Norton Limestone, *above* the Knotty Bed, the term " Swerford Beds " will be useful.

The limestones *below* the Knotty Bed are usually more massive than those above, have often waterworn, " wavy " surfaces, and when traced in an easterly direction, are found to become very sandy, and, in appearance, when soft, not unlike the Harford Sands on Cleeve Hill, near Cheltenham, or the sands associated with the beds about the horizon of the Collyweston Slates at Collyweston, in North Northamptonshire. For these beds, Mr Walford has employed the term " Hook-Norton Limestones,"[3] but latterly he has dropped it, and has used the term " *Trigonia-signata*-Sands and Limestones "[4] for these beds, *plus* the overlying *T.-signata*-Bed.

The Chipping-Norton Limestone, in its more sandy development, gives rise to a light, very sandy soil. Percolating, carbonated waters dissolve up the calcareous cement, and in the process cause considerable settling, slipping and faulting of the beds. The carbonate of lime is often deposited

1 Called the " Old Man " by the quarrymen at Sharp's Hill. This bed in its " knotty " development is excellently seen in a quarry opposite the Merry-Mouth Inn, Fyfield, where there is the usual kind of limestone above and below.
2 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 238.
3 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 238.
4 On Some New Oolitic Strata in North Oxfordshire " (1906), pp. 4, 5 and 27.

in the form of massive travertine, called "lac lunæ" by the early mineralogists. All this dissolution naturally encouraged fissuring, and into many of the cracks the clay of the immediately superincumbent deposit has often found its way. On this account, Mr Walford has termed the clay-bed immediately on top of the Chipping-Norton Limestone, the "Rift Bed."[1]

Neæran Beds.—To Mr Walford, practically alone, are we indebted for our knowledge of these beds. He gave them their name; worked out the sequence of their component layers, and to no small extent, their palæontology, at Sharp's Hill; and proceeded a considerable way towards indicating their geographical extent in North Oxfordshire. As will be seen shortly, they comprise a most interesting collection of dark-coloured tough clays of various tints, and marls and limestones —the marls sometimes ultra-limy, and the limestones often considerably arenaceous; while fossils, mostly of novel form to Cotteswold workers, abound. The mutual relations of the component layers of the Neæran Beds are difficult to determine, and so are their relations to the overlying Great-Oolite beds.

Very similar deposits to these Neæran Beds have been described in the department of L'Indre, France, by MM. Cossman and Benoist.[2]

II.—Local Details.—Descriptions of Sections.

The best section in the district whereat to commence a detailed investigation, is that at Sharp's Hill (3 on map), two miles north-west by west of Hook-Norton Church. It has been described in some detail by Mr Walford (pp. 7-15),[3] and is extremely instructive as demonstrating the variability of the beds between the black clay ("Rift-Bed") and the *Rhynchonella-* and *Ostrea*-Bed of the Great Oolite proper.

1 *Vide* H. B. Woodward, "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England and Wales (Yorkshire excepted)," vol. iv. (1894), p. 159.

2 Bull. Soc. Géol. de France, 3ième ser., tome xxvii. (1899), pp. 136-143 and 543-585, pls. xiv.-xvii.

3 References, such as this one in brackets after Mr Walford's name refer to his pamphlet "On Some New Oolitic Strata in North Oxfordshire," Buckingham, 1906.

No. 3. SHARP'S HILL QUARRY[1]

		Thickness in ft.	ins.
	1. Reddish soil: 6 ins. to 1 ft...	1	0
	2. *Rhynchonella-* and *Ostrea*-Bed. Marls, yellowish, clayey, crowded with oysters and specimens of *Rhynchonella*: *Camptonectes annulatus* (Sow.)	1	0
Neæran Beds	3. Clay, brown and dirty greenish-grey at the top, darker towards the base[2]: about ..	1	0
	4. *Ostrea*-Clay. Marly clay crowded with whitened oysters	0	6
	5. *a.* Clay, tough, dark-brown and greenish: 6 ins. *b.* Intermittent bed of brown sandstone: 0 to 2 ins. *c.* Clay, tough, bluish, passing down into greenish-blue and yellow-streaked clay, and this again into bed 6: 1 ft. 10 ins.	2	6
	[*Position of beds* [2] *to* [6] *of Langton Bridge* (*teste Walford*)]		
	6. Bituminous Clay. Clay, black (in places almost a coal-seam), constituting a particularly noticeable horizon and usually overlying a seam of rich-brown clay: 2 to 8 ins.	0	6
	(*Beds* 7 *to* 10 *of Walford should come here, but Mr Paris and I did not detect them*).		
	11. *Viviparus*-Marl. Marl, pale-purplish, with numerous pebbles and concretions, some ochreous, others phosphatic—the whole deposit having an appearance best colloquially described as "like an ash-heap." *Viviparus langtonensis* (Hudl.),[3] *Ataphrus labadyei* (d'Arch.), *Nerinæa* spp., etc: 0 to 1 ft. 4 ins.	0	8
	(*This deposit rests, where present, upon an uneven surface of bed* 12).		
	12. Upper *Nerinæa*-Bed. Limestone, generally a hard bed, but more rubbly in places and sometimes passes into a whitish-grey marl. Also appears to be a lenticular deposit in the quarry-face (Aug., 1910), but re-appears at the extreme western end as an intermittent limestone-bed. Large *Nerinæa* of *eudesi*-type common, *N.* cf. *voltzi* Desl., *Nerita minuta* Sow. at the base, *Corbula buckmani* Lyc., *Arctica loweana* (M. and L.) dwarfed form, *Gervillia waltoni* Lyc., *Ostrea*, *Volsella imbricata* (Sow.), etc. 1 ft. 2 ins. to 2 ft.	1	9

1 Near Temple Mill, quite close to Sharp's Hill, is a quarry in which the sequence of beds displayed is similar to that at Sharp's Hill. At the top is the *Rhynchonella-* and *Ostrea*-Bed. About 6 inches of clay separate this from the *Ostrea*-Clay, while below this are clays black at the top and bottom and of a tea-green hue in the middle. The clays above and below those of tea-green colour contain iron and weather a rusty colour. Below come similar beds to those at Sharp's Hill, only the Upper *Nerinæa*-Bed is not nearly so prominent (often only lumps of limestone embedded in marl) and the *Cyathopora-bourgeti*-Bed is thinner and contains fewer concretions.

2 At Temple-Mill Quarry an irregular limestone-band is present in the middle of bed 3.

3 *V. langtonensis* was recorded by Hudleston in his Monograph from Sharp's Hill, Castle Barn and Langton Bridge. He remarks that it resembles *Paludina scotica* Tate (Q. J. G. S., vol. xxix., pl. xii., fig. 3). The species resembles *V. aurelianus* Crossman (Bull. Soc. Géol. France, 3ième série, vol. xxvii. (1899) p. 141, fig. 4 and page 565, pl. xvii., figs. 2-7), but the spire is more produced than in that species. *V. aurelianus* is from the "Bradfordian."

Neæran Beds

	Thickness in	ft.	ins.
13.	*Cyathopora-bourgeti*-Bed. Marl of a greenish-grey colour with numerous peculiar white concretions (and irregular limestone-layers) and therefore an easily-found bed; *Nerinæa voltzi, Gervillia waltoni, Perna mytiloides* Lamarck, *Placunopsis socialis* M. and L. *Nucula menkei* (Roemer), *Ostrea, Volsella imbricata* (Sow.), etc: *Cyathopora bourgeti* occurs principally at the base: o ins. to	2	1
	Lower *Nerinæa*-Bed.[1] Limestone, pale-green when freshly-fractured and readily-recognised by innumerable specimens of *Nerinæa*. At the western end represented only by an occasional nodule; *Cyathopora bourgeti* (Defr.) near the top, *Arctica loweana* (dwarfed form), *Rhynchonella concinna*, auctt., *Astarte, Nerinæa*, etc.: o ins. to 1 ft.	0	8
	Irregular parting of clayey marl: o to ..	0	2
15.	*Astarte-oxoniensis*-Limestone.[2] Limestone, very variable in thickness and mixed with marl. When freshly fractured is pale-green, with a tendency to become "rotten," while the harder portions are blue and shelly; *Perna* cf. *mytiloides, Nucula menkei* auctt., *Volsella imbricata, Exelissa* spp., etc.: o to 8 ins.	0	5
	Fairly persistent parting of greenish clayey marl: 1 to 3 ins.	0	3
16.	*Exelissa*-Limestone. Limestone with pale-yellow or whitish exterior, blue-hearted. The weathered surfaces show innumerable specimens of *Exelissa*. The nether surface is very irregular; *Amberleya* aff. *nodosa* M. & L., "*Phasianella*" *pontonis* Lyc., *Protocardia buckmani* (M. & L.), *Nucula menkei*, etc.: o to 10 ins.	0	6
(17.	*Limestone, according to Walford, 5 inches thick*).		
18.	*Perna*-Bed. Pale-yellow and greenish and bluish marl and stone. *Perna oxoniensis* Paris, *P. mytiloides, Gervillia waltoni*, [*G. richardsoni* Paris[3]] *Protocardia lingulata* (Lyc.), *Pleuromya* cf. *unioniformis* (M. and L.), *Vol. imbricata, Ataphrus labadyei*: [*A. discoideus* M. & L., *Delphinula benoisti* Cosmann[4]], *Exelissa* spp., etc.: 1 ft. to ..	1	6
19.	Reddish-brown sandy layer with nodules and masses of a blue shelly limestone on its horizon; *Perna, Placunopsis socialis, Gervillia, Volsella, Exelissa*, numerous ostracods (in the limestone-band): o to ..	0	8
20.	Clay, black with a reddish-brown seam (20*a*) at the base	1	11

1 This bed might be called the Lower *Nerinæa*- and *Volsella*-Bed in this area; and
2 This bed the *A.-oxoniensis*- and *N. menkei*-Bed.
3 Not found *in situ*. See page 234, and Pl. xxvii., figs.. 3*a* and *b*.
4 Not found *in situ*. *D. benoisti* is figured in the Bull.Soc. Géol. France, vol. xxvii., 3ième série, 1899, pl. xv., figs. 12-14.

			Thickness in ft.	ins.
Swerford Beds	21.	[=2 of Hook-Norton Section, p. 213]. Plant-Bed. Limestone, perforated with tubular holes, into which black clay has infiltrated: 1 ft. 6 ins. to 2 ft. 8 ins.	1	6
	21*a*.	Clay, tough: 0 to 2 ins.: average.. ..	0	1
	22.	Limestones, fine-grained, siliceous, fawn-coloured, but blue-hearted, with numerous fragments of black lignite: according to Walford 2 to 8 ft. thick	4	8
Hook-Norton Beds: *T.-signata* Bed	23.	[Bed 12 of Hook Norton]. *Trigonia-signata*-Bed of Walford, the "Old Man" of the quarrymen. This bed is a fawn-coloured, blue-hearted limestone, joined on to the bed above; *Trigonia* spp. abundant. The bed is extremely hard	1	4
Hook-Norton Beds: Beds	24*a*.	Limestone, fine-grained, siliceous, blue, weathering brown, with numerous fragments of lignite	2	4
	b.	Conspicuous layer of ironstone: 0 to 4 ins.	0	2
	c.	Limestone, similar to 24*a*, but more ferruginous: seen 2 ft., but according to Walford	9	0
		(*The following beds, not exposed at the time of my visit, have been noted by Mr Walford*).		
Inf. Oolite: *Clypeus*-Grit	25.	"Rubbly, earthy limestone with nodules; *Gervillia prælonga*, *Trigonia* sp., *T. producta*, *Gresslya abducta*, *Avicula braamburiensis*, *Lima ovalis*. Thickness not determined.		
	26.	Compact, fine-grained yellow limestone, with yellow sand at base (thickness not determined.)"		

It is important to obtain first a general idea of this fine section, and then to investigate its many beds in detail.

It should be first of all noticed that there are groups of various-coloured clays near the top of the section and immediately above the Swerford Beds. The deposits in between are principally limestones, all of which, *Exelissa*-Limestone, *Astarte*-Bed and Lower and Upper *Nerinæa*-Beds, are important. Scarcely less so are the associated deposits, the *Perna*-Bed and *Cyathopora-bourgeti*-Bed.

The Upper *Nerinæa*-Bed varies considerably as regards lithic structure. In places it is a hard limestone, in others a marl.

Previous to the deposition of the *Viviparus*-Marl, there was an erosion. The non-sequential relation of the purplish *Viviparus*-Marl to the whitish Upper *Nerinaea*-Bed (in its marly condition) is very obvious.

The *Viviparus*-Marl, however, is not continuous throughout the section. It indicates a change, and in places the non-sequence between it and the underlying deposits is far greater than at Sharp's Hill. At Castle Barn (44), for example, it rests directly upon the Chipping-Norton Limestone.

The *Ostrea*-Clay and *Rhynchonella*- and *Ostrea*-Bed are difficult deposits to deal with. When, as is usually the case, the clays with oysters are close to the top of a section, it is difficult to say if they represent the *Ostrea*-Clay or the *Rhynchonella*- and *Ostrea*-Bed. The presence or absence of specimens of *Rhynchonella* constitute the main guidance. In some sections the *Rhynchonellæ* are seen to be associated with specimens of *Terebratulæ* of the group colloquially spoken of as the " *T.-globata*-Group."

Near Whichford is a quarry (75), in which such a *Rhynchonella*- and *Ostrea*-Bed, containing specimens of " *T. globata*," is close down upon the Swerford Beds; only deposits comparable with those numbered 19 and 20 at Sharp's Hill separate them. The limestones in this quarry are very much disturbed. Sometimes in large blocks and sometimes flaggy, they are at others reduced to a yellowish sand. Also in places they are highly ferruginous—especially the top-layer, which is probably on the horizon of the Plant-Bed of Sharp's Hill.

The quarry numbered 76 is in limestones, which are, however, less ferruginous.

LONG-COMPTON QUARRY.—The Chipping-Norton Limestone is worked in a quarry (77) on the hill to the north of Long Compton. The upper portion of the limestone has been reduced to a sand; but on top of it, the extremely ferruginous equivalent to the Plant-Bed may be descried. Waters, rendered chalybeate from this stratum, have percolated the " sands," and have imparted to them a rich rouge colour. Above the Plant-Bed equivalent is reddish-brown sand, then a tough, dark clay (4 ins.), with pieces of limestone rich in specimens of *Placunopsis*, and next reddish-brown sand again: the three layers being equivalent to beds 19 and 20 of Sharp's Hill.

OATLEY HILL.—A little over a mile south-south-west of the Sharp's Hill Quarry is Oatley Hill or "Otley Hill," as it is more generally known amongst geologists (No. 4).

The locality has long been famous as an interesting collecting-ground, and Prof. J. W. Judd, Mr E. A. Walford and others have obtained and listed therefrom a considerable number of specimens. Now, however, the classic section is quite overgrown, and the highest beds at present visible are on the same stratigraphical horizon as those seen in the quarry (No. 5), near Oatley-Hill Farm. However, it is easy to see from the lists of fossils given by Judd[1] and Walford[2] that the Chipping-Norton Limestone, *Trigonia-signata*-Bed and Hook-Norton Beds, part of the Pea-Grit-Series equivalent and *Scissum*-Beds are represented. Mr H. B. Woodward has listed a few of the more noteworthy fossils from the "lower beds" of Oatley Hill,[3] and of them it may be remarked that the *Montlivaltia lens* is probably the *Scissum*-Bed variety, which is so commonly associated with *Rhyn. cynocephala* and *Pholadomya fidicula* in the Cotteswold Hills, as it is here also at Oatley Hill; the *Acrosalenia* is probably the *A. lycetti*, which at the Edge, near Painswick,[4] occurs abundantly in association with huge specimens of *Nautilus*; while *Nerinæa cingenda* and *N. pisolitica*, are common in the Dogger of Blea Wyke and in the top-portion of the Pea-Grit[5] in the Cotteswold Hills respectively.

OATLEY-HILL-FARM QUARRY.—In a field belonging to Oatley-Hill Farm is a quarry (5) in which about 8 feet of Chipping-Norton Limestone is exposed. The beds are brown and sandy, and give rise to a very sandy soil. They contain numerous pieces of brown lignite, occasional specimens of *Lima? cardiiformis* (Sow.), *Lucina* (fairly common); whilst on certain of the weathered slabs can be distinguished fragments of an *Acanthothyris*, *Gervillia*, *Ostrea*, *Syncyclonema*, *Serpula* and Polyzoa. There also appears to be evidence of Mr Walford's *Trigonia-signata*-Bed, for certain pieces of shelly limestone that were lying about contained numerous specimens of *Trigoniæ*, *Ostreæ* and a large *Camptonectes lens* (Sow.).

1 "The Geology of Rutland, etc." (1875), pp. 21-23. Mem. Geol. Surv.
2 Quart. Journ. Geol. Soc., vol. xxxix. (1883), pp. 232-233 and 242.
3 "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)," vol. iv. (1894), p. 157. Mem. Geol. Surv.
4 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908), p. 164.
5 Slatter collected a specimen of *Terebratula simplex*, J. Buckman, at Oatley Hill.

In a quarry (6), which is becoming rapidly overgrown, situated a mile and a quarter to the south-south-west of the above, siliceous Chipping-Norton Limestone is exposed that is weathering at the top into a white sand. Two or three feet of similar sandy limestones are to be seen in an old quarry near Rollright-Heath Farm (7) and about 8 feet were exposed in a temporary excavation marked 8.

Hook-Norton Railway-Cutting Section (No. 9.)—Three quarters of a mile still further east is the Hook-Norton Tunnel, which is approached at both ends by means of deep cuttings. In both cuttings excellent sections have been available showing the junction of the Upper-Lias clay with the succeeding Oolite, and also the sequence as far up as the *Exelissa*-Limestones of the Neæran-Beds. Hence the sections are very important, and have, therefore, been studied by several geologists, while several palæontologists have investigated certain members of the fauna.

The banks of the approach-cutting to the southern (or Duckpool-Farm) end of the tunnel are, for the most part, overgrown; but in the northern approach-cutting there is still a very good section. This is mainly due to the fact that huge masses of Oolite are continually becoming detached from the parent mass, and slipping forward, occasion much concern to those responsible for the safety of the travellers on the railway below.

T. Beesley, the first to describe the sections, thought that the whole of the Oolite in this northern approach-cutting belonged to the *Murchisonæ*-Zone of the Inferior Oolite, and that it was comparable with the development that obtains at Ebrington and Bredon Hills.[1] He gives a long list of fossils, and, in his account of the cutting on the south side of the tunnel, notes that the sequence there is from the Upper Lias to the Great Oolite.[2]

Mr Walford published a more detailed record in 1883,[3] and so closely does it agree with the present one, that I have retained his numbers for the beds. The beds about those numbered 22-24 vary considerably, as might be expected in the neighbourhood of a Conglomerate-Bed that marks an important non-sequence.

1 Proc. Geol. Assoc., vol. v., No. 4 (1877), p. 170.
2 *Ibid.*, p. 172.
3 Quart. Journ. Geol. Soc., vol. xxxix. (1883), pp. 228-231 and 239-242.

Towards the tunnel-end of the western bank the Coral-Bed becomes well-defined and therefrom the late R. F. Tomes collected a number of corals.[1]

The record given by Mr H. B. Woodward is based upon those published by Beesley and Walford. This section also agrees in general with the present one, and the beds numbered 25 and 26a, b and c in my section correspond to those that are bracketed together by Mr Woodward as equivalent to the "Northampton Beds." Mr Woodward observes that[2]

> "the Chipping Norton Limestone is, no doubt, represented in the upper strata, while lower down, the *Clypeus*-Grit and the *Trigonia*-Grit of the Cotteswolds may be represented in point of time."

The *Clypeus*-Grit is probably represented by the Conglomerate-Bed, and it may be that the Coral-Bed is on the horizon of the Upper Coral-Bed of the Cotteswolds and Bath-Doulting district; but I did not notice any representative of the Upper *Trigonia*-Grit.

No. 9. THE HOOK-NORTON RAILWAY-CUTTING SECTION

(*West side of the Cutting*)

				Thickness in feet	ins.
Great Oolite; Bathonian (*pars*)	Neaeran Beds	1.	Soil, with here and there, according to Walford,[3] pieces of the *Exelissa*- and *Astarte*-Limestones;[5] *Cyathopora pratti*, E. & H., *C. luciensis*, E. & H.,[6] etc...	0	6[4]
			Non-sequence		
	Swerford Beds	2[7]	Horizon of Plant-Bed. Limestone, flaggy, white, oolitic	2	0
		3.	Sand, weathering white and very conspicuous	3	6
		4.	Limestone, bored in places by annelids ..	1	9
		5.	Sand, brown and yellow — With *Ostrea calceola* and *Lima*, (*teste* Walford)..	0	11
		6.	Limestone, sandy — With *Ostrea calceola* and *Lima*, (*teste* Walford)..	0	4
		7.	Sand, brown and yellow — With *Ostrea calceola* and *Lima*, (*teste* Walford)..	0	5
		8.	Limestone, sandy, with incipient "pot-lid" structure at the base: 2 ft. 3 ins. to 3 ft..	2	3
		9.	Sand, yellow and brown; *Serpula* & *Ostrea*	0	1
		10.	Limestone, sandy. The top-surface of this bed is often well waterworn and pitted and covered with oysters	1	10
		11.	Sand, coarse, gritty	0	2
	T-signata Bed	12.	"Old Man." Limestone, hard, brown, sandy, with a waterworn surface covered with oysters and pebbly at the base	1	3
	Hook-Norton Beds	13.	Sand, brown and yellow, with occasional "knots."	0	2
		14.	Limestone, brown, shelly; *Pteria inæquivalvis*, auctt., and shell-fragments: about ..	1	11
		15.	Clay, dark, with a brown layer	0	7
		16.	Limestone, shelly	0	5
		17.	Clay, arenaceous	0	2
		18.	Limestone, hard, sandy, brown but blue-centred, with numerous pieces of lignite ..	1	0
		19.	"Plant-Bed" (of Walford). Limestone, brown, sandy, full of brown fragments of lignite. This bed is really the bottom-portion of 18	0	4
		20.	Clay	0	2½
		21.	Limestone, brown, shaly, and marl ..	2	0

1 Proc. Geol. Assoc., vol. vi., No. 4 (1879), pp. 152-165.
2 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 155.
3 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 230.
4 The thicknesses of beds 1 to 9 are extracted from Mr Walford's record, but were checked as far as was possible.
5 And probably of the Lower *Nerinæa*-Bed as well.
6 Proc. Geol. Assoc., vol. vi., No. 4 (1879), p. 161.
7 Beds 2 to 13 = Block E of Walford; beds 14 to 21 = his Block D; and 22*a* and *b* (Walford's beds 22-24) = his Block C.

Series	Stage	Beds	Hemera	Bed and description	Thickness in feet	ins.
Inferior Oolite	Upper Coral-Bed and *Clypeus*-Grit Equivalent	These beds 22-24 of Walford vary considerably.		22*a*. Limestone, very hard, somewhat ferruginous, with a very irregular under surface, forming a kind of cap to the Conglomerate-Bed; *Astarte minima*, Phil., *Trigoniæ*, *Acanthothyris* sp.: about	0	6
				22*b*. Conglomerate-Bed. Pebbles, water-worn, bored by *Lithophagi* and often covered with oysters, and *Serpulæ*, in a brown, rather sandy, marl with bleached oysters and well-rolled shells. Where this bed is thicker and less conglomeratic, the Coral-Bed[4] comes in at the base; *Rhynchonella* cf. *subtetrahedra*, Dav., common, *Gresslya abducta* (Phil.), *Pleuromya* cf. *goldfussi* (Lyc.) and other species, *Pholadomya* sp., *Myoconcha*, *Cucullæa*, *Alectryonia*, *Pteria inæquivalvis*, auctt., *Serpulæ*, etc: average	0	5
				Limestone, very hard	0	5
				Limestone, hard, iron-speckled, with irregular under surface	0	4
				Non-sequence		
	Aalenian (*pars*)	*Scissum*-Beds		25[1] "Ammonite-Bed." Limestone; *Lioceras opalinum* (Reinecke), *L. thomsoni*, S. Buckman, *Hammatoceras* aff. *newtoni*, S. Buckman,[3] *Volsella sowerbyana* (d'Orb.), *Pleuromya* sp., *Gresslya abducta* (Phil.), etc ..	1	6
				26*a*.[2] Limestone, massive, often joined on to the bed below; *Trigonia brodiei* Lyc., *Rhyn. cynocephala* (Rich.), *Astarte elegans* Sow., *Belemnites* spp., *Isocrinus*-ossicles, etc. ..	1	5
				26*b*. Limestone, massive	1	8
				26*c*. Limestone, massive	2	2
				27. Seam of sand, not very conspicuous	0	3
Upper Lias	Toarcian		Hemera	*Non-sequence*		
			brauniani *fibulati* *subcarinati* and *falciferi*	28. Clay, blue, with curiosly-shaped, hard grey-blue limestone-nodules; *Peronoceras fibulatum* (J. de C. Sow.), *Harpoceras subplanatum* (Oppel.) *Nuculana ovum* (Sow.), *Inoceramus dubius*, Sow., *Orbiculoidea reflexa* (Sow.), etc.: 30 to	40	0
			[*acuti*	29. Position of "Transition-Bed"].		
Middle Lias	Pliensbachian		*spinati*	Marlstone.		

1 Bed 25 = Block B of Walford, and
2 Beds 26*a*, *b*, *c* and 27 = his Block A.
3 "Monogr. Inf. Ool. Amm. Brit. Isles," pt. 2 (1888), pp. 52 and 53; Suppl., p. xxxv. Pal. Soc.
4 R. F. Tomes recorded from the Coral-Bed (Proc. Geol. Assoc., vol. vi., No. 4 (1879), pp. 156, etc.), *Clausastræa conybeari* (E. & H.), *Isastræa beesleyi*, Tomes, *I. limitata* (Lamx.), *I. serialis*, E. & H., *Latimeandra lotharinga* (Michelin), *Thamnastræa defranciana* (Mich.), *Thamnastræa* sp., etc.

The *Scissum*-Beds are typical and quite easy to locate and date.

The Conglomerate-Bed is a most interesting deposit, and, it should be particularly noticed, contains "dark pebbles," which serve to differentiate it from other conglomerate-beds in higher subdivisions. Also, it should be observed, that if this deposit were absent, it would be difficult on a cursory inspection to separate the *Scissum*-Beds from the Hook-Norton Beds.

The beds *below* the Conglomerate-Bed contain plant-remains only rarely; but those above, not infrequently, and at certain horizons, as in bed 19, even abundantly.

Mr Walford did not identify any stratum in this section with his *Trigonia-signata*-Bed, but Mr Paris and I are of opinion that bed 12 is on its horizon.

SWERFORD QUARRY.—This quarry (10) is known locally as "Bennet's Quarry" and has been briefly described by Mr Walford.[1]

No. 10. SWERFORD QUARRY

		Thickness in feet	ins.
Neæran Beds	4. *Ostrea*-Clay (in pockets). Clay, dirty-yellow; *Ostrea* abundant		
	5. Clay, stiff, dirty-brown, passing down into bed 6. [?*Horizon of "Neæran Slates"* (Walford) *of Langton Bridge*].		
	6. Bituminous Clay. Clay, black and bluish-grey, tough, brownish at the base: 6 ins. to 2 ft.	1	3
	(*Beds 7 to 12, incl., absent*).		
	13 [2].[2] *Cyathopora-bourgeti*-Bed. Dirty grey-white marl with bluish-grey (weathering white) concretions; *Perna mytiloides*: 6 ins. to	2	0
	14. *Lower Nerinæa-Bed.* Limestone, grey, sandy, with specimens of *Nerinæa*, *Ostrea* and *Perna mytiloides* common on the nether surface, which is irregular; *Protocardia buckmani* (M. & L.): 11 ins. to	1	3
	(*Bed 15, the Astarte-Bed, absent*).		
	16. [? Bottom-portion of Walford's bed 4]. *Exelissa*-Limestone. Limestone (similar to that at Sharp's Hill), very shelly ..	0	6
	(*Beds 17 and 18, bed 18 being the Perna-Bed, absent*)		
	19 and 20. [5], Clay, brown and yellow: 1 to 6 ins.	0	3
	20*a*. [6], Rubbly, sandy rock and reddish-brown sand passing down into the bed below: 3 ins. to 1 ft.	0	7

1 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 231.
2 The numbers in square brackets refer to Mr Walford's record.

			Thickness in feet	ins.
Swerford Beds	2.[1]	Plant-bed equivalent. Limestone, siliceous, weathering flaggy	2	0
	3 & 4	Limestones, very siliceous, with a particularly shelly-bed (comparable with a similar bed in sections 12, 17, 22, 28 and 33) at 2 to 3 feet down. At the south-eastern end of the quarry, these beds have been reduced to a white sand, in which the "*shelly-bed*" is conspicuous as a yellower band[2] ..	4	2
	5 to 11	Limestones, more massive, with oysters very abundant (especially in the top-bed) and noticeable	6	0
T.-signata Bed	12	Conglomerate-Bed, with well-rolled pebbles of oolite (some of them bored and encrusted with oysters and Serpulæ) at 6 feet down. Associated with the pebbles are waterworn oysters, *Lima ?cardiiformis*[3] and echinoid-radioles	1	0
Hook-Norton Beds	13 to 18.	Limestones: seen:	3	0

The principal non-sequence in the Swerford Quarry occurs at the same horizon as that at Sharp's Hill, that is, immediately below bed 6. The *Exelissa*-Limestone is readily-recognised, being identical, as regards faunal and lithic characters, with its equivalent at Sharp's Hill.

The following are notes on sections of minor importance:

Quarry 11.—In this old circular quarry there are traces of black clay (? bed 6) and of the flaggy limestone, bed 2.

Quarry 12.—In this quarry there is seen, in descending order, the flaggy limestone (bed 2); yellow sand and sandy rock (with a 4-inch "*shelly-bed*," full of *Trigoniæ*, at 2 feet from the top); and then massive limestones.

Quarry 13.—This quarry is in Chipping-Norton Limestone.

Quarry 14.—This section is now quite overgrown; but Mr Walford[4] observed traces of black clay on top of the limestone.

Quarry 17.—In this quarry a 12-foot face of Chipping-Norton Limestone is seen, with the "*shelly-bed*" (which contains specimens of *Isastræa, Astarte, Trigonia*, etc.) about the middle.

Quarry 18.—This quarry is in similar beds to the preceding (17).

Quarry 19.—Here slightly higher beds are exposed. They comprise four beds of limestone (with *Ostreæ*) with intervening "sand-beds," the top one of which is more marly than the others, and full of *Nerinæœ*.

Quarry 20.—In this quarry there is a marl, rich in *Nerinææ*, similar to the *Nerinæa*-Marl in quarry 19; but in this case it occurs in a marl and "sand"—the whole deposit being not unlike that which is numbered 3 in the Hook-Norton Railway-Cutting Section.

1 These numbers correspond to those used in dealing with the Swerford, *Trigonia-signata-* and Hook-Norton Beds in the Hook-Norton Railway-cutting.

2 In fissures in this limestone were observed, in places, little black concretions similar to those seen in a quarry near Lower Swell, near Stow-on-the-Wold (*vide* Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), pp. 24 and 25).

3 In this paper a query refers to the word it precedes.

4 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 232.

DUNTHROP.—Mr H. B. Woodward has published some notes on this section (22) and queried all the limestones below the " shelly-bed " as being equivalent to the Oolite Marl[1].

No. 22. DUNTHROP QUARRY

			Thickness in feet	ins.
Neæran Beds		Reddish, sandy and clayey soil and subsoil.		
Swerford Beds	2.	Limestone, weathering into flaggy pieces ..	2	0
	3 & 4	Limestone, also weathering flaggy. At the top it often breaks up into a yellowish, oolitic, rubbly and seemingly " sandy marl " [= the *Clypeus*-Grit of Mr Woodward[2]), and at 2 feet 2 inches below bed 2 is an irregular shelly-bed (sometimes pebbly)[3] in which *Trigoniæ* abound, and occasional specimens of *Ostrea*, *Lima ?cardiiformis*, *Perna* and *Isastræa* occur	4	4
	5 to 11	Limestones, more massive-bedded, iron-stained along the joints	5	0
T. signata-Bed	12	Limestone, hard, average	1	0
Hook Norton Beds	13 etc.	Limestones, with irregular runnelled surfaces similar to those in quarry number 33 : seen ..	3	0

The following sections are of less importance:

WEST-WOOD QUARRY (23).—At the top are white " sandy " marls and rubble, similar to the deposit seen in the quarry north of Chapel House (20), then a marl-bed similar to that seen in the Dunthrop Quarry (22), with brown oolitic limestones, which pass down into more-than-usually-ferruginous limestones, below.

LEYS-FARM QUARRY (24).—In this quarry, the highest bed seen is the equivalent of bed 2 in the Dunthrop Quarry. At its base is the equivalent to the rubbly marl of that section and of the sandy marl of the West-Wood Quarry. Then comes a conspicuous bed of limestone, under which is oolitic rubbly marl, about on the horizon of the " shelly-bed " of Dunthrop, with below, the ordinary limestones. Another quarry (25), nearer the farm, is in similar limestones.

THE DOWNS QUARRY.—In this quarry about 15 feet of Chipping-Norton Limestone is exposed. As a rule, the limestone is well oolitic, and has a tendency to become sandy in the upper portion and black speckled in places. In one part of the quarry a considerable number of pieces of a greyish limestone were found, which were literally crowded with gastropods—mostly *Nerinææ*. The bed was not detected *in situ ;* but there is little doubt that it is on the horizon of the Lower *Nerinæa*-Bed and is comparable with the Gastropod-Bed seen in a quarry near Lower Swell, near Stow-on-the-Wold.[4]

1 " The Jurassic Rocks of Britain," vol. iv. (1894), p. 161.
2 Mr Woodward queries this suggestion.
3 When this layer is pebbly, it is not unlike that in Boulter's-Barn Quarry, near Churchill (51)
4 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), p. 24.

Quarry number 27 is also in the Chipping-Norton Limestone.

GREAT TEW.—This section is an important one (28) and should be visited by anyone working the district.

No. 28. QUARRY AT GREAT TEW

	Bed	Description	Thickness in feet	ins.
Swerford Beds	2.	Limestone, pale-brown, hard, rubbly: seen (in the eastern side of the quarry)	1	9
	3 & 4.	Limestone, similar, rubbly mixed with sand, in the southern face becoming a white and yellow sand with the "shelly-bed" about the middle	4	6
	5 to 11	Limestone, hard, massive, with an extremely shelly bed (with *Trigoniæ*, *Lucinæ*, etc.) joined on to the bottom limestone	3	2
		Limestone, sandy, rubbly, mixed with sand ..	1	6
"Old Man"	12.	Limestone, massive, sandy, in three layers, ferruginous and shelly. Pebbles waterworn, bored by *Lithophagi* and with oysters on them, are embedded in the top-portion of the bed, which has a very irregular nether surface..	2	3
Hook-Norton Beds	13.	Sand, brown and grey-streaked	0	10
	14.	Hard calcareous sand-rock passing into soft brown sand	0	9
	16.	Brown sandy rock; *Syncyclonema demissum* auctt.	0	7
	18.	Somewhat hard, bluish-grey centred shelly sandy rock: seen	0	4

Tomes records *Cryptocœnia luciensis* E. & H. and *Isastraea beesleyi* Tomes, from Great Tew.[1] They would come from higher beds than any now exposed in this quarry, the main feature of which is the tendency for the beds *above* 12 to become rubbly and sandy, and for those *below* (which all contain plant-remains in the form of black lignite with occasional fern-fronds) to become noticeable soft brown sand.

BELL-INN QUARRY.—This quarry (29) is fast becoming filled up with refuse. This is unfortunate, for some of the beds are extraordinarily fossiliferous and the majority of the specimens excellently preserved.

Mr Walford has given a brief record of this section,[2] which has otherwise escaped attention.

1 Proc. Geol. Assoc., vol. vi., pt. 4 (1879), pp. 157 and 160.
2 "On Some New Oolitic Strata in North Oxfordshire" (1906), pp. 24-25.

No. 29. BELL-INN QUARRY, ENSTONE

		Thickness in feet	ins.
	2. Clay, dirty-yellow, marly; *Ostrea* (common), *Terebratula globata* auctt., passing down into ..	0	7
Neæran Beds	3. Clay, dirty-green	0	2
	(*Bed* 4, *the Ostrea-Clay, absent*).		
	a. Upper Placunopsis-Bed. Marl, dirty-yellow and greenish-grey, crowded with *Placunopsis socialis* M. & L., and containing occasional pieces of shelly stone	0	6
	b. Sand, reddish-brown intimately associated here with bed 14	0	2
	(*Beds* 5*c* to 13 *incl. absent*).		
	14.[4 of Walford]. *Lower Nerinæa*-Bed. *a*. Sandstone, very hard, calcareous, passing down into the *b*. "*Fossil-Bed.*" Limestone, yellowish, very fossiliferous; *Arctica loweana* (M. & L.), *Astarte minima* Phil., *Corbula buckmani* Lyc., *Gervillia enstonensis* Paris, *Grammatodon* sp., *Perna oxoniensis* Paris, *Ostrea* aff. *acuminata* Sow., *Placunopsis socialis* M. & L., *Volsella imbricata* (Sow.), *Alaria* sp., *Nerinæa eudesi* M. & L. and other species, "*Phasianella*" *elegans* M. & L., etc.	0	8
	(*Beds* 15, *i.e. the Astarte-Bed*, 16, *the Exelissa-Limestone, and* 17 *absent*).		
	18 [and 19 = 5 of Walford]. *Perna*-Bed. Marly limestone; *Perna oxoniensis* Paris, *Ostrea* and many of the shells of the bed above, common. Passes down into		
	19. Clay, greenish-grey marly	0	9
	20 [6]. Clay, black	0	6
	20*a*. [7]. Sand, reddish, and ferruginous sandy stone	0	1
Chipping-Norton Limestone	Limestones, compact: seen:	11	0

It is unnecessary to add any remarks to the above record.

Traces of black clay (bed 20), white marl and fossiliferous limestone, are seen (all very much intermingled) on top of the Chipping-Norton Limestone in quarry 30, that is, the section referred to by Mr H. B. Woodward as "south of Enstone (east of the 69th milestone)."[1] In the same quarry are fine masses of travertine.

The Chipping-Norton Limestone is exposed in the quarry numbered 31; while 32 is Walford's "Fulwell Quarry."

1 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 161.

No. 32. FULWELL QUARRY

			Thickness in feet	ins.
		Dark green clayey subsoil with numerous *Ostreæ*: seen	1	0
Neæran Beds	5.	*a.* Upper *Placunopsis*-Bed. Clay, bluish-grey, shelly, with occasional pieces of bluish limestone full of *P. socialis*	0	6
		b. Reddish-brown, sandy and		
		c. Greenish-grey sandy clay } 3 to 6 ins. ..	0	4
	6.	Bituminous Clay		
		(*Beds 7 to* 13, *incl., absent*).		
	14.	Lower *Nerinæa*-Bed. *a.* Sandstone, very hard, calcareous; *Perna oxoniensis* Paris, *P. mytiloides*, *Mytilus*, *Camptonectes lens* (Sow.), *Volsella imbricata* (Sow.), *Nerinæa* spp., *Rhynchonella concinna*, *Cyathopora bourgeti* (Defr.), etc.: 0 to	0	3
		b. Limestone, greyish-white, rubbly, mixed with some marl; *Perna oxoniensis*, *Grammatodon* sp., *Tancredia* cf. *angulata* Lyc., *Ataphrus labadyei* (d'Arch), etc.	0	6
		(*Beds* 15, *the Astarte-Bed,* 16, *the Exelissa-Limestone,* 17, 18 *the Perna-Bed, and* 19 *absent*).		
	19.	Clay, greenish-grey, marly with small concretions that weather into soft calcium carbonate, passing down into	0	6
	20.	Clay, black (weathering bluish-grey): about..	0	8
Swerford Beds	2.	[?Horizon of Plant-Bed]. Limestone-layers graduating into brown sandstones with intervening layers of marly sand and clay, weathering to a cream colour on the surface	1	6
	3 to 11	Limestones, massive, sandy	7	0
"Old Man"	12.	Limestone, massive	1	4
Hook-Norton Beds	13 to 18.	Limestones, fairly well bedded, brown and sandy, with a tendency to become reduced to a yellow sand: seen	4	0

Charlbury-Road Quarry, Enstone.—In this quarry (33) the pale-coloured marls 19 and black clay 20 are seen at the top with the Lower *Nerinæa*-Bed puzzlingly intermingled. Below are the Chipping-Norton Limestones with at from 2 to 3 feet down a "shelly-bed," and at 9 feet down a fairly massive bed, one foot thick, which is probably on the horizon of the "Old Man." Below are limestones with "wavy" surfaces. Large stretches of these were exposed in the floor of the quarry, and are reminiscent of the waterworn surfaces of the Sully Beds at Lavernock, near Cardiff. The beds probably correspond to the Hook-Norton Beds, which at Great Tew are so sandy.

Chipping-Norton Limestone is exposed in the quarries numbered 34 and 35.

DITCHLEY-ROAD QUARRY, CHARLBURY.—This quarry (36) has been considerably worked since Mr Walford published his brief description of it (pages 23 and 24 of his paper). The Upper and Lower *Placunopsis*-Beds (*i.e.*, beds 5 and 19-20 respectively) can be made out, but at the time of my visit, there was only a 4-inch bed of black and brown clay parting them. An *Ostrea*-Clay occurs above the Upper *Placunopsis*-Bed, and is succeeded by limestone, which is several feet in thickness. According to Mr Walford "black clays with [an] oyster bed at [their] base" and 1 ft. 5½ ins, thick come above this limestone and are succeeded by the *Rhynchonella*-Bed of the Great Oolite.

HAWK-STONE QUARRY, DEAN.—This quarry (37) displays some most interesting beds, full of large gastropods. As far as can be seen they constitute a local modification of the top-portion of the Chipping-Norton Limestone.

HAWK-STONE QUARRY, DEAN

			Thickness in feet	ins
Neæran Beds	19 & 20	Clay, dirty greenish and brown at the base, with inclusions of "sooty" clay: *Placunopsis socialis* ..		
Chipping Norton Lime-stone	*a.*	Upper Gastropod Limestone. Limestone very hard, white; large gastropods (? *Pseudomelaniæ*): about	1	0
	b.	Limestone, hard, white, with numerous small specks of calcite which weather in relief: 6 ins. to 1 ft...	0	9
	c.	Marl, bluish-grey: 4 to 8 ins.	0	8
	d.	Limestone, white	0	8
	e.	Lower Gastropod Limestone. Limestone, hard, brownish; large gastropods	1	7
		Limestone, fairly massive: seen	8	0

EAST-END QUARRY, CHADLINGTON.—The following is the succession in this quarry (38):

EAST-END QUARRY, CHADLINGTON

			Thickness in feet	ins.
Great Oolite		Limestones		
	2.	Clay, dirty-yellow and greenish-grey; *Ostrea* (common), [*Rhyn. concinna* not found *in situ*] ..		
	Cf.S.S.	Limestone, hard, greyish brown, fissile in places; nether surface very level: about..	4	8
		(*Beds* 3 *to* 18, *incl., absent*).		

EAST-END QUARRY, CHADLINGTON—*continued.*

			Thickness in feet	ins.
Neæran Beds	19.	Yellow sand with some "films" of greenish clay: 0 to	0	3
	20.	Reddish-brown sand: 0 to 2 ins.	0	1
		Black sooty clay: 0 to 2 ins.	0	1
		Lower *Placunopsis*-Bed. Reddish-brown or chocolate-coloured marly clay, with occasional seams of sand; *P. socialis* very abundant: 0 to 6 ins. ..	0	3
		(*These Neæran Beds rest upon a very uneven surface of the underlying limestones, and in places are absent, the bed marked "Cf. S.S.* [*Compare Stonesfield Slate*]*" then resting directly upon the Chipping-Norton Limestone*).		
Chipping-Norton Limestone	*a.*	Upper Gastropod Limestone. Limestone, creamy-white and brown, full of large gastropods as at the Hawk-Stone Quarry. Very irregularly-developed: about	1	0
		(*Beds b, c, d and e of the Hawk-Stone Quarry absent*).		
		Limestones, very much disturbed	8	0

The Upper Gastropod Limestone may be on the horizon of the Plant-Bed.

The two quarries (39) and (40) near Barter's-Hill Farm are in the Chipping-Norton Limestone.

Barter's-Hill-Camp Quarry.— Here (41) about 15 feet of limestone is exposed. At the base are massive limestones, then comes the "Knotty-Bed" (= "Old Man"), and this is followed by less-massive limestones that have a shelly-bed at 2 feet above the top of the Knotty-Bed.

Lyneham-Barrow Quarry.—Beds similar to those seen in the last quarry are exposed here (42). The limestones *below* the Knotty-Bed are very massive, and have a tendency to fissure vertically. Those *above* comprise false-bedded and flaggy limestones, which may be on the horizon of the Gastropod Limestones and associated deposits of the Hawk-Stone and East-End Quarries, with a rather white limestone on top. Upon this stratum rests all that represents the Neæran Beds—a layer of clay (bed 19) overlaying reddish-brown sand (bed 20), which together measure 4 inches in thickness. Above these deposits come 5 feet of Great-Oolite limestones, which contain not infrequently fish-teeth, such as *Mesodon*, which are not uncommon in the true Stonesfield Slate at Stonesfield.

LYNEHAM-BARROW QUARRY 2.—In the quarry numbered (43), most of the limestone exposed is Chipping-Norton Limestone. At the extreme north-west corner, however, are later beds. They comprise, in ascending order, marl with *Placunopsis socialis* M. & L. abundant, overlain by brown and bluish clays with sandy patches and "sooty" (wood) inclusions (beds 19 and 20), and then pale yellow marl and stone 8 inches thick (bed 18), which adheres to the base of Great-Oolite limestones similar to those exposed in the preceding section (42).

The 8-inch bed is important. It is in part of remanié nature, containing *Strophodus magnus* Ag., *Homomya*, *Ostrea*, *Trigonia*, *Perna*, *Rhynchonella*, etc. The occurrence of specimens of *Perna* is important, because it shows that the marls with *Placunopsis* below are on the horizon of the Lower *Placunopsis*-Bed.

CASTLE-BARN QUARRY.—This section (44) is best known in connection with the *Viviparus*-Marl[1] which is replete with specimens of *Viviparus langtonensis* (Hudleston).

No. 44. CASTLE-BARN QUARRY

			Thickness in feet	ins.
		Prominent bed of irregularly-fissile, oolitic, shelly limestone: seen	2	0
		Ostrea-Bed. Marl, dirty yellow, and dark clay: *Ostrea*	0	6
		Limestone, sparsely-oolitic, flaggy-bedded, except at the bottom where there is a massive bed (1 ft. 3 ins.) splitting on exposure into a rough tilestone (*cf.* Stonesfield Slate). The under surface is irregular and has pebbles embedded in it	5	6
		(*Non-sequence*).		
Neæran Beds	11.	*Viviparus*-Marl. Marl, white, indurated, sparsely-oolitic; full of specimens of *Viviparus langtonensis* (Hudl.), passing down into a brownish-white marl (8 ins.) with which is associated greenish clay	1	8
		(*Beds 12 to 20, incl., absent*).		
Chipping-Norton Limestone	2 to 11	Limestone, brown oolitic, more massive at the base	6	6
	12.	Limestone, very hard, "knotty"	1	0
	13 to ?	Limestones, massive, with sandy partings: seen ..	6	0

In quarry 45 there is a trace of greenish clay belonging to the Neæran Beds, as at Padley's Quarry, resting upon oolite, whose granules have been separated by dissolution to resemble a marl-deposit at a distance, and soft enough for rabbits to burrow in. Below are more massive limestones.

1 H. B. Woodward "The Jurassic Rocks of Britain," vol. iv. (1894), p. 153.

Quarry east of Sarsgrove.—In this quarry (46), as Mr Woodward has remarked, "some of the layers [of the Chipping-Norton Limestone]. . are remarkably false-bedded."[1]

Quarry west of Chadlington-Down Farm.—The section in this quarry (47) has been referred to by Mr Woodward, who has given a sketch of a portion of the quarry-face and a brief record of the beds exposed.[2]

QUARRY SOUTH-WEST OF CHADLINGTON-DOWN FARM

			Thickness in feet	ins.
Neæran Beds.	19 & 20.	Brown clayey subsoil at the western end	0	9
Chipping-Norton Limestone	a.	Limestone, close-grained, flaggy, sparsely-oolitic	2	0[3]
	b.	Limestone, hard, white, with specks of calcite weathering in relief	0	8[3]
	c.	Marl, whitish-grey,[4] passing down into hard brownish clays with yellow sand, and lumps of hard sandy limestone (= Bed 3 of Mr Woodward's record) intimately associated with the top-bed of..	1	2
		Limestones: seen	10	0[5]

A quarter of a mile south of Chadlington-Down Farm are two quarries (48) in which much the same beds are exposed as in quarry 47. In the western one of the two, about 4 feet of Chipping-Norton Limestone is exposed, then a marly zone to poorly represent bed *c* in the preceding section, with a dense white limestone with numerous specks of calcite, which weather in relief (1 ft. 6 ins.) to represent bed *b* of that section; while on top comes 2 feet of whitish limestone.

About a mile due west of Chadlington-Down Farm are two quarries. The first (49) is abandoned; but the second (50) is in work. In it about 18 feet of Chipping-Norton Limestone is exposed, and here and there at the top, and often filling in large fissures, are remains of the same type of Neæran Beds as at Padley's Quarry, pieces of the *Placunopsis*-Marl being especially noticeable; while here and there pieces of marl with oysters—indicative of the *Ostrea*-Marl of that section—occur.

1 "The Jurassic Rocks of Britain, etc." vol. iv. (1894), p. 153.
2 *Ibid*, pp. 152-153. 3 = Bed 6 of Woodward. 4 = Bed 4 of H. B. W.
5 = Beds 1 and 2 of H. B. W.

BOULTER'S-BARN QUARRY, CHURCHILL.—In this quarry the Chipping-Norton Limestones differ somewhat from their usual aspect.

No. 51. BOULTER'S-BARN QUARRY

		Thickness in feet	ins.
	Soil in places clayey, with a few *Ostreæ*.		
Chipping-Norton Limestone	Limestone more or less flaggy as in the sections in the north-eastern portion of the district: seen	2	0
	Limestones, hard, with numerous pebbles of oolite and occasionally of quartz; *Nerinæa* spp.	1	0
	Limestones	10	0
	Brownish rubbly stone and marl; *Ostrea sowerbyi* M. & L., *O.* cf. *subrugulosa* M. & L. and *Alectryonia costata* (Sow.)	0	6
	Limestone: seen	2	0

Typical *Clypeus*-Grit is occasionally seen in the road-banks between this quarry and Churchill (*vide* map, figure 1).

PADLEY'S OR THE CETIOSAURUS QUARRY, CHIPPING NORTON.—This classic quarry (52) is situated in the part of Chipping Norton called "Tite's End"; but now the once vast quarry is practically abandoned, and cottage-gardens are sheltered in its welcome depression. Now, this part of Chipping Norton is better known as "The Quarry."

The following details were obtained at the extreme southern end of the quarry.

No. 52. PADLEY'S QUARRY, CHIPPING NORTON

			Thickness in feet	ins.
		Limestone, coarse, oolitic, shelly with a tendency to become flaggy at the base. The bottom-layer, as at the Ditchley-Road Quarry, Charlbury, has an irregular under surface, is intermittent and is mixed up with some chocolate-coloured clay in places. The top-portion of this irregular limestone has occasional gastropods in it, and in the bottom-portion, numerous oysters; *Trigonia pullus* M. & L.: seen 4 to	5	0
Neæran Beds	4. & 5.	*Ostrea*-Clay. Clay, dirty greenish-grey and pale-yellow, crowded with oysters: more clayey at the top and marly below; *Placunopsis socialis* M. & L., *Serpula*, pentacrinoid ossicles and echinoid-radioles	1	6
		Clay, tough, greenish, irregular; bones of *Cetiosaurus*: 0 to 9 ins.	0	4
		[*Position of bed* 11 *of Castle-Barn Quarry*]		
	19 & 20.	Marl, pale-yellow, with "race"; *P. socialis* M. & L., abundant: 0 to 6 ins.	0	3
		Shaly, dirty-green, reddish-brown clay with crowds of *Placunopsis socialis* M. & L. ..	0	3
		Clay, tough, greenish-brown	0	4
		Limestone, rotten, often reduced to white carbonate of lime: 0 to 2 ins.	0	2
		Yellowish sand and clay, intimately associated with the irregular sandy limestone-top of the beds below	0	8
Chipping-Norton Limestone		Limestones: seen	12	0

This section has been briefly described by Hudleston[1] and the top-bed of the above record corresponds to his bed A; 19 and 20 to his bed B, together with his "variable line of loose reddish sand"; and the top-layer of the Chipping-Norton Limestone to his bed C. Mr H. B. Woodward has also given a record,[2] which in the main, agrees with the above; but he records the remains of *Cetiosaurus*[3] from the deposit in his section that corresponds to beds 19 and 20 in the above record.

The Chipping-Norton Limestone is well displayed in a quarry near the Workhouse (53) and has been worked at Over Norton and other places in the immediate neighbourhood. It is poorly exposed at the top of the bank in the deep cutting (55) on the way to Langton Bridge, where Windoes identified the *Clypeus*-Grit "and the probable equivalents of [Walford's blocks] C and D" below it.[4]

LANGTON-BRIDGE RAILWAY CUTTING.—The section here (56) has been described in detail by T. Beesley;[5] a somewhat clearer record has been published by Hudleston;[6] and additional details have been given by Mr Walford (pp. 15-16).[7]

No. 56. LANGTON-BRIDGE RAILWAY-CUTTING

			Thickness in feet	ins.
	[1].	Great Oolite marls and limestones with a bed of fissile sandy limestone at the base	74	0
		T. Beesley records that the lowest of these beds is a pale grey clay with *Ostrea sowerbyi* and *Rhynchonella concinna*, 2 feet		
	[2].	Limestone, compact grey crystalline and shelly ..	3	8
	[3].	Grey marl with *Pteroperna*, oysters and gastropods ..	1	8
	[4].	Neæran Slate. A fissile limestone with *Neæra ibbetsoni*	0	4
	[5].	Marl, shelly and sandy	0	2
	[6].	Clay, grey, rather sandy at the base, with *Ataphrus, Isastræa* sp.	0	6
6	[7].	Bituminous Clay. Black, but lighter in the lower part: 3 feet thick according to Hudleston: average ..	1	6
		(*Beds 7 to 10 incl. absent*).		
11	[8]	*Viviparus*-Marl. Grey mortar-like limestone (= sticky, marly clay with small *Ostrea*, etc. of Hudleston's record, 2 ft. 7 ins.); *Nerinæa, Viviparus langtonensis* (Hudl.)	3	0
20	[9].	Red Sand	4	0
C.N.L.	[10-13].	Limestones, fawn-coloured, siliceous: seen ..	16	6

1 Proc. Geol. Assoc., vol. v., No. 7 (1878), pp. 384-385.
2 "The Jurassic Rocks of Britain, etc.," vol. iv. (1894), p. 327.
3 See also Owen, Proc. Geol. Soc., vol. iii., p. 457.
4 Quart. Journ. Geol. Soc., vol. xxxix. (1883), p. 236.
5 Proc. Geol. Assoc., vol. v., No. 4 (1877), pp. 178-180.
6 *Ibid.*, No. 7 (1878), pp. 379-381.
7 Also Quart. Journ. Geol. Soc., vol. xxxix (1883), p. 234.

The numbers in square brackets refer to Mr Walford's record (pp. 15-17). Beds 2 to 6 = beds 14 and 15 of Beesley's record; bed 7, his bed 16; and beds 8 and 9, Beesley's bed 17, but the measurements and descriptions vary considerably. Beesley thought that the red sand [9] passed horizontally into the *Viviparus*-Marl [8]; but I have little doubt that Mr Walford's arrangement is right, as the beds then come into line with similar deposits elsewhere. Hudleston's record agrees generally with Mr Walford's; but he would regard bed [2] as more closely related to the overlying Great Oolite than to what Mr Walford calls the Neæran Beds. Mr Walford regards the *Viviparus* [*Paludina*] -Marl here as equivalent to the *Viviparus*-Marl of Sharp's Hill, and therefore assigns beds [2] to [7], inclusive, to a position between the *Viviparus*-Marl and Bituminous Clay at Sharp's Hill.

The irregular thickness of the red sand at Langton Bridge reminds one of the similar and yet more irregular deposit in the quarry near Stow-on-the-Wold.[1] The Oxfordshire sections might give the impression that the deposit was mainly derived from the dissolution of the immediate subjacent sandy Chipping-Norton Limestones; but that near Stow shows that it was an independent irregular accumulation, as it there rests directly upon ordinary oolitic limestones.

The quarry numbered 58 is in Chipping-Norton Limestone. The upper beds are much shattered; the lower are black-speckled and somewhat iron-stained. Other quarries in this Limestone are those numbered 59, 60, 61 and 62.

OAKHAM QUARRY.— In this quarry (63) the Chipping-Norton Limestone is an oölitic, somewhat sandy limestone, with occasional oysters and shell-fragments and pebbles. Some very large blocks of stone can be obtained; but the beds are generally much fissured, and into these large openings clay has been introduced from above.

A greenish clay is the most noticeable bed in the quarry. Below it are, here and there, masses of soft calcareous and extremely shelly marl, crowded with specimens of *Placunopsis socialis* M. & L. These deposits are best seen in a kind of trough fault at the south-western corner of the quarry. Here,

1 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 1 (1907), p. 25.

above the green clay, come two beds of very fossiliferous limestone with a median band of brown marl, and above these again, green clay and rubble—the green clay containing whitened oysters.

No. 63. OAKHAM QUARRY

			Thickness in feet	ins.
Neæran Beds	?4. & 5.	Dark purple clayey subsoil. Clay, dirty green and yellowish-blotched, with fragments of whitened oysters : seen	1	0
	12.	Limestone, weathers rubbly, very shelly ; *Ostrea, Quenstedtia, Volsella imbricata* (Sow.) very common, *Pholadomya, Nerinæa* spp., *Nerita pseudocostata* d'Orb., at the base, *Turbo ?burtonensis* Lyc., *Ataphrus labadyei* (d'Arch.)		
	?13.	Marl, brownish ; *Ostrea, Placunopsis socialis* : 6 to 8 ins.	0	5
	14.	Limestone, rubbly shelly ; *Pleuromya, Chlamys vagans* (Sow.), *Grammatodon, Volsella imbricata* (Sow), *Nerinæa, Clypeus mülleri, Strophodus* (tooth), lignite, etc. : average	1	10
		(*Beds* 15 *to* 18 *incl. absent*).		
	19. & 20.	Clay, tough, greenish : average	0	4
		Marl, brown, shelly, and stiff chocolate-coloured clay, often enclosing irregular masses of rotten shelly (*P. socialis*) marl. In places near the base, are masses of brown gritty limestone : 0 to 3 ft.	2	0
C.N.L.		Limestones: plant-remains, *Oppelia fusca* (Qu.)	12	0

This section was first noticed by Hull,[1] who referred all the beds to the Great Oolite. In connection with the deposits numbered 19 and 20, he wrote :

> " The thick bed of marl is very constant over the district, and may again be observed in the quarries in the Moreton Road, as also in a quarry [now overgrown, 69 on map], near the gate of Daylesford Park, which opens into the Cornwell Road, where it is associated with thin bands of sand and gravel."

In the neighbourhood of the Cross-Hands Inn (64, 65, etc.) there are extensive workings in the Chipping-Norton Limestone.

Chastleton-Hill Quarry.—This quarry (66) is on the golf-course, and has been extended in a south-westerly direction in two workings. If the observer enters this quarry and the right-hand extension, he will notice the best section of the beds in the quarry-face on the left ; but, as usual, the beds are very much disturbed. The beds correspond very well with those at the Oakham Quarry and it should be especially noticed that, in the top bed, specimens of *Rhynchonella* and *Terebratula* are common.

1 " The Geology of the Country around Cheltenham " (1857), p. 59 ; see also H. B. Woodward, " The Jurassic Rocks of Britain," vol. iv. (1894), p. 328.

No. 66. CHASTLETON-HILL QUARRY

			Thickness in feet	ins.
		2. *Ostrea-* and *Rhynchonella-Bed.* Greenish-grey clayey marl with *Ostrea; Terebratula, Rhynchonella concinna* auctt. very common, *Trapezium, Pholadomya, Nerinæa*, etc.: about	0	6
		(*Beds* 3 *to* 11, *incl.*, *absent*).		
Neæran Beds		12. Limestone, pale-yellow, rubbly, oolitic; *Ostrea, Trapezium*, etc., and *Nerita pseudocostata* d'Orb., at the base	1	0
		?13. Clay, dark greenish-grey; *Ostrea*	0	3
		14. Limestone, hard, brownish, in two layers. Rather a waterworn top..	2	2
		(*Beds* 15 *to* 18, *incl.*, *absent*).		
	19 & 20	*a.* Marl, pale-yellow: about	0	5
		b. Clay, tough	0	2
		c. Sand, brownish, with limy inclusions at the top. In the other working, in the north-westerly face, the clay-beds (*b* and *d*) are seen enclosing a mass of marl (with *P. socialis*) and conjointly measuring 1 ft. 6 ins across (vertical). The sand is 6 ins. thick in places and is occasionally replaced by chunks of hard brown limestone: 2 to 18 ins.	0	10
		d. Clay, tough, dark: 0 to 2 ins.	0	2
C.N.L.		Limestones; top-bed (? = Plant-Bed) very hard and gritty: seen	12	0

FREEBENCH QUARRY.—In this quarry (67) about 15 feet of black-speckled Chipping-Norton Limestone is exposed, and while some of the beds are close-grained and non-oolitic, others are decidedly oolitic.

POINTED-HEATH QUARRY.—The beds above the Chipping-Norton Limestone in this quarry (68) are very much disturbed.

No. 68. POINTED-HEATH QUARRY

			Thickness in feet	ins.
Neæran Beds		14. Lower *Nerinæa*-Bed. Limestone, pale pinkish-brown, shelly, rather fissile and ofttimes sandy; *Nerinæa* spp. common *Gervillia ornata* Lyc. non Moore: seen about	1	0
	19 & 20.	Marl, pale-green; *Nerinaeæ* not uncommon, *Ostrea acuminata* Sow., *Perna mytiloides*	0	6
		Clay, very tough, dark-brown..	0	3
		Limestone very hard, gritty, pinkish-brown and bluish, shelly. On top of it, and separated therefrom by a thin layer of clay, is a band of limestone, largely composed of specimens of *P. socialis* (1 inch) ..	0	6
		Sand, yellow	0	1
		Clay, tough, dark-brown	0	5
		Marl, greenish-grey mixed with white rubble ..	0	6
C.N.L.		Limestones, with black-specks and more definite plant-remains: seen	10	0

The prominent bed of limestone in 19-20 and the richness of bed 14 in gastropods are the most noteworthy features of this section. The faunal and lithic characters of the Lower *Nerinaea*-Bed are precisely the same as those of the equivalent bed in the quarry near Lower Swell, near Stow-on-the-Wold.

Whitequarry-Hill Quarry.—This quarry (73) is now abandoned, but the Chipping-Norton Limestone and marly oolites and clays of the Neæran Beds are exposed, although often puzzlingly intermingled.

No. 73. WHITEQUARRY-HILL QUARRY

			Thickness in feet	ins.
		Limestone, white, well-oolitic, with occasional pieces of lignite and tubular infillings; *Ostrea*: seen ..	3	0
	2	*Rhynchonella*- and *Ostrea-Bed*. Marl and marly stone, pale-yellow; *Ostrea*, *Rhyn. concinna*, auctt., *Terebratula*, *Trapezium*, etc.: average	0	6
Neæran Beds	? parts of 3,4 and 5	*Ostrea-Clay*. Clay, tough, dark-brown; *Ostrea* very abundant in the upper portion	0	5
Neæran Beds		(*Beds 6 to 11, incl., absent*).		
Neæran Beds	12.	Marl, brown, sandy, intimately associated with the bed below; *Ostrea* very common: 4 to 6 ins.	0	5
Neæran Beds		Limestone, rubbly; *Homomya vezelayi* (Lajoye), *Ostrea*, *Trigonia costata*, *Volsella sowerbyana* (d'Orb.) ..	0	10
Neæran Beds	? 13.	Similarly-coloured shaly marl and rubble; *Ostrea* ..	0	5
Neæran Beds	14.	Limestone, often massive-bedded; *Clypeus mülleri* Wr.	2	0
Neæran Beds	19 & 20.	Greenish clayey marl, often preponderating, passing down into .. .. Brown clayey, sandy marl, and this into .. .. Brown sand .. .. Purplish clay, with *Placunopsis socialis* .. .. Brown sand with lumps of limestone	1	0
C.N.L.		Limestone (with waterworn surface) flaggy, oolitic: seen	8	0

Below the Chipping-Norton Limestone is the *Clypeus*-Grit. Typical pieces of rock of this subdivision can be picked up at the spring near Hill Farm, Chastleton, and at the top of the bank above that at Cornwell (70).

Below the *Clypeus*-Grit at Cornwell is a thin representative of the *Amusium-personatum*-Limestones of the Pea-Grit Series, and below these again, the *Scissum*-Beds. The *Scissum*-Beds are best seen in a small way-side section near the spring (at 72), and have yielded the usual fossils—*Rhyn. subdecorata*, Dav., *Pholadomya fidicula*, Sow., *Volsella sowerbyana* (d'Orb.), etc.

Oddington Stone Quarries

On the hill between Oddington and Stow are several quarries, but only one " in work," and this is situated a little to the south-west of the old windmill. The beds are extraordinarily disturbed, and this, combined with quarrying operations, renders it impossible to identify the same section at two consecutive visits if they are separated by any length of time.

The following record, I have little doubt, sets forth the true sequence of the beds :

ODDINGTON STONE QUARRY

		Thickness in feet	inches
	Reddish soil with small Northern-Drift Pebbles		
	Limestones, hard, sparsely-oolitic, somewhat flaggy, brownish, shelly, *Ostrea* being the most abundant fossil	*Several feet*	
Rhyn.-Isast. Bed	*Rhynchonella-Terebratula-Isastræa*-Bed. Greenish yellow, clayey oolitic marl, passing into almost a shell-bank, and in other places into a shingle. *Isastræa limitata* common, *Rhyn. concinna* auctt., *Terebratula*, *Ostrea*, *Chlamys vagans*, *Exogyra lingulata* (Walton MS.), *Serpula*, etc. Some of the pebbles have oysters and polyzoa attached to them : 1 foot to 1 ft. 6 ins ..	1	3
cf. S.S.	Limestones, brownish, oolitic ; *Ostrea* and shell-fragments : about	5	0
Neæran Beds	Dirty-green, chocolate and yellow and brown clay, with pebbles of dense brown limestone and reddish-brown sand at the base. Some of the pebbles are in the process of being converted into rotten white carbonate of lime. Lignite : up to	1	4
C. N. L.	Limestone, brownish, oolitic with oysters in places and brownish lignite. Thickness not ascertainable ..	6	0+
"Fullers' Earth"	Clay, blackish, tough	0	6
Clypeus-Grit	Limestone, rubbly, coarsely-oolitic to pisolitic, with typical specimens of *Ter. globata* auctt., *Clypeus ploti*, *Grammatodon hirsonensis*, etc. At the top, in places, is a finer-grained bed, in which specimens of *Perna* are extremely abundant along with a large *Camptonectes* : seen, about	4	0

There is no doubt about the identity of the *Clypeus*-Grit ; the " Fullers' Earth " is comparable with that at Great Rissington ; and the Chipping-Norton Limestone is unmistakable. How thick it is, Mr Paris and I were unable to ascertain, but in the Rissington-Burford district, it occurs over a considerable area and is readily recognised by its black specks.

APPENDIX

NEW LAMELLIBRANCHS (GERVILLIA AND PERNA) FROM THE NEÆRAN BEDS

By E. TALBOT PARIS, F.C.S.

[Plate XXVII.]

During my work in connection with the revision of the lamellibranchs from the Lower and Middle Jurassic Rocks of Britain, it has not been found possible to identify certain species of *Gervillia* and *Perna* from the Neæran Beds of the Chipping Norton District with any described forms. Hence they are dealt with in this Appendix.

GERVILLIA ENSTONENSIS sp. nov. Pl. XXVII., fig. 2.

Description (Left valve only,—Left valve moderately convex, with a subovate outline. The hinge-margin is ·73 of the length of the shell (measured parallel to the hinge-line). Anterior and posterior extremities rounded.

Remarks.—From *Gervillia ovata* (Sow.) this species differs in being less elongate, and less curved. The posterior extremity is not so pointed, and the antero-ventral margin is straighter than in that species.

The form identified with *Gervillia ovata* (Sow.) by Morris and Lycett (Monogr. Mollusca Gt. Ool., pt. II., p. 22, and tab. II., figs. 12 and 12*a*) appears to resemble this species. It has, however, a more evenly rounded-ventral margin and a more pointed posterior extremity. The hinge-margin also is slightly concave, whereas in *G. enstonensis* it is straight.

The holotype is from the Fossil-Bed (14) of the Bell-Inn Quarry, Enstone, Oxfordshire.

GERVILLIA RICHARDSONI sp. nov. Pl. XXVII., Figs. 3*a* and *b*.

Description.—A very high subquadrate shell, with a short hinge-margin. The anterior margin is slightly concave, making with the cardinal margin, an apical angle of about 60°. The posterior margin is straight, but curved round at its dorsal end into the cardinal margin—making with it, roughly speaking, an obtuse angle. The hinge-area has about six transverse sulcations, the distance between any two sulcations being equal to the width of one of them.

Remarks.—This species is closely allied to *Gervillia bathonica* Morris and Lycett, but differs therefrom in having a greater apical angle.

The holotype (figured on Pl. XXVII., figs. 3*a* and *b*) is in Mr Richardson's collection and is from the Neæran Beds (probably Bed 18) of Sharp's-Hill Quarry, near Hook Norton, Oxfordshire.

PERNA OXONIENSIS sp. nov. Pl. XXVII., figs. 1*a*, *b*, *c* and *d*.

Description.—Shell with a subtriangular outline; cardinal margin very long, being extended posteriorly to form an acuminate posterior wing. Anterior extremity pointed. The anterior margin is concave immediately below the umbo, making an angle of 60° to 70° with the hinge-line; posterior margin concave.

The shell is inæquivalve, the left valve being more convex than the right especially towards the umbo. The umbo of the right valve is not prominent.

The hinge-area is wide and has five or six deep ligamentary grooves.

Remarks.—The length of the hinge margin, the pointed posterior wing, and the subtriangular form of the shell, distinguishes this species from *Perna rugosa* Münster, *P. rugosa* var. *quadrata* Morris and Lycett, and from *P. mytiloides* Lamarck. The hinge-margin is also relatively longer than in *P. obliqua* Lycett—the latter species being narrower anteriorly and having a narrower hinge-area with more numerous sulcations.

The holotype (Pl. XXVII., figs. 1*a*, *b*, *c*, and *d*) is from the *Perna*-Bed of the Bell-Inn Quarry, Enstone, and is in Mr Richardson's collection.

Photo. E. T. Paris.

LAMELLIBRANCHS FROM THE NEÆRAN BEDS

EXPLANATION OF PLATE XXVII.

Figs. 1*a-d*. *Perna oxoniensis* sp. nov.

1*a* right valve—exterior 1*b* right valve—interior

1*c* left valve—exterior 1*d* left valve—interior

Perna-Bed, Neæran Beds, Bell-Inn Quarry, Enstone, Oxfordshire.

Fig. 2. *Gervillia enstonensis* sp. nov.

Fossil-Bed (14), Neæran Beds, Bell-Inn Quarry, Enstone.

Figs. 3*a* and *b*. *Gervillia richardsoni* sp. nov.

Bed 18 (probably), Neæran Beds, Sharp's Hill Quarry, near Hook Norton, Oxfordshire.

All the specimens are in Mr L. Richardson's collection. The figures are ·95 *natural size.*

NOTES ON SOME SPECIES OF GERVILLIA FROM THE LOWER AND MIDDLE JURASSIC ROCKS OF GLOUCESTERSHIRE[1]

By E. TALBOT PARIS, F.C.S.

[Plates XXVIII.-XXIX.]

I. INTRODUCTION

During the progress of my work in connection with the revision of the lamellibranchs from the Lower and Middle Jurassic rocks[2] of Gloucestershire, a considerable amount of useful information concerning certain species of the Genus *Gervillia* has been obtained, which it appears desirable to record in the Proceedings of the Club.

All the specimens referred to in this paper are in Mr Richardson's collection, unless otherwise stated. His collection has been mainly studied because it appeared desirable to be sure of the horizons from which the specimens were obtained.

The Genus *Gervillia* belongs to the family Pernidæ, Zittel. The Pernidæ altogether embrace seven genera. Of these, one (*Bakewellia*) is found only in Permian deposits, another (*Odontoperna*) occurs only in the Trias, and another (*Crenatula*) does not definitely make its appearance until the Cretaceous period. The remaining four (*Gervillia, Perna, Pernostrea* and *Inoceramus*) are known to occur in Jurassic rocks, but the Lower and Middle Jurassic rocks of Gloucestershire have yielded representatives of only three, namely, *Gervillia, Perna* and *Inoceramus*.

1 I have to acknowledge my indebtedness to the Government Grant Committee of the Royal Society for assistance towards acquiring the information contained in this paper and figuring the specimens.

2 As defined by Mr A. J. Jukes-Browne in "The Students' Handbook of Stratigraphical Geology."

Gervillia and *Perna* range upwards from the Trias, and where they are first found in the Lias already possess well-marked generic characters. *Inoceramus*, on the other hand, makes its first appearance in the Lower Lias, and some of the forms which occur at that horizon differ somewhat from the typical examples of the genus which are found in Cretaceous rocks. Some of them exhibit a strong resemblance to *Perna*, which is probably the parent-genus.

Owing to the fact that the classification of this group of shells is based primarily on the characters of the cardinal area, it is frequently a matter of difficulty to assign any particular form to its proper genus. For it is only in exceptional cases that the hinge-area is exhibited, and when it is not, the general form of the shell has to be used as a guide.

Below is given, in tabular form, a summary of the chief characters of each of the three genera, *Gervillia*, *Perna* and *Inoceramus*.

Genus	Ligament	Dentition	General Form, etc.
Gervillia, Defr.	Usually four or five ligamentary sulcations in hinge-area.	Generally two or three teeth, obliquely placed, but sometimes these are represented only by obscure dental ridges.	The shell, as a rule, is much more elongate than either *Perna* or *Inoceramus*.
Perna, Brug.	As in *Gervillia*, but the sulcations are often *more pronounced.*	Edentulous.	Usually of a subquadrate form.
Inoceramus, Sow.	Ligamentary sulcations *smaller & more numerous* than in *Perna* or *Gervillia*.	Edentulous.	Generally of a more rounded appearance than *Perna*.

TABLE I.—SPECIES OF *GERVILLIA* FROM GLOUCESTERSHIRE NOTICED IN THIS PAPER

Name of Species	*Horizon or hemera*
Gervillia aurita Lycett	*bradfordensis.*
G. bathonica Morris and Lycett	Great Oolite
G. bicostata Lyc.	Great Oolite.
G. compressa Whidborne	*bradfordensis.*
G. coriniensis sp. nov.	Forest Marble
G. crassa J. Buckman	*turneri* or *obtusi, oxynoti*
G. crassicosta M. & L.	Great Oolite
G. fornicata Lyc.	*variabilis* and *moorei*
G. lævis J. Buckman	*striati-capricornus*
G. lata Phillips	*murchisonæ*
G. monotis Eudes-Deslongchamps	Great Oolite
G. "ornata" Lyc.	Great Oolite
G. prælonga Lyc.	*discitæ, post-discitæ, witchelliæ* and *truellei.*
G. subcylindrica M. & L.	Great Oolite
G. tortuosa (Sowerby)	*murchisonæ, concavi, discitæ* or *post-discitæ.*
G. waltoni Lyc.	Great Oolite and Forest Marble.
G. whidbornei nom. nov.	*variabilis, ?concavi, discitæ* and *post-discitæ*

So far, seventeen species belonging to *Gervillia* have been recognised in Gloucestershire, one of which is new. Of these seventeen species, the Lias has yielded four, the Inferior Oolite six (one common to Lias and Oolite), and the Great Oolite series eight.

In order to secure the correct identification of the species most of the type-specimens have been examined. Through the courtesy of the curators, I have been permitted to borrow the type-specimens of *Gervillia* from the Geological Survey Museum, York Museum, Bath Museum, and the Sedgwick Museum, Cambridge. In each case the types have been photographed and measured, and the matrix of the specimen carefully examined with a view to ascertaining the exact horizon from which the specimen was obtained. Fortunately, many of the types are from localities in Gloucestershire, and are preserved in matrices which have been readily identified by Mr Richardson.

A complete list of the species examined and the dates of their existence are given on Table I., and both there and in the following notes, the species are arranged alphabetically.

R2

GERVILLIA AURITA Lycett. Pl. XXIX, Fig. 6.

Type-description (*T.d.*) 1853. Proc. Cottesw. Nat. F.C., vol. i., p. 82.
Type-figure (*T.f.*) *Ibid.*, pl. II., Fig. 4.
Type-locality (*T.l.*) "Nailsworth, Gloucestershire."
Horizon (*H.*) "Inferior Oolite" [Aalenian].
Hemera ($\hat{\eta}$). [*bradfordensis.*]
Collection (*Colln.*) Museum of Practical Geology, Jermyn Street, London. [Reg. No. 8862.]

Type-description.—"*Gervillia aurita*: equivalve, smooth, very oblique, both the auricles very much extended and acuminated, the entire figure being very slender."

Remarks.—The label attached to the type-specimen gives the locality as "Nailsworth," which is close to Minchinhampton. The matrix of the specimen, a white oolitic limestone, shows that it could only have come from the Aalenian at that locality. In his list of species from the Oolite Marl, Lycett ("Cotteswold Hills," 1857, p. 56) records *G. aurita*, and mentions it from no other horizon. Probably the specimen is from the local *Nerinæa*-Bed (Oolite Marl) of the old Scar-Hill Quarry, Nailsworth, whence Lycett obtained so many lamellibranchs (*vide* L. Richardson, Proc. Cottesw. Nat. F.C., vol. xvii., pt. I., 1910, p. 131.)

Records.—The only record is that of the holotype from the *bradfordensis* deposits of Nailsworth.

GERVILLIA BATHONICA Morris and Lycett.

T.d. 1853. Monogr. Moll. Gt. Ool., pt. II, pp. 21-22. Pal. Soc.
T.f. *Ibid.*, tab II., fig. 15.
T.l. "Minchinhampton [near Stroud, Gloucestershire]."
H. "Great Oolite." [Bathonian]
$\hat{\eta}$. ["*maxillatæ.*"]
Colln. ——
1882. *Gervillia bathonica* M. and L., E. Witchell, Geol. of Stroud, p. 80, pl. 2, fig. 8.

Record.—Great Oolite, Minchinhampton Common near Stroud.

GERVILLIA BICOSTATA Lycett.

Td.. 1863. Suppl. Monogr. Moll. Gt. Ool., pp. 111-112. Pal. Soc.
T.f. *Ibid.*, tab. XL., fig. 21.
T.l. "Bussage, near Bisley [near Stroud]."
H. "Great Oolite." [Bathonian]
. ["*maxillatæ*."]
Colln. ——

Record.—The holotype appears to be unique.

GERVILLIA COMPRESSA Whidborne. Pl. XXIX., Fig. 5

T.d. 1883. Quart. Journ. Geol. Soc., vol. xxxix., p. 517.
T.f. *Ibid.*, pl. xvi., fig. 6.
T.l. "Nailsworth, Gloucestershire."
H. "Inferior Oolite." [Aalenian]
η̂. [*bradfordensis*]
Colln. Mus. Pract. Geol., Jermyn Street. [8863].

Remarks.—The holotype of *Gervillia compressa* is labelled "*Gervillia lata* Phill. I.O. Nailsworth." Probably this was Lycett's identification of the species. The matrix is a white oolitic freestone and is evidence that the specimen was obtained from either the *Bradfordensis*-Beds or the Lower Freestone at Nailsworth—probably from the old Scar Hill Quarry.

Compared with *Gervillia lata* Phillips, this species is more elongate, and has a relatively shorter hinge-line. *G. lata*, moreover, does not possess the marked, slightly concave carina, extending from the umbo to the posterior extremity of the shell; nor is it so flattened along the antero-ventral border.

The statement in Whidborne's description that the hinge-line of *G. compressa* is "nearly of the same length as the shell" is inaccurate, even when it is remembered that the so-called "length of the shell" in his description is what is now called the "height." The following measurements have been taken from the holotype. Length (measured parallel to the hinge-line), 67 mm.; height (measured at right angles to the hinge-line), 37 mm.; length of the hinge-margin, 48 mm.

Record.—*Bradfordensis*-Beds or Lower Freestone, Nailsworth, Gloucestershire.

GERVILLIA CORINIENSIS sp. nov. Pl. XXIX., figs. 1*a* & *b*.

T.l. Quarry one mile W.S.W. of Siddington St. Peter, near Cirencester, Gloucestershire.

H. Forest Marble. Bathonian.

Colln. L. Richardson.

Description (*left valve*).—A *Gervillia* characterized by seven transverse costæ. The shell is elongate, tapers posteriorly, and has a concave postero-dorsal margin. The cardinal margin is produced posteriorly and is approximately ·6 of the length of the shell.

The hinge-area is large for the size of the shell and is traversed by three oblong ligamentary sulcations. The test is thick.

Measurements.—Length, 78 mm.; height, about 33 mm.; length of the hinge margin, ?46 mm.

Remarks.—This species differs from *Gervillia crassicosta* Morris and Lycett, in having fewer ribs, no secondary ribbing, and in being more elongate.

GERVILLIA CRASSA James Buckman (*ex* Strickland MS.) Pl. XXVIII., figs. 1*a*, *b*, *c*, and *d*.

T.d. 1844. "An Outline of the Geology of Cheltenham," 2nd ed., Appendix, p. 98.

T.f. *Ibid.*, tab. 10, fig. 9.

T.l. "Railway-cutting in several places between Gloucester and Bredon."

H. "Lias." [? Top of Sinemurian]

$\hat{\eta}$. [? *obtusi-stellaris*]

Colln. Mus. Pract. Geol., Jermyn Street, London. [3684].

Type-description.—"Hinge-line a little more than half the length of the shell, teeth few, shell thick, very rugose."

Remarks.—The species differs from *Gervillia lævis* in being proportionately higher, in having a more sinuous antero-ventral margin and a more concave postero-dorsal margin, and in being more rounded at the posterior extremity.

Gervillia hagenowii Dunker[1] resembles this species. It may be distinguished therefrom by the antero-ventral margin, which, in *G. hagenowii* descends from the umbo for about half the length of the shell at an angle of approximately 50° with the hinge-line. In *G. crassa*, the antero-ventral margin makes an angle of from 60° to 70° with the hinge-line. This gives *G. crassa* a more quadrate appearance, and makes its anterior end less acuminate than in *G. hagenowii*.

1 Ueber die in dem Lias bei Halberstadt vorkommenden Versteinerungen (1851), pp. 37-38, tab. vi., figs. 9-11.

The syntypes, of which there are two, are in Jermyn Street Museum (Nos. 3684 and 25177). They are from the " Lias, Railway cutting . . . between Gloucester and Bredon." No. 3684 is the specimen figured by Buckman and may be taken as the lectotype.

Owing to the indefiniteness of the locality given, it is impossible to determine the exact horizon of the beds from which these specimens were obtained. It may be stated, however, that probably the highest beds exposed during the construction of the railway (Midland) between Gloucester and Bredon were *armatum*-beds, and it is improbable that there were any seen of earlier date than *turneri*. Moreover, James Buckman on page 84 (*loc. cit. supra*) definitely gives Bredon as one of the localities at which this species was found, and it is known that the cutting at Bredon Station is in beds of about *obtusi-stellaris* hemeræ.

Records.—Apart from the type-specimens only one other record of this species has come under my notice, namely that of a left valve from the beds of *oxynoti-armati* hemerae at Gloucester Gas-works.

GERVILLIA CRASSICOSTA Morris and Lycett.

T.d. 1853. Monogr. Mollusca Gt. Oolite, pt. II., p. 23. Pal. Soc.
T.f. *Ibid.*, tab. II., fig. 9.
T.l. "Minchinhampton Common, [near Stroud, Gloucestershire]."
H. "Great Oolite." [Bathonian]
$\hat{\eta}$. [" *maxillatæ* "]
Colln. Mus. Pract. Geol., Jermyn Street, London. [9177]

Type-description.—" *Test valde obliquâ elongatâ, convexiusculâ, auriculo antico rotundato, postico truncato et brevi ; costis radiantibus subundatis, elatis majoribus* 8, *alternatim minoribus, et cum striis transversis numerosis, indentatis, latero postico elongato : valvâ dextrâ ignotâ.*

" Shell very oblique, elongated, convex, anterior auricle rounded, posterior auricle short and emarginated ; radiating costæ slightly waved, elevated, the larger, 8 in number, distant, and alternating with as many smaller, and impressed with numerous rather indistinct transverse striæ: posterior and inferior extremity elongated and slightly acuminated; right valve unknown.

" Of this rare species we have only obtained three examples ; the hinge border is much shorter than in *Pteroperna costatula*, the posterior wing being but little produced; the whole contour of the shell is very oblique and the larger costæ are very prominent ; the greater degree of obliquity, convexity and alternation of the costæ readily serve to distinguish it from *P. costatula*."

Record.—The holotype is the only specimen I have seen.

GERVILLIA FORNICATA Lycett. Pl. XXVIII., fig. 3.

T.d. 1857. "The Cotteswold Hills," p. 121.

T.f. [None given by Lycett. Type-figure Pl. XXVIII., fig. 3].

T.l.[1] "Nailsworth, Gloucestershire."

H. "Upper Lias." [Toarcian]

η. [*variabilis*]

Colln. Mus. Pract. Geol., Jermyn Street, London. [25183].

Type-description.—"Shell ovate, hinge line straight, oblique, lengthened; umbones acute, elevated, anterior auricle short, sloping somewhat downwards, dorsal surface very much elevated, and narrow, lines of growth numerous and faintly marked; antero-inferior border slightly sinuated; hinge plate narrow, sulcations numerous, irregular. The right or more flattened valve is unknown.

"*Gervillia glabrata*, Koch and Dunker [Versteinerungen des Norddeutschen Oolithgebildes, 1837, pp. 27-28, tab. II., fig. 1], approximates to this species in figure, but that shell is more elongated, less convex, has a shorter hinge line, and much larger folds of growth. It is rare.

"Position.—The *Cynocephala*-Stage.

"Locality.—Buckholt Wood."

Remarks.—This species is remarkable for the great convexity of the left valve.

Lycett did not figure any example of this species, nor did he mark any specimen as being that upon which he based his description. In the original description, he gives the horizon of his species as the "*Cynocephala*-Stage" and the locality as "Buckholt Wood" (*vide supra*). But there is no specimen in the Lycett Collection at the Museum of Practical Geology, Jermyn Street, from this horizon at this locality. There are, however, two specimens from Nailsworth which were originally in Lycett's possession. On p. 25 of his book "The Cotteswold Hills," he records this species from the "Basement Bed of the *Cynocephala*-Stage" at Nailsworth. This bed, which in the words of Lycett, "is a brown or chocolate coloured argillaceous sandstone," occurs a few feet above the base of the Cotteswold Sands, and Mr Richardson thinks is of about *variabilis* hemera.[2]

So the matter stands thus: the proterotype came from the Cephalopod-Bed (probably that portion which is of *moorei* date) of Buckholt Wood, but cannot now be found. It is described on p. 121 of Lycett's "Cotteswold Hills" Two specimens (idiotypes) are in the Museum of Practical Geology [25182, 25183] which were recorded on page 25 of the same

1 Lycett's type cannot be found, therefore details are given concerning the lectotype.
2 Proc. Cottesw. Nat. F.C., vol. xvii., pt. 1 (1910), p. 127.

work. They are both labelled " *Gervillia fornicata* Lyc., Sands, Nailsworth," but the less well-preserved one, 25182, has, in addition, the item " Handbook p. 121." It should have been " p. 25."

It is proposed to select the better preserved specimen [25183] as the standard of reference for the species. It consists of a left valve (see pl. xxviii., fig. 3), very convex, having a maximum diameter of 11 mm. The antero-ventral margin is almost straight, and makes an angle of 45° with the hinge-line; the postero-dorsal margin is slightly concave. Two obscure, but apparently circular, ligamentary pits can be made out on the hinge behind the umbo.

Only one right valve of the species has been examined. This is on a specimen in Mr Richardson's collection from the Cephalopod-Bed (*moorei*) at Coaley Wood, near Stroud; it is not well exhibited, but appears to be rather less convex than the left valve.

Gervillia oblonga Moore (Proc. Somerset. Archæol. and Nat. Hist. Soc., vol. xiii., 1867, p. 216, pl. 7, fig. 11) appears from the figure to be closely related to *G. fornicata*.

Records.—*Variabilis*-Beds, Hartley Cottages well, Leckhampton Hill, Cheltenham (L. R.—bed 5, Geol. Mag., 1910, p. 103); *Variabilis*-Beds, Nailsworth (idiotype locality); Cephalopod-Bed (*moorei*), Coaley Wood, near Dursley (L. R.; Proc. Cottesw. Nat. F. C., vol. xiii., pt. 1, 1910, p. 115).

GERVILLIA ISLIPENSIS Lycett. Pl. XXIX., fig. 4.

T.d. 1863. Lycett, Suppl. Monogr. Moll. Gt. Ool., p. 37.
T.f. *Ibid.*, tab. XL., fig. 35.
T.l. " Stonesfield, Oxfordshire."
H. " Stonesfield Slate." [Bathonian]
ή. [*gracilis*]
Colln. Mus. Pract. Geol., Jermyn Street, London. [9179].

Remarks.—This fossil is poorly preserved and probably came from one of the softer layers associated with the Stonesfield Slate-series. Lycett records it also from the Cornbrash of Islip, Oxfordshire, but this specimen appears to be lost.

This species is mentioned here because it should be found in the basal Great Oolite of Gloucestershire and better preserved specimens are desired.

GERVILLIA LÆVIS James Buckman. Pl. XXVIII., figs. *2a*, *b*.

T.d. 1844. "An Outline of the Geology of Cheltenham," 2nd ed., Appendix, p. 98.

T.f. *Ibid.*, tab. 10, fig. 8.

T.l. "Foot of Battledown Hill, Hewlett's Road [Cheltenham, Gloucestershire]."

H. "[Lower] Lias." [Pliensbachian]

η. [*striati*]

Colln. Mus. Pract. Geol., Jermyn Street London. [3683].

1904. *Gervillia lævis* J. Buckman, L. Richardson, "Handbook to the Geology of Cheltenham," pp. 45 and 221, pl. XV., fig. 4.

Type-description.—"Hinge line a little more than one-third the length of the shell, teeth few, but narrower than in the preceding [*Gervillia crassa*], shell slightly curved, very smooth and thin, anterior extremity rather pointed."

Remarks.—The holotype is preserved in the Museum of Practical Geology [3683], and is from the *Striatum*-Beds of the Lower Lias at Battledown, Cheltenham.

As shown by the measurements given below, the length of the hinge-line relative to the length of the shell is ·62 or ·69, (according as the "length" is measured parallel to the hinge-line or diagonally from the anterior to the posterior end) and not "a little more than one third" as stated by Buckman. The "teeth" referred to in the protolog are the ligamentary grooves.

At certain localities (given below) there occurs an abundance of a small form of *Gervillia lævis*. These may be either immature examples of the species or a dwarf variety; there is not yet sufficient evidence to justify a decision. Typical examples of *G. lævis* occur at the same horizon, but have not been found associated with the small form.

The following are the measurements of four specimens: —

Specimen	Length	Height	Diameter	Hinge-line
(1)	58·5	29·5	16+	ca. 30
(2)	47	29	16	ca. 27
(3)	40+	23·5	10	ca. 20
(4)	34+	19	—	21

Specimen No. 2 is the holotype; Nos. 1 and 3 are topotypes; and No. 4 is a specimen from the *Capricornus*-Beds at Pilford, Cheltenham. Six of the small forms mentioned above from the *Capricornus*-Beds were also measured, and the results showed the mean values of the ratios height/length and hinge-line/length to be ·64 and 1·03, respectively. The hinge is thus relatively longer than in mature forms of *Gervillia lævis*, but from observations on the halt-lines of the latter, it appears to be about the same as it would be in specimens of *G. lævis* of corresponding size. None of the small forms has been known to exceed 13·5 mm. in length.

Gervillia betacalcis Quenstedt (Der Jura, 1856, tab. 12, fig. 19) resembles this species, but appears to be a shorter and more rounded form. Quenstedt's figure depicts a damaged specimen which does not show the slight byssal sinus which is always present in mature forms of *G. lævis*.

Records.—*Striatum*-Beds, Battledown Brickworks, Cheltenham (common; type-locality): *Striatum*- or *Capricornus*-Beds (probably latter), Prestbury (well at Queen's-Wood Cottages), near Cheltenham: Pilford, Cheltenham: and in the Railway-cutting (G.W.R.), Greet, near Winchcombe. The small forms occur in abundance in beds of *capricornus* hemera at Aston-Magna Brickworks, near Moreton-in-the-Marsh: Robins' Wood Hill, near Gloucester, and at Dumbleton Brickyard, near Beckford.

GERVILLIA LATA J. Phillips. Pl. XXVIII., figs. 4*a*, *b* and *c*.

T.d. 1829. Geology of Yorkshire, pt. I., p. 156.
T.f. *Ibid.*, pl. XI., figs. 16 and 17.
T.l. "Blue Wick [Ravenscar, Yorkshire]."
H. "I[nferior] O[olite. Dogger]" [Aalenian]
ῃ. [*murchisonæ*]
Colln. York Museum.

1835. Phillips, Geol. Yorksh., pt. I., (2nd ed.), p. 128., pl. XI., figs. 16, 17.
1875. Phillips, *ibid*, 3rd ed., p. 247, pl. XI., figs. 16 and 17.

Remarks.—In the third edition of Phillips' work, two views of this fossil are given: one a general view of the specimen; the other of the hinge-area—but magnified, and showing the ligamentary pits. The specimen in the York Museum, however, does not exhibit these pits and therefore, presumably, the specimen is not the holotype, but a syntype. It is desirable to make it the lectotype. It came from the red Dogger of Blea Wyke, below Ravenscar, and has the following measurements: length (parallel to the hinge-line), 47 mm.; height, 32 mm.; diameter, 19 mm.; length from anterior to posterior extremity, 51 mm. The left valve is more convex than the right and overlaps along the ventral margin.

Records.—Phillips records this form from the Millepore Oolite of Cloughton as well, but I have not seen this specimen. In Gloucestershire, Mr Richardson has collected a specimen from the Pea-Grit (*murchisonæ*) of Crickley Hill; Lycett records it from the Inferior Oolite of Minchinhampton (Proc. Cottesw. Nat. F. C., vol. i., 1853, p. 74); while Witchell records it from the Oolite Marl of the Stroud district, but misled by its form assigned it to the genus *Pteroperna* (Geol. Stroud, 1882, p. 51).

GERVILLIA MONOTIS Eudes-Deslongchamps.
Pl. XXIX., fig. 3.

T.d. 1824. Mem. Soc. Linn. du Calvados vol. I., p. 130.
T.f. *Ibid.*, pl. V., figs. 1 and 2.
T.l. ——
H. ——
η̂. ——
Colln.——

1853. *Gervillia monotis* Deslongchamps, Morris and Lycett, Monogr. Moll. Gt. Ool., pt. II., pp. 22-23, tab. II., figs. 14, 14*a*, and 14*b*. Pal. Soc.

1882. *Gervillia monotis* Deslongchamps, E. Witchell, Geol. of Stroud, p. 80, pl. 3, fig. 24.

Record.—Great Oolite, Minchinhampton Common, near Stroud (appears to be fairly common).

GERVILLIA "ORNATA" Lycett.

T.d. 1863. Suppl. Monogr. Moll. Gt. Ool., p. 111. Pal. Soc.
T.f. *Ibid.*, tab. XXXVI., fig. 7.
T.l. "Minchinhampton, near Stroud."
H. "Great Oolite." [Bathonian].
η̂. ["*maxillatæ*"]
Colln. Mus. Pract. Geol., Jermyn Street, London. [9176.]
Non 1861. *Gervillia ornata* Moore, Quart. Journ. Geol. Soc., vol. xvii., p. 500.

Remarks.—The name *Gervillia ornata* was applied to a Rhætic species by Charles Moore in 1861, and therefore when used by Lycett was preoccupied. Edward Wilson ("List of Fossil types and Described Specimen in the Bath Museum," Proc. Bath Nat. Hist. and Antiqu. F. C., vol. vii., 1892, p. 50) regarded *G. ornata* Moore as synonymous with *G. faberi* Winkler. If this is the case, then the name *G. ornata* may be retained for the Great Oolite species. There is some doubt as to whether the specimen quoted above is really the type of the species.

Record.—Great Oolite, Minchinhampton, near Stroud.

GERVILLIA PRÆLONGA Lycett.

T.d. 1857. "The Cotteswold Hills," p. 127.
T.f. *Ibid.*, pl. VI., fig. 6.
T.l. "Rodborough Hill, [Stroud, Gloucestershire]."
H. "The *Spinosa*-Stage of the Inferior Oolite in the Gryphite-Grit [Lower *Trigonia*-Grit]." [Bajocian]
$\hat{\eta}$. [*discitæ*]
Colln. Mus. Pract. Geol., Jermyn Street, London. [8864].

Remarks.—This species is closely allied to *Gervillia subcylindrica* Morris and Lycett and to *G. acuta* Sowerby. From the former it is distinguished by the greater curvature of the shell—*G. subcylindrica* being almost straight. *G. acuta* appears never to attain the size of *G. prælonga*, has a relatively shorter hinge-line, is higher, and more pointed at its posterior extremity.

Collectors in the Cotteswolds have often referred the right valve of this species to *Gervillia acuta* Sowerby, to which it bears a strong resemblance.

The specimen figured by Lycett is a left valve from the Lower *Trigonia*-Grit[1] of Rodborough Hill, near Stroud. It has the following dimensions :—length, ca. 146 mm. ; height ca. 38 mm. ; hinge-line, ca. 83 mm.

Records.—*Clypeus*-Grit (*schlœnbachi*), Rolling Bank Quarry, Cleeve Hill, near Cheltenham ; Notgrove Freestone (*witchelliæ*), Leckhampton ; *Witchellia*-Grit (*witchelliæ*), Cold Comfort, near Cheltenham ; Buckmani-Grit (*post-discitæ*), Cleeve Hill, near Cheltenham ; Tuffley's Quarry, near Crickley Hill, and Charlton Common, near Cheltenham ; Lower *Trigonia*-Grit (*discitæ*), Rodborough Hill, near Stroud ; Leckhampton Hill, Charlton Common, and Wistley Hill, near Cheltenham.

GERVILLIA SUBCYLINDRICA Morris and Lycett

T.d. 1853. Mongr. Moll. Gt. Ool., pt. II, p. 21. Pal. Soc.
T.f. *Ibid.*, tab. III., figs. 13, 13*a* and *b*.—"*Gervillia subcylindrica* ? var. of *Gervillia acuta* Sow."
T.l. "Minchinhampton Common, where it occurs somewhat rarely in the
H. "planking [Great Oolite]" [Bathonian]
$\hat{\eta}$. [? *maxillatæ*]
Colln. Mus. Pract. Geol., Jermyn Street, London. [9181, 9182]

1 Matrix identified by Mr Richardson

Remarks.—The two specimens figured by Morris and Lycett (*op. cit.*, tab. III., figs. 13, 13*a*) may be taken as the syntypes of the species. They are in Jermyn Street Museum and are registered as No. 9182 (right valve; fig. 13) and No. 9181 (left valve; fig. 13*a*). The matrix is the characteristic "Minchinhampton Stone" of the Minchinhampton Beds.

Record.—Minchinhampton Common, near Stroud.

GERVILLIA TORTUOSA (J. de C. Sowerby)

T.d. 1826.[1] *Gastrochœna tortuosa* J. de C. Sowerby, Min. Conch vol. vi., p. 49.

T.f. *Ibid.*, tab. DXXVI., fig. 1.

T.l. "Blea Wyke" [Ravenscar, Yorkshire].

H. "Dogger" [*Nerinæa*-Bed. Aalenian].

$\bar{\eta}$. [*murchisonæ*].

Colln. Sowerby Colln., Brit. Mus. Nàt. Hist., London. [43007].

1829. *Gastrochœna tortuosa* Sow., J. Phillips. Geol. of Yorksh., pt. I., (1st ed.), p. 155, pl. XI., fig. 36.

1835. *Gastrochœna tortuosa* Sow., J. Phillips, Geol. Yorksh., pt. I., (2nd ed.), p. 157, pl. XI., fig. 36.

1842-44[2] *Gastrochœna tortuosa* Sow., Conchyliologie Minéralogique de la Grand Bretagne (French edition of Sowerby's Min. Conch.), translated by E. Desor. with notes by L. Agassiz, p. 540, tab. DXXVI., figs. 1-3.

1842-45[2] *Gastrochœna tortuosa* Sow., Mineral-Conchologie Grossbrittaniens (German edition of Sowerby's Min. Conch.), by E. Desor. and L. Agassiz, p. 548, tab. DXXVI., figs. 1-3.

1853. *Gervillia tortuosa* Phillips, J. Lycett, "The Cotteswold Hills," pp. 48, 56 and 64.

1875. *Gervillia tortuosa* Phill., R. Etheridge in J. Phillips, Geol. Yorksh., pt. I. (3rd ed.) p. 247, pl. XI., fig. 36.

1882. *Gervillia tortuosa* Phillips, E. Witchell, "Geol. of Stroud," pp. 48, 52 and 59.

Remarks.—The type-specimen in the Sowerby Collection at the British Museum (Nat. Hist.) came from the *Nerinæa*-Bed in the Dogger at Blea Wyke.

1 I am indebted to Mr C. D. Sherborn for directing my attention to a pamphlet by Renevier (Bull. Soc. vaud. des Sci. nat., vol. IV., No. 36, 1855, pp. 318-320) in which the exact dates of publication of the various parts of Sowerby's Min. Conch. are worked out.

2 These dates are given on the authority of Mr C. D. Sherborn.

There are many records of this characteristic species from Gloucestershire, although it cannot be said to be common.

Records.—Pea-Grit (*murchisonæ*), Crickley Hill, near Cheltenham; Harford Sands (*concavi*), Cleeve Hill, near Cheltenham. Pisolite and Freestones, Stroud (*teste* Witchell); Oolite Marl (*bradfordensis*), Selsley Hill, near Stroud (*teste* Lycett); "Gryphite-Grit" [Lower *Trigonia*- or *Buckmani*-Grit] (*discitæ*), near Stroud (*teste* Lycett and Witchell).

GERVILLIA WALTONI Lycett. Pl. XXIX., figs. 2*a*, *b* & *c*.

T.d. 1863. Suppl. Monogr. Moll. Gt. Ool., pp. 110-111. Pal. Soc.

T.f. *Ibid.*, tab. XXXII., figs. 4, 4*a* and 4*b*.

T.l. "Farley, Gastard."

H. "Forest Marble." [Bathonian].

ῆ. ["*coarctatæ*"]

Colln. Sedgwick Museum, Cambridge.

Remarks.—The syntypes of this species, three in number, are from the Forest Marble—the label on the tablet to which they are attached bearing the localities "Farley, Gastard" One specimen (fig. 4*a* of Lycett) is in addition labelled "Farley," which is near Bath. The other two are unlabelled and may be from either Farley or Gastard, Wiltshire.

Records.—*Gervillia*-Bed, Great Oolite, Stow-Road and Wiggold Railway-cuttings, between Foss Cross and Cirencester; "Great Oolite 17" [? *Gervillia*-Bed], Stoney Furlong Railway-cutting, near Chedworth.

GERVILLIA WHIDBORNEI nom, nov. Text-figs. 1*a* & *b*.

Td. 1883. Quart. Journ. Geol. Soc., vol. xxxix., pp. 516-517. (*Sub Gervillia intermedia*).

T.f. *Ibid.*, pl. XVI., figs. 8 and 9.

T.l. "Bradford Abbas, [near Sherborne, Dorset]."

H. [Inferior Oolite]. [Aalenian].

ῆ. [probably *concavi* or *discitæ*].

Colln. Sedgwick Museum, Cambridge.

Syn. 1844. *Gervillia hartmanni* Goldfuss, J. Buckman in Murchison's Geol. of Cheltenham, 2nd ed., p. 75 and tab. 7, fig. 4.

1883. *Gervillia intermedia* Whidborne, *loc. cit. supr.*

Remarks.—The specific name *intermedia* was applied by Wissmann and Münster in 1841 to a *Gervillia* from the St. Cassian Beds[1]; it has therefore been necessary to re-name Whidborne's species.

This species, which is abundant in the Buckmani-Grit of the Cotteswold Hills, resembles *Gervillia hartmanni* Munster

1 Beitr. Geogn. und Petref.-kunde des Südöslichten Tirol's vorzüglich der Schichten von St. Cassian (1841), p. 80.

(Goldfuss, Petref. Germ., 1862, pp. 115-116, tab. cxv., fig.) under which name it appears to have been frequently recorded. It differs from that species, however in being more inæquivalve—a fact noted by Whidborne.

Whidborne remarks that it

"may possibly agree with G. fornicata, Lycett, . . . but seems to differ in wanting the sinuations in the infero-anterior border, and being less oblique."

It may be noted that *G. fornicata* is also a more convex form, and appears to be almost equivalve.

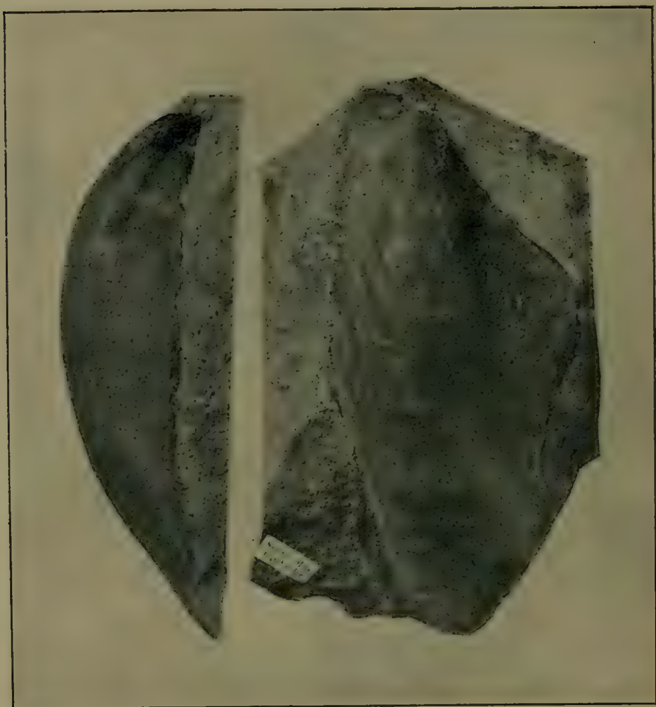

Fig. 1.—*Gervillia whidbornei* nom. nov.

Of the two specimens figured by Whidborne, fig. 8 represent one from the Cotteswold Sands at Frocester Hill, and fig. 9 one from an ironshot bed (probably of *concavi* or *discitæ* hemera) in the Inferior Oolite of Bradford Abbas. They are in the Sedgwick Museum, Cambridge.

In Text-fig. 1 Whidborne's fossil from Bradford Abbas is refigured under its new name.

Records.—*Buckmani*-Grit (*post-discitæ*), Leckhampton Hill, Charlton Common, and Roadstone Hole, Cleeve Hill; Lower *Trigonia*-Grit (*discitæ*), Frith Quarry, near Painswick; Cotteswold sands (*variabilis*), Frocester Hill, near Gloucester.

Photo. E. T. Paris.

LIASSIC AND INFERIOR-OOLITE GERVILLIÆ

EXPLANATION OF PLATE XXVIII.

Figs. 1*a-d*.—GERVILLIA CRASSA J. Buckman

1*a* = right valve of lectotype ; 1*b* = left valve of lectotype ;
1*c* = left valve of syntype ; 1*d* = right valve of syntype.
Horizon : Lower Lias (? top of Sinemurian).
Locality : " Railway cutting . . . . between Gloucester and Bredon."
Collection : Mus. Pract. Geol., Jermyn Street, London. [Reg. Nos. 3684 (lectotype) and 25177 (syntype)].

Figs. 2*a* and 2*b*.—GERVILLIA LÆVIS J. Buckman

2*a* = right valve of holotype ; 2*b* = left valve of holotype.
Hor. : Striatum-Beds of the Lower Lias, Pliensbachian.
Loc. : Battledown, Cheltenham.
Colln. : Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 3683].

Fig. 3.—GERVILLIA FORNICATA Lycett

Left valve of idiotype.

Hor. : Upper Lias. Toarcian.
Loc. : Nailsworth, Gloucestershire.
Colln. : Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 25183].

Figs. 4*a-c*.—GERVILLIA LATA Phillips

4*a* = right valve of lectotype ; 4*b* = left valve of lectotype ;
4*c* = dorsal view of lectotype.
Hor. : Dogger (Inferior Oolite). Aalenian.
Loc. : " Blue Wick [Ravenscar, Yorkshire]."
Colln. : The Museum, York.

(*All the figures are about natural size*).

EXPLANATION OF PLATE XXIX.

Figs. 1*a* and 1*b*.—Gervillia coriniensis sp. nov.

1*a* = left valve of holotype; 1*b* = hinge of left valve of holotype, showing ligamentary grooves.

Hor.: Forest Marble. Bathonian.
Loc.: Near Cirencester.
Colln.: L. Richardson.

Figs. 2*a-c*.—Gervillia waltoni Lycett

External views of the syntypes (three left valves).

Hor.: Forest Marble. Bathonian.
Loc.: Farley.
Colln.: Sedgwick Museum, Cambridge.

Fig. 3.—Gervillia monotis Eudes-Deslongchamps.

External view of the left valve figured by Morris and Lycett, Monogr. Moll. Gt. Ool., tab. II, figs. 14*a* and 14*b*.

Hor.: Great Oolite. Bathonian.
Loc.: Minchinhampton Common, near Stroud.
Colln.: Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 9178].

Fig. 4.—Gervillia islipensis Lycett

Left valve of holotype.

Hor.: Stonesfield Slate. Bathonian.
Loc.: Stonesfield, Oxfordshire.
Colln.: Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 9179].

Fig. 5.—Gervillia compressa Whidborne.

Left valve of holotype.

Hor.: Inferior Oolite. Aalenian.
Loc.: Nailsworth, Gloucestershire.
Colln.: Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 8863].

Fig. 6.—Gervillia aurita Lycett

Left valve of holotype.

Hor.: Inferior Oolite. Aalenian.
Loc.: Nailsworth, Gloucestershire.
Colln.: Mus. Pract. Geol., Jermyn Street, London. [Reg. No. 8862.]

(*All the figures are about natural size*).

Photo. E. T. Paris.

FOREST-MARBLE, GREAT-OOLITE AND INFERIOR-OOLITE GERVILLIÆ

NOTE ON GERVILLIA ACUTA AUCTT. NON SOWERBY (GERVILLIA SCARBURGENSIS NOM. NOV) FROM THE SCARBOROUGH LIMESTONE

By E. TALBOT PARIS, F.C.S.

GERVILLIA SCARBURGENSIS nom. nov.

T.f. 1853. Morris and Lycett, Monogr. Moll. Gt. Oolite, pt. II., tab. xiv., figs. 1 and 1*a* (*sub Gervillia acuta* Sowerby).

T.l. "Scarborough, Yorkshire."

H. "Scarborough Limestone." Bajocian.

η̂. ? *blagdeni.*

Colln. Leckenby Collection, Sedgwick Museum, Cambridge.

Syn. 1829. *Gervillia acuta* Sow., Phillips, Geol. Yorksh., pt. I., pl. IX., p. 151, fig. 36.

1835. *Gervillia acuta* Sow., Phillips, *ibid.*, p. 123, pl. IX., fig. 36.

1853. *Gervillia acuta* Sow., Morris and Lycett, Monogr. Moll. Gt. Oolite, pt. II., p. 142, tab. xiv., figs. 1 and 1*a* (*non* p. 20, tab. III., figs. 12 and 12*a*).

1875. *Gervillia acuta* Sow., Phillips, Geol. Yorksh., pt. I., (3rd ed.), p. 247, pl. IX., fig. 36.

Non 1826. *Gervillia ? acuta* Sow. Min. Conch., vol. VI., p. 15, tab. DX,. fig. 5.

1853. *Gervillia acuta* Sow., Morris and Lycett, Monogr. Moll, Gt. Oolite, pt. II., p. 20, tab. iii., figs. 12 and 12*a*.

Remarks.—Gervillia scarburgensis is broad and somewhat spathulate posteriorly, and this feature serves to distinguish it from *G. acuta* Sow., which has a subacuminate posterior extremity and is a relatively more elongate form, and appears never to attain the size of the average example of *G. scarburgensis*. Moreover the hinge-margin is relatively longer than in *G. acuta*, the ratio hinge-line/length being about ·57 for *G. scarburgensis* whereas it is ·46 for *G. acuta*.

It is allied to *Gervillia prælonga* Lycett and *G. subcylindrica* Morris and Lycett, from both of which it is distinguished by its greater height, its broad posterior portion, and the greater convexity of its ventral margin.

The right valve figured by Phillips (*loc. cit. supra*) from the Scarborough Limestone belongs to this species, though Phillips' figure makes the shell appear rather too cylindrical. Several specimens in York Museum which were named *Gervillia acuta* Sow., by Phillips have been examined and compared with the types of *G. scarburgensis*, but it has not been possible to identify any particular specimen as that actually figured by Phillips.

Münster (in Goldfuss) appears to have recognised the difference between *Gervillia acuta* Sow. and Phillips' interpretation of that species, for he cites "*Gervillia acuta*, Phillips" as synonymous with his *G. lanceolata*.[1] (Petref. Germ., p. 123, tab. cxv., fig. 9). The latter species, however, cannot be regarded as identical with *G. scarburgensis*.

The specimens selected as syntypes are the two figured by Morris and Lycett (*loc. cit. supra*) as *Gervillia acuta* Sow., and are now in the Leckenby Collection, Sedgwick Museum, Cambridge. They are from the Scarborough Limestone at Scarborough.

1 The specific name *lanceolata* was used by Sowerby in 1826 (Min. Conch., vol. VI., p. 17, tab. DXII. fig. 1) for a species which he referred to *Avicula* [*Pteria*], but which must, I think, be referred to *Gervillia*. The absence of the ligament-pits from the type of "*Avicula*" *lanceolata* Sow. seems to be a matter of preservation, and while there are many similar sabre-like shells which are undoubted *Gervillias*, there is none, so far as I know, referable to *Pteria*. Nevertheless, Mr E. T. Newton (Quart. Journ. Geol. Soc., vol. lvii., 1901, p. 232) prefers to retain this species in the genus *Avicula* [*Pteria*].

THE NORTH AND MID COTTESWOLDS AND THE VALE OF MORETON DURING THE GLACIAL EPOCH

BY

JOSEPH W. GRAY, F.G.S.

CONTENTS

(The following is an abstract of the paper)

I.—INTRODUCTION

The superficial deposits of Gloucestershire have been described by Buckland,[1] Strickland,[2] Murchison,[3] Phillips,[4] Hull,[5] Symonds,[6] E. Witchell,[7] W. C. Lucy,[8] Dr C. Callaway,[9] Mr L. Richardson,[10] and others. Of these contributions, Lucy's are the most notable.

In most of the attempts to explain the origin of the deposits in question an invasion by one or more great ice-sheets or a submergence holds a prominent place. As neither of these hypotheses appears to me to account for the whole of the phenomena, I have carefully examined the ground and attempted to ascertain whether more satisfactory explanations could be offered.

1 Trans, Geol. Soc. (1821), vol. v., pp. 506-544 ; *Reliquiæ Diluvianæ* (1823), pp. 196-7 and 249-57.

2 Proc. Geol. Soc., vol. ii., pp. 5, 95 and 111. See also *ibid.*, vol. vi., pp. 545-55 ; Analyst (1835), vol. ii., pp. 1-10, and "Memoirs of H. E. Strickland," by Jardine (1858), pp. clxiv.-clxvii., 79-110 and 139-44.

3 Proc. Geol. Soc., vol. ii., (1838) pp. 230-3 ; Silurian System (1839) pp. 527-8.

4 Mem. Geol. Surv., vol. ii., pt. 1 (1848), pp. 13-15, 125 ; "Geol. Oxford and Valley of the Thames" (1871), pp. 458-65.

5 Quart. Journ. Geol. Soc., vol. xi., pp. 477-96 ; Mem. Geol. Surv.: "Geol. Country around Cheltenham" (1857), pp. 85-96.

6 Proc. Cottesw. Nat. F.C., vol. iii., pp. 31-9 ; *ibid.*, vol. vi., pp. 247-56 ; Severn Straits (1883), p. 25.

7 Proc. Cottesw. Nat. F.C., vol. iv., pp. 56-9 ; *ibid.*, vol. vi., pp. 146-153 ; "Geology of Stroud" (1882), pp. 85-99.

8 Proc. Cottesw. Nat. F.C., vol. v., pp. 71-142 ; *ibid.* vol. xi., pp. 6-14, *ibid*, vol. vii., pp. 50-61.

9 *Ibid.*, vol. xiv., pp. 118, 183-94, Geol. Mag., May, 1905, pp. 216-19.

10 Proc. Cottesw. Nat. F.C., vol. xvi., pp. 28-9. Geol. Mag., vol. xx. (1908) pp. 528-9.

In recent years new light has been thrown on local problems by work accomplished in connection with the Glacial Deposits in adjoining areas,[1] but it must be admitted that we are still unable to form a definite idea as to the conditions that prevailed in this district during the Glacial Epoch.

In some parts of the country, where remnants of Tertiary and Glacial beds occur, it is possible to obtain some knowledge of the sequence of events; but there are no Tertiary Beds in Gloucestershire, and the superficial deposits furnish no undoubted evidence of ice-action. No great changes in the land level appear to have occurred since the close of the Ice Age, and it may be inferred from the position of the "Cheltenham Sands" on the flanks of the Hills that there has not been any considerable recession of the escarpment.

It is held by some geologists that in early Tertiary times rivers flowed from north-west to south-east across what is now the Lower Severn Valley; but I think that the initiation of north to south streams could not have been long delayed—the flow in that direction probably being influenced not only by the structure of the rocks, but by a continued elevation of the Malvern Range.

It is unnecessary here to enter into the subject of river-development;[2] except to observe that apparently some time late in the Tertiary Period, the area under consideration was drained by a stream flowing from a northerly direction.

THE CONVERGING ICE-SHEETS.—There is evidence that ice moved towards this district—

(1) From the Arenig group of mountains as far as Birmingham and the neighbourhood of Bromsgrove;[3]

1 H. J. Osborne White, Proc. Geol. Assoc., vol. xv., pp. 157-74; H. B. Woodward, Geol. Mag. (1897), pp. 485-97; O. A. Shrubsole, Quart. Journ. Geol. Soc., vol. liv., pp. 585 600; B. Thompson, Quart. Journ. Geol. Soc., vol. lv., pp. 65-88; F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii., pp. 470-514; Geol. Mag. (1906), p. 470; Rep. Brit. Assoc., 1906 (1907), pp. 572-3; Mem. Geol. Surv. W. J. Harrison, "Sketch of the Geology of the Birmingham District," pp. 87-96: T. I. Pocock, "Geol. Country around Oxford" (1908), pp. 81-105.

2 On this subject, see:—T. S. Ellis, Proc. Gloucester Sch. of Sci. Phil. Soc. (1882); Geol. Mag. 1908), pp. 109-12 and 446-54; "The Winding Course of the River Wye," Gloucester (1910); Prof. W. M. Davis, Geogr. Journ. (1894-5), pp. 127-146; S. S. Buckman, Geol. Mag. (1902), pp. 366-75; Nat. Sci. (1899), pp. 273-89; Proc. Cottesw. Nat. F.C., vol. xiii., pp. 25-32 and 175-90; L. Richardson, "Handbook Geol. Cheltenham" (1904), pp. 177-90; "Geology—Vict. Co. Hist."—Herefordshire (1908), pp. 28-9; Trans. Woolhope Club (1908), pp. 57-60.

3 W. J. Harrison, "Geol. Birmingham District," p. 89; Carvell Lewis, "Glacial Geology of Great Britain," pp. lxiv.-lxxiv; Crosskey, Rep. Brit. Assoc. for 1873-93 (Reports of Erratic Blocks Committee); W. T. Heming, Proc. Dudley Geol. Soc. (1876), pp. 19-20; J. Humphreys, Presidential Address, The Institute, Bromsgrove, Oct., 1902.

(2) From Mid Wales into Central Herefordshire, not far from the gap between May Hill and the Malverns ;[1]

(3) From the Brecons nearly to the shore of the Bristol Channel ;[2] and

(4) From the Vale of York and Doncaster district and Scandinavia.[3]

There does not appear to have been any intrusion of these ice-sheets into the Cotteswold area except, perhaps, the northern flanks and the Vale of Moreton.[4]

II.—Classification of the Superficial Deposits

The Drift and other Superficial Deposits of the district under consideration may be classified as follows :—

(1) Scattered Drift pebbles, principally of quartz and quartzite, together with artificially flaked flints, found at all elevations.

(2) Drift pebbles and unflaked flints found below about 700 feet ;

(3) Gravels composed mainly of Jurassic débris, with sands, seams of clay and a great variety of Drift pebbles and rock-fragments (including red and white chalk) unworn flints, and a few large boulders. These occur between about 550 feet and 300 feet above ordnance-datum.

(4) Gravel formed of small fragments of Jurassic rocks without Drift pebbles, at various elevations below 1000 feet.

Note.—*In addition to the above, Lucy and others have included among the Drift Deposits, certain clayey and arenaceous soils now known to have been derived from the weathering of " solid " rocks.*

1 Proc. Cottesw. Nat. F.C., vol. xv., pt. 3, pp. 196-7 ; T. S. Aldis, H. C. Moore, H. E. Grindley and L. Richardson, Trans. Woolhope Nat. F.C. (1866), pp. 253-4 ; (1870), pp. 173-7 ; (1877), pp. 20-22 ; (1902-4), pp. 228 and 325-36 ; (1905-7), pp. 60-67, 163-8 and 194.

2 Prof. Edgworth David, Trans. Cardiff Nat. Soc., vols. xiii. and xiv. See also Quart. Journ. Geol. Soc., vol. xxxix., pp. 39-54 ; Dr A. Strahan, Summr. Progr. Geol. Surv. for 1897-99 and 1901 ; Rep. Brit. Assoc., Winnipeg (1909), p. 475 ; F. T. Howard, " Notes on Glacial Action in Brecknockshire," pp. 38-9 and 46.

3 P. F. Kendall, Quart. Journ. Geol. Soc., vol. lviii., pp. 495-6.

4 W. J. Harrison, " Geol. Birmingham District," p. 94 ; H. B. Woodward, Geol. Mag. (1897), p. 485 ; F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii., pp. 471., 489 and 500 ; S. S. Buckman, Proc. Cottesw. Nat. F.C., vol. xiv., p. 115.

While there is a wide difference between the typical examples of each class they frequently merge into each other, and it is impossible to pronounce definitely where the line between them should be drawn.

(1) *Scattered Drift pebbles and artificially-flaked flints.*—The pebbles of this class are noticeable for their symmetry, and many approach a spherical shape. The pebbles and flints are widely distributed, and at places, as on Meon Hill, near the Air Balloon Inn (Crickley), Hazlewood Copse Camp (near Nailsworth), the Barton Pits (Cirencester), and near Whitehall Farm (Puckham, near Cheltenham), they occur very abundantly—at the last place suggesting that they formed part of a Drift Deposit that had been introduced along the valley of the Colne.[1] No Drift pebbles have been noticed on the higher portions of Bredon, Oxenton and Alderton Hills ; but a few flaked flints have been found thereon. It is likely that the pebbles and flints described under this head have been introduced by man.

Drift Pebbles have been recorded, amongst other localities, from Saintbury (800 feet) O.D.*, Willersley Camp (890), Bourton-on-the-Hill (800), Cleeve Cloud (1000), Charlton Abbots (760)*, Whitehall Farm (900)*, Hawling (900), Puckham (900), Leckhampton Hill (960)*, Salterley (850)*, Hartley (915)*, Ullenwood (820-)*, Cowley (755)*, Birdlip (820)*, Stockwell Farm (820)*, Cooper's Hill (800)*, Kimsbury Castle (929), Uley Bury (760)*, Symonds Hall Hill (810)*, etc.

At the localities marked with an asterisk flaked flints have also been found.

(2) *Drift pebbles and unflaked flints.*—On the eastern side of the Cotteswold Hills and on the high ground above the valleys of the Stour and Evenlode, between 700 and 650 feet above ordnance-datum, there are Drift pebbles, amongst which unflaked flints are rare. These pebbles and flints may be remnants of a drift similar to that which occurs at Tangley, associated with clay on the surface, and in fissures that were visible at the time of my visit. This section is important, and has occasioned some discussion.[2] The flints at Tangley are distinguished from those in other parts of the district by a light yellow colour and patches of black stain.

Pebbles of brown quartzite, white quartz, flaked and unflaked flints, and waterworn pebbles of oolite occur in the clayey soil of a field just below the 700-foot contour-line on

1 *Cf.* H. J. Osborne White, Proc. Geol. Assoc., vol. xv. (1897), p. 157.
2 C. Callaway, Geol. Mag. (1905), pp. 216-9, and L. Richardson, Proc. Cottesw. Nat. F.C., vol. xvi., pp. 28-9.

the eastern side of the Buggilde Street, about 200 yards to the north of the lane leading from Harford Bridge to Slaughter Manor. This occurrence of unflaked flints is important, as being among the very few on the Cotteswold Hills above an elevation of about 650 feet.

Lucy has noticed Drift pebbles on :—
Brailes Hill (607 feet above O.D.), at Wychford (731), Batsford (612), Long Compton (730), Oakham, near Little Compton (555), Chapel House, near Chipping Norton (721), Chipping Norton (716), Stow (700-740),[1] Upper Slaughter (695), Shipton Downs (614), Wychwood Forest (556), Northleach (554) and Taynton Common (700).

Drift pebbles have been found on Meon Hill by Mr J. M. Dixon, and together with unflaked flints, at Tangley, by Dr C. Callaway, Mr L. Richardson and myself.

Buckland remarked that quartzite pebbles are abundantly scattered on the high ground bordering the Evenlode Valley.[2]

I have been unable to verify Lucy's record of the occurrence of "greenstone and Mountain Limestone pebbles with encrinital stems" at Compton Scorpion (607 feet) near Chipping Norton.[3]

Boulders and Stratified Drift Gravels.—Below elevations of about 500 feet, the Drift pebbles and unflaked flints become much more numerous and varied in character. They are spread over the relatively low-lying ground of the Moreton Valley, and extend as far as the Mickleton ridge in the gap between Ebrington and Dover's Hills. Associated with pebbles and flints in the Moreton Valley are deposits of clay, sand, fragments of red and white chalk, and large unworn chalk flints and igneous and other rocks not traceable to an origin in the Bunter rocks. No pebbles of Malvern or Scandinavian rocks have, to my knowledge, been found on the Cotteswolds or in the Moreton Valley. All the gravels contain varying proportions of Jurassic detritus although in some cases, as at Moreton-in-the-Marsh, the proportion is very small.

No large erratic boulders have been recorded as occurring on the Cotteswolds above 400 feet, the rock on the summit of

1 Mr S. S. Buckman records flints in addition Proc. Cottesw. Nat. F.C., vol. xiv., p. 117.
2 *Reliq. Diluv.* (1823), p. 251.
3 Proc. Cottesw. Nat. F.C., vol. v., p. 98. In dealing with pebbles found scattered over the surface, as at Compton Scorpion and other places above enumerated, great care is required in discriminating between naturally and artificially introduced material. Carboniferous Limestone, Clee Hill dolerite and Drift pebbles and flints are carried long distances for use in metalling roads, the scrapings from which are spread over the fields.

Cleeve Hill, described by Lucy as a Glacial boulder[1] having been identified as a "burr" in the Harford Sands—a deposit of Inferior-Oolite age.[2]

The principal sections in the Vale of Moreton and contiguous areas recorded by Lucy and others are at :—

Honington Hill (362 feet above O.D.),[3] Mickleton Tunnel (490),[4] Wilmington (272),[5] Blackdown (400),[6] Stretton-on-the-Fosse (380),[7] Burmington,[8] Chipping Campden,[9] Berrington,[10] Paxford (500),[11] Todenham (412),[12] Aston Magna (400),[13] Weston Park Farm,[14] Little Wolford (400),[15] Great Wolford (365),[16] Lower Lemington (360).[17] Long Compton,[18] Barton-on-the-Heath,[19] Moreton-in-the-Marsh (415),[20] Four-Shire Stone (425),[21] Evenlode (near),[22] Adlestrop,[23] Daylesford (380),[24] Oddington,[25] Kingham (360),[26] Churchill-Heath Farm (near),[27] Bledington (350)[28] Foscote (390),[29] Bowl (395),[29] and Bruern Wood,[29] Lyneham,[30] Milton (400),[31] and Ascot (above Langley Mill).[32]

In the valleys of the Churn, Colne and Windrush there are extensive deposits of waterworn gravel formed of local rocks with an occasional Drift pebble, such as in the glebe gravel-pit at Kempsford (*teste* Rev. W. Butt).

Mr L. Richardson[33] and Dr A. E. Salter[34] have not detected any "Northern Drift" in the Vale of Bourton, but Prof. Hull says that it

> "follows the western flank of the Bourton Valley along the southern bank of the Windrush River nearly as far as Burford, where it strikes southwards for several miles."[35]

Among the more important sections enumerated above, is that at Aston Magna, now overgrown, where Gavey[36] noticed large flints from the chalk (some weighing one to two hundredweight) along with blocks of chalk, greensand and clay, together with a quantity of siliceous sand and pebbles. The late R. F. Tomes thought that some of the blocks were glacially striated.[37]

1 Proc. Cottesw. Nat. F.C., vol. xi., pp. 7-9 and 11. 2 P. F. Kendall, Glacialists' Mag., vol. i., No. 4 (1893), pp. 97-9. 3 Lucy, Proc. Cottesw. Nat. F.C., vol. v., p. 93.
4 *Ibid.*, vol. v., pp. 95-6, 107, 112, 117 ; vol. vii., p. 51 ; Gavey, Quart. Journ. Geol. Soc., vol. ix., p. 29 ; Hull, Quart. Journ. Geol. Soc., vol. xi., p. 493 ; A. E. Salter, Proc. Geol. Assoc., vol. xix., p. 39.
5 Lucy, Proc. Cottesw. Nat. F.C., vol. v., p. 93. 6 *Ibid.*, pp. 99, 100, 115. 7 *Ibid.*, p. 100.
8 J. W. Sollas, Quart. Journ. Geol. Soc., vol. lxv., p. 262. 9 Brodie, Quart. Journ. Geol. Soc., vol. xxiii., p. 209 ; Lucy, Proc. Cottesw. Nat. F.C., vol. v., p. 99. 10 Lucy, *ibid.*, p. 98. 11 Lucy, *ibid.*, p. 100.
12 Lucy, *ibid.*, vol. vii., p. 54. 13 Lucy, *ibid.*, vol. v., pp. 97-8, 112, 117 ; Gavey, Quart. Journ. Geol. Soc., vol. ix., p. 35. 14 Lucy, *ibid.*, pp. 93, 115. 15 Lucy, *ibid.*, pp. 93-5 ; Buckland, *Reliqu. Diluv.*, pp. 250-1. 16 Lucy, *ibid.*, p. 115. 17 Lucy, *ibid.*, pp. 100, 114.
18 Lucy, *ibid.*, p. 95. 19 Lucy, *ibid.*, p. 101. 20 Lucy, *ibid.*, pp. 101-2 ; Symonds, Proc. Cottesw. Nat. F.C., vol. ix., p. 10 ; "Severn Straits," p. 25 : A. E. Salter, Proc. Geol. Assoc., (1903) p. 39 : Callaway, Geol. Mag. (1905), p. 218. 21 Lucy, p. 102.
22 Callaway, Geol. Mag. (1905) p. 218. 23 Hull., Quart. Journ. Geol. Soc., vol. xi., p. 492, Lucy, p. 102 ; O. A. Shrubsole, Quart. Journ. Geol. Soc., vol. liv., p. 593.
24 Lucy, p. 102. 25 Hull, Quart. Journ. Geol. Soc., vol. xi., p. 492. 26 Callaway, Geol. Mag. (1905) p. 218. 27 Lucy, p. 102. 28 See page 263. 29 Hull, Quart. Journ. Geol. Soc., vol. xi., p. 493 ; Mem. Geol. Surv., "Country around Cheltenham," p. 96. 30 See page 263.
31 Callaway, Geol. Mag. (1905) p. 217 ; L. Richardson, Proc. Cottesw. Nat. F.C., vl. xvi., p. 32,
32 Lucy, p. 103 ; Hull, Quart. Journ. Geol. Soc., vol. xi., p. 492. 33 Proc. Geol. Assoc., vol. xviii.. (1904), p. 402. 34 *Ibid.*, vol. xix. (1905), pp. 37-8. The term "Northern Drift" is used in this paper only in quotations from other writers. 35 Quart. Journ. Geol. Soc., vol. xi., pp. 493-4. 36 *Ibid.*, vol. ix., p. 35. See also Proc. Cottesw. Nat. F.C., vol. v., pp. 96-8, vol. vii., p. 60. 37 *Ibid.*, vol. v., pp. 96-8.

The gravel-pits near Moreton-in-the-Marsh and Wolford have been frequently described[1]—the latter as having yielded red chalk. The old pit, near Pepperwell Farm, probably that in which Buckland found the first pebbles of that rock in the Vale of Moreton, is quite overgrown, but at a distance of about 200 yards, and at a slightly lower level, a pit has been opened showing about 12 feet of sand with a few small fragments of oolite, Drift pebbles and flints in seams.

In the gravel-pit at Bledington, half a mile west of Kingham Junction, I observed, at about 4 feet from the surface, a rounded " boulder " of fine siliceous sand, about $2 \times 1\frac{1}{2} \times 1\frac{1}{2}$ feet. A wedge or " pile " of hard stony clay appeared to connect a bed of the same material at the surface with a sandy clay under the intervening beds of gravel and quartzose sand, as though a narrow channel had been cut through the gravel and afterwards filled. The gravel consists largely of water-worn Oolitic detritus with a few flints and Drift pebbles streaked by thin seams of sand similar to that of which the boulder is composed. Some large fresh flints have, however, been dug out under a hard ferruginous band at the lowest part of the excavation, where the water-level was reached, and gravel of a different character may exist below.

On approaching Kingham it is observed that the Drift no longer contains white and red chalk: the cherts, limestones, and other Vale of Moreton pebbles become fewer, and the boulders are no longer represented by Carboniferous limestone and igneous rocks, but by subangular blocks of fine-grained grit, resembling sarsen-stones. These boulders are described by Prof. Hull as by no means rarely scattered over the Vale of Moreton, and as increasing numerically towards the north.[2]

Although pebbles of grit are not uncommon in the Stour-Evenlode gravels, the larger boulders are now rarely seen, and only four are now visible—one each at Bowl and Frescot, one near Evenlode, described by Dr C. Callaway,[3] and one found some years ago on Merriscourt Farm, in the parish of Lyneham. The last has been removed to Sarsden House

1 Buckland, *Reliq. Diluv.* (1823), pp. 250-1; Lucy, Proc. Cottesw. Nat. F.C., vol. v., pp. 93-95, 101-2; *ibid.*, vol. vii., p. 79; S. S. Buckman, *ibid.*, vol. xiv., pp. 111-8; Trans. Geol. Soc., vol. v. (1821), p. 518. See also F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii. (1907), p. 500.

2 Mem. Geol. Surv., " Geology Country around Cheltenham," 1857, p. 96: Quart. Journ. Geol. Soc., vol. xi., p. 493.

3 Geol. Mag. (1905) p. 218.

by Lord Moreton, who has kindly supplied me with the particulars. These can hardly be considered to represent the number existing at the time of Prof. Hull's survey.

The transportation of these blocks has been referred to the agency of ice, but this origin does not appear to have been established. It is probable that if they had been transported from the north or north-east, they would be associated with other erratics from the same direction. Similar siliceous grits are not found *in situ* within many miles of the Moreton Valley.

Certain sandstones known as " grey-weathers " or " sarsen-stones " are found on the Wiltshire Downs, and as far north as the Oolitic plains near Swindon and beyond,[1] and it has been stated that boulders of rock similar to the sarsens formerly overspread the country nearly as far as Cirencester.[2]

Clays and Clayey Soils.—Clayey soils resulting from the decomposition of argillaceous beds *in situ* have been erroneously described by Lucy as " boulder clays."[3]

Clay, sometimes containing Drift pebbles, is occasionally found in fissures in the rocks, as at Cirencester,[4] Taits Hill,[5] Chedworth,[6] Woodchester-Park Farm,[7] Tetbury[8] and Tangley.[9]

The pebbles and other siliceous material probably formed part of a pre-Glacial Drift, remnants of which were subsequently introduced along with clay into the fissures.

Arenaceous Soils.—Soils, formed in the denudation of arenaceous " solid " rocks, have in some cases been mistaken for Glacial drift.[10] Typical examples are seen on Ebrington Hill and at Chapel House, near Chipping Norton.

Gravels formed of Oolite débris.—These gravels are of entirely local origin, and have been noted at all altitudes between 300 and 1000 feet, and in most parts of the Cotteswolds. Some of the deposits are formed of angular débris ; others of smaller and more rounded material.

1 Prof. Hull refers to Oolitic gravels to the south of Cirencester as containing chalk-flints derived from the waste of the chalk escarpments to the south and east. Quart. Journ. Geol. Soc., vol. xi., p. 490. Mem. Geol. Surv., Wilts, and Gloucestershire, 1858, pp. 42-3.

2 Proc. Cottesw. Nat. F.C., vol. ii., p. viii.

3 Proc. Cottesw. Nat. F.C., vol. vii., pp. 50-51. See also vol. v., p. 111 ; vol. vi., p. 116 ; vol. vii., pp. 51-5 ; vol. xi., p. 12 : Dr C. Callaway, Geol. Mag. (1905), p. 217 ; Symonds, " Severn Straits," p. 25.

4 Church, Proc. Cottesw. Nat. F.C., vol. v., pp. 239-40 ; vol. vi., p. 19.

5 Smithe, *ibid.*, vol. viii., pp. 5 and 6.

6 Lucy, *ibid.*, vol. x, p. 7.

7 *Ibid.*, vol. v., pp. 107., 109., 111.

8 Playne and Lucy, *ibid.*, vol. vii., p. 51.

9 For some difference of opinion as to the nature and origin of this clay, the reader is referred to comments by Dr C. Callaway in the Geol. Mag. for 1905, pp. 216-9, and by Mr L. Richardson in the Proceedings of this Club, vol. xvi., pp. 28-9.

10 Quart. Journ. Geol. Soc., vol. xi., p 489 ; Proc. Cottesw. Nat. F.C.. vol. v., p. 116.

Prof. Hull regarded them as vestiges of a true sea-beach, but found no traces of marine shells.[1] Prestwich regarded them as having been probably deposited during a marine submergence.[2] Lucy held that they were due to the slipping of frozen snow and land-ice, carrying down the limestone detritus at a time when the climate had become comparatively mild ;[3] while Edwin Witchell regarded them as " the waste of the rocks disintegrated by frost, and probably washed down by heavy rains and melting snow in spring to the places of deposit." In some observations on the " Gravel Period " in the later stages of the Glacial Epoch, the same writer says it is probable that " the intense frost caused the surface of the rocks to split off into fragments, which became pulverized, and most of the angular gravel was deposited in the way described.[4]

Mr H. B. Woodward mentions some of the sections described, and calls attention to the " more remarkable accumulations of rubble," among which is that to the north-west of Break Heart Hill, near Dursley, the most southerly exposure of the gravel that has yet been recorded.[5]

The Oolitic gravels of the Cotteswolds have also been described by Murchison,[6] Strickland[7] and James Buckman.[8]

I have not been able to detect any difference among the various gravels described by these authors other than the size and the more or less waterworn condition of the fragments. The only organisms other than Jurassic fossils found in the gravels in question are a few fragments of land-shells in the upper part of a bed on Cleeve Hill.

The uniform fineness that is the principal characteristic of the variety of gravel under discussion could not, I think, have been maintained under exposure to alternate frost and thaw or the action of torrents and movements of the soil, or marine submergence.

1 "The Geology of the Country around Cheltenham" (1857), pp. 87-8. Mem. Geol. Surv.; Quart. Journ. Geol. Soc., vol. xi., pp. 487-8.
2 Quart. Journ. Geol. Soc., vol. xlviii., pp. 314-333.
3 Proc. Cottesw. Nat. F.C., vol. v., p. 113.
4 "Geology of Stroud," pp. 94-5 and 98. For other descriptions of the Cotteswold Jurassic Gravels, see Proc. Cottesw. Nat. F.C., vol. iv., pp. 56-9, and vol. vi., pp. 98, 146-53.
5 Geol. Mag., Nov., 1897, pp. 487-8.
6 "The Geology of Cheltenham" (Augmented and Revised by Buckman and Strickland), 1845, pp. 60-2; "The Silurian System," pp. 527-8.
7 "Memoirs of H. E. Strickland," by Jardine, pp. 92, 103, 142.
8 "The Ancient Straits of Malvern."

The fact that there is no evidence of a comparatively recent submergence of the Cotteswolds deep enough to reach the level of some of the gravels is conclusive against a marine origin. The deposition of the small gravel in Glacial lakes, held up by local ice against the slopes upon which many of them rest at considerable elevations above the valleys, or the existence of a sufficient thickness of foreign ice to hold up lakes to the same height, is improbable.

As evidence of the work of land-ice, the Jurassic gravels of the Cotteswolds are of little value: some of them may be remnants of ancient deposits due to local snow and ice—even of Glacial age—the reduction in size of the smaller fragments having, perhaps, been effected by long exposure to the action of acidulated waters. There is nothing in their arrangement or composition to permit of reference to that or any other particular epoch, except, perhaps, the examples that can be traced to recent river-action or are interstratified with recent alluvial deposits. A greater antiquity than that of the Glacial epoch cannot be claimed for any of the gravels lying on or near the western slopes of the hills, a position which many of them occupy, for it is obvious that even a slight recession of the escarpment would have completely obliterated all traces of deposits of that age. If they are of Glacial age the causes were purely local since they contain no admixture of Drift pebbles or flints. Under the conditions of an invasion by one of the great ice-sheets or of icebergs floating on marine waters, the gravels must have received some addition of Drift material.

III.—Mammalian Remains and Traces of Early Man

No mammalian remains assignable to the Glacial Epoch have been found on the higher portions of the Cotteswolds; but probably their absence is due to non-preservation. A human skeleton was found in the cutting at the northern end of the Mickleton Tunnel in blue clay at a depth of 9 ft. 6ins. from the surface under loamy clay and drift pebbles.[1] It may have been covered by a landslip in the Lias Clay.

Remains of *Bos* (short-horned), *Equus*, *Cervus* (2 spp.), *Sus* and *Canis vulpes* have been found in a superficial deposit

1 Gavey, Quart. Journ. Geol. Soc., vol. ix., p. 26.

at Mickleton Tunnel;[1] "bones of elephants" at Shipton-on-Stour, Bourton-on-the-Water and Ascot-under-Wychwood;[2] and remains of *Elephas primigenis, Rhinoceros tichorhinus, Cervus tarandus* and *Bos*, (a late Pleistocene assemblage) at Ganicox Pit, Stroud.[3]

There is no evidence that man inhabited the Cotteswolds during the Glacial Epoch. No remains of Palæolithic Man have been found in the district, but there are on the hills numerous remains of Neolithic villages, burial places and flint-implements.

IV.—The Avon Valley Drift

In the various explanations of the origin of the Cotteswold Drift, references have been made to that part of the Avon Valley forming the northern boundary of the hills; but the minute descriptions by several writers, including Strickland,[4] Lloyd,[5] and Wilson[6] render unnecessary any detailed account of the superficial deposits.

The records of large boulders are very few, considering that the eastern ice is said to have advanced as far as the Vale of Evesham. They may have been swept away by floods from the melting ice and buried in the deeper troughs of the lower reaches, just as we find them in the valley of the Yorkshire Calder at Mytholmroyd, Mirfield and Wakefield. The distinctive boulders are not, however, found in the Severn Valley or lower down in the estuary or on the shores of the Bristol Channel.

A boulder of Leicestershire Granophyre found in the gravel pit at Loxley Road, Stratford-on-Avon, measured about 2 ft. 6 ins. × 1 ft. 9 in. × 1 ft. 6 ins.[7] Lucy records from Throckmorton a piece of coarse granite and a small block of Millstone Grit.[8] His supposition that the latter is striated is probably erroneous, as the Millstone Grit is one of the rocks least capable of accepting or retaining striæ. Lloyd describes the following: at Charlton, a Felstone, 4 ft. × 1 ft. 8 in. × 1 ft. 4 in.[9] and at

1 Quart. Journ. Geol. Soc., vol. ix., p. 26. 2 Lucy, Proc. Cottesw. Nat. F.C., vol. v., p. 123; see also Hull, Quart. Journ. Geol. Soc., vol. xi., pp. 490-2. 3 Lucy, Proc. Cottesw. Nat. F.C., vol. v. pp. 90 and 122. Quart. Journ. Geol. Soc., vol. xi., p. 490.
4 Memoirs, by Jardine, pp. 88-110. 5 Quart. Journ. Geol. Soc., vol. xxvi, pp. 202-25.
6 *Ibid.*, vol. xxvi., pp. 192-202. 7 F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii, p. 499.
8 Lucy, Proc. Cottesw. Nat. F.C., vol. v., p. 87. 9 Lloyd, Quart. Journ. Geol. Soc., vol. xxvi., p. 213.

Cropthorne a rounded boulder of Felstone measuring about 2 ft. 2 in. × 1 ft.[1] At Cropthorne, Lucy found a block of syenite weighing 20 ℔.[2] Several small grit boulders with blunt edges have been found in the gravel pit near the Cemetery at Stratford-on-Avon.

Flints occur in great numbers in the gravels, and many of them are worn and fractured. Chalk and unrolled flints are found at Hatton,[3] and blocks of flint of considerable size and in fresh condition at Stratford-on-Avon, Evesham and Cropthorne.[4]

Striated white chalk and flint are recorded from between Rugby and Lowmorton, and chalk gravel three or four feet in thickness from Hilmorton.[5] In a small field at Rowington, Brodie found "little bits of very hard chalk, rounded and scratched, together with some Greensand."[6] I have met with no authentic account of the discovery of red chalk in the Avon Valley.

Boulder Clays are recorded as occurring at various places in the Avon Valley. "Glacial Till" occurs at Exhall,[7] Blue Clay, with chalk, at Coventry and Berkswell,[8] Boulder Clay at Rugby,[9] and Laminated Clay (?Lake-mud) at Snitterfield and near the New Inn on the Ridgway.[10] No trace of Boulder Clay equivalent to that found in the district round Birmingham occurs in South Warwickshire[11] where it is replaced by sand and gravel.[12]

Contortion in the Lias Clay at Bilton, near Rugby, was noticed by the Rev. J. M. Wilson.[13] Furrows in the Lias at Bredon Railway Station have been described by Mr L. Richardson.[14] In the Lias at Church Honeybourne and South Littleton crumpling and folding of the surface have been observed by Mr H. B. Woodward.[15]

1 Quart. Journ. Geol. Soc., vol. xxvi., pp. 213-4. 2 Proc. Cottesw. Nat. F.C., vol. v., p. 85.
3 Brodie, Quart. Journ. Geol. Soc., vol. xxiii., p. 209. See also "Erratic Blocks," Rep. Brit. Assoc. (1903) p. 19. 4 Lucy, Proc. Cottesw. Nat. F.C., vol. v., pp. 85-90. F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii., p. 499.
5 Wilson, Quart. Journ. Geol. Soc., vol. xxvi., pp. 194-5. 6 Quart. Journ. Geol. Soc., vol. xxiii., p. 209. 7 Startin, Proc. Warwickshire F.C. (1866) pp. 26-33.
8 Andrews, *ibid.* (1884-5) p. 32. 9 T. G. B. Lloyd, Quart. Journ. Geol. Soc., vol. xxvi., p. 206.
10 T. G. B. Lloyd, *ibid.*, pp. 207-8. On the Boulder Clays; see also H. B. Woodward, Geol. Mag., (Nov., 1897.) pp. 485-97, and B. Thompson, Quart. Journ. Geol. Soc., vol. lv., pp. 65-88.
11 Harrison, Rep. Brit. Assoc., 1890, p. 2. 12 Proc. Liverpool Geol. Soc. (1885) pp. 216-33.
13 Quart. Journ. Geol. Soc., vol. xxvi., p. 196. 14 Proc. Geol. Assoc., vol. xviii., pt. 8 (1904) p. 407. 15 Geol. Mag. (1897) p. 492.

Mammalian remains occur in great numbers in the drifts of the Avon Valley. Buckland describes a remarkable collection of bones in a cavity in the Lias at Little Lawford, now long since worked out.[1]

Lucina borealis, *Turritella*, *Anomia*, *Cardium* and *Rissoa* are recorded as having been found at Beckford, 120 feet O.D.,[2] and a doubtful fragment of *Cyprina* at Berry's Coppice, Dunnington, 280 feet O.D.[3]

An advance of ice from the north into the Avon Valley is supposed to be indicated by the presence of rocks of northern type on the summit of Welcomb Hill, near Stratford-upon-Avon 300 feet above O.D. A careful search, however, in the gravel pit at that place leads me to the conclusion that the whole of the drift material consists of pebbles of the Bunter type and much weathered flints, not necessarily ice-borne.

V.—Origin of the Drift

Permian breccias and conglomerates occur near Enville in Staffordshire and at Gatacre in Shropshire, on the flanks of the South Staffordshire Coalfield, at the south end of the Warwickshire Coalfield, and in certain other places. Bunter Pebble-Beds are present in the Lickey and Clent Hills, and extend almost without interruption from Romsley (928 feet) to Cannock Chase on the west of the Staffordshire Coalfield, to Lichfield on the east.

Most of the Drift of the area under consideration could have been derived from these rocks,[3] which contain sub-angular and rounded pebbles, varying in size from half an inch to eighteen inches across, and they include yellow, brown and liver coloured quartzites, vein quartz, sandstones, chert, limestone with encrinites, slate, lydian stone and various igneous rocks, together with varying proportions of loose sand.[4]

Some of the worn constituents of the gravels may have been derived from a conglomerate similar to that in the Lower Greensand at Swindon.

1 *Reliqu. Diluv.*, p. 174 and 176. See also Wilson, Quart. Journ. Geol. Soc., vol. xxvi., pp-201-2, and Lloyd, Quart. Journ. Geol. Soc., vol. xxvi., p. 216. Strickland, Memoirs by Jardine, p. 94. 2 *Ibid.*, p. 85; Bird, *ibid.*, vol. iii., p. 255; Lloyd, Quart. Journ. Geol. Soc., vol. xxvi., pp. 211-6; Symonds, "Severn Straits," p. 35. 3 Lloyd, Quart. Journ. Geol. Soc., vol. xxvi., pp. 209-10.

3 Specimens of Drift and other materials collected by me for the purposes of this inquiry will, together with a map, be placed in the Cheltenham Public Museum.

4 Profs. Lapworth and Watts, "A Sketch of the Geology of the Birmingham District" (1907) pp. 59-60: W. Wickham King, 2 Quart. Journ. Geol. Soc., vol. lv., pp. 97-128.

It is probable that much of the gravel that lies between Wychwood Forest and the River Avon was introduced by Tertiary streams that have been beheaded by the development of the Severn tributaries. The pebbles of quartz and quartzite and the flints on the higher portions of the Cotteswold Hills were probably introduced by Neolithic man, mainly for use as sling stones. Many of the unworn flints in the neighbourhood of Aston Magna and Moreton-in-the-Marsh are quite fresh ; a condition that suggests derivation from the parent rock in some other manner than transport from a distance by land ice. Red chalk is naturally associated with hard white chalk and grey flints in Yorkshire and Lincolnshire, from whence it is contended by some authorities that both chalk and flints have been derived. If this is the case it is curious that they do not appear to have been accompanied in their journey to the Cotteswolds by Scandinavian rocks, examples of which are said to occur at Bedford and Hatton in Warwickshire.

VI.—Transport of the Drift

Submergence.—Murchison,[1] Phillips,[2] and Lucy[3] considered that the Drift was transported during a marine submergence ; but if such had been the case the more elevated superficial deposits of the district would have occurred at more uniform elevations. This uniformity does not exist ; the deposits do not contain marine shells, and are formed of local detritus, and there is no evidence of the extensive changes in land-level that would necessarily be involved if such a theory were correct.

It is not improbable, however, that during or even since the Glacial Epoch the Severn and Avon Plain may have been subject to estuarine conditions ; but there is no evidence that any of the gravels above a height of about 150 feet O.D. were laid down in an arm of the sea as suggested by Murchison,[4] Strickland[5] and Lloyd.[6] Marine shells have been found in the vicinity of the Cotteswolds at Cropthorne, but these shells are

1 "Silurian System," p. 530. 2 "Geol. Oxford," p. 462. 3 Proc. Cottesw. Nat. F.C., vol. vii., pp. 53-4. 4 "Silurian System," p. 552 : see also Mellard Reade, C.N.F.C., vol. xiv., pp. 111-3. 5 "Memoirs of H. E. Strickland," p. 104. 6 Quart. Journ. Geol. Soc., vol. xxvi., p. 223 : see also E. Witchell, "Geol. Stroud," p. 98.

mostly fragmentary and it is possible that some of them may have been derived from Glacial beds in the Upper Severn Valley.[1]

Rivers.—Mr S. S. Buckman has suggested that the Lower portion of the Moreton gravels are of fluviatile origin and of Pliocene age and that the upper portion is composed of material introduced by a river in Glacial times—the vertical position of the larger stones suggesting that they were "conveyed by floating ice and dropped as the ice gradually melted."[2] The vertical position may, I think, be explained by the supposition that there has been a settlement of the gravel owing to the elimination of a part of the soluble constituents.

Glacial Lakes.—It has been suggested that the North Cotteswold and Vale of Moreton Drift was transported by ice-floes on the waters of a glacial lake extending from the melting front of the eastern glacier to a barrier in the Bristol Channel or the Avon Plain.

Although the drainage of the Severn Basin may have been obstructed by ice advancing up the Bristol Channel from the Irish Sea or crossing from Central and South Wales,[3] it seems improbable that a dam thus formed would raise the level of the lake sufficiently high to allow the floating of bergs into the Vale of Moreton about 500 feet O.D. or, if Tangley be included, about 650 feet O.D. There are no signs of the presence, in Pleistocene times,[4] of so large a body of water in the Severn Plain.

As an alternative to an invasion of the eastern ice-sheet, Mr F. W. Harmer suggests that "the overflow from a Glacial lake, then filling a part of the basin of the Avon, carried Bunter pebbles and Lincolnshire flint towards the south." [5]

The principal objection to the lake-hypothesis is the absence of any signs of an efficient dam in the Avon Valley, which is the normal course of the channel by which drainage from the eastern ice would flow towards the Severn. When,

1 Proc. Cottesw. Nat. F.C., vol. xiv., pp. 184-7. 2 *ibid.*, pp. 113-8; Quart. Journ. Geol. Soc., vol. lv., p. 220.

3 F. W. Harmer, Quart. Journ. Geol. Soc., vol. lxiii., p. 474; H. C. March, Proc. Dorset. Nat. Hist. F.C., vol. xix., p. 136. The subject will be further discussed in dealing with the Severn Valley deposits.

4 A reference to the formation of "Lake Bosworth" will be found in Harrison's chapter on the "Ancient Glaciers of the Midland Counties," in the Geology of the Birmingham District, p. 94. and in Kelly's Directory of Warwickshire, p. 20. See also Prof. P. F. Kendall, Quart. Journ. Geol. Soc., vol. lviii., p. 568. 5 Quart. Journ. Geol. Soc., vol. lxiii., p. 500.

however, certain conditions not improbable during the Glacial Epoch are taken into consideration there appears to be nothing in the position or arrangement of the minute sub-divisions of the Lower Avon Valley Drifts described by Lloyd, inconsistent with the supposition that, instead of a large lake occupying the whole of the area, a stream from the eastern ice-front was ponded up at intervals by morainic débris, thus forming a series of small lakes occupying different positions and levels at various times. In these, laminated clay, sand and gravel would be deposited and cut through and redistributed by floods as the level was lowered, leaving the deposits now skirting the stream. After the recession of the ice from the vicinity of the Cotteswolds the Valley would still be the channel for enormous floods from the melting of the northern and eastern glaciers, charged with detritus borne from increasing distances as the ice retreated. The probability of such fluvio-glacial conditions seems to render unnecessary an appeal to the presence of a lake of considerable extent in the Vale of Evesham in order to account for the complex deposits of that part of the district.

If the Drift had been transported by ice-floes on a lake or the overflow therefrom into the Vale of Moreton, the deposits would not have been confined to their present limited area on the eastern flanks of the Cotteswold Range.

That a lake of great extent ever occupied the district is rendered still more improbable by the absence on the northern slopes of the Cotteswolds of overflow channels such as are described by Prof. P. F. Kendall as occurring in the Cleveland district of Yorkshire. So far as I can ascertain there are no indications of such an overflow at the places where it would most likely occur except, perhaps, through the Mickleton Gap. The local rocks, owing to their softness and liability to considerable landslips, such as are visible now on the northern slope of Meon Hill, are certainly not favourable to the preservation of such signs ; still, a further investigation may reveal examples hitherto overlooked. Lake-channels excavated in very soft Jurassic silts preserve a sharp contour in the Cleveland area, even near the upper limits of glaciation ; but the lake or lakes postulated in the Cotteswolds must have belonged to a much earlier phase of glaciation, and therefore have been longer exposed to denudation.

Land-Ice.—The view that the drift was distributed by land-ice, which extended over the whole of the district,[1] is held by few geologists. There are no signs of the passage of any of the great ice-sheets over the Cotteswold uplands. Most of the rocks are easily eroded, yet it is improbable that hard stony clays, smoothed surfaces, striated boulders and other phenomena associated with a glaciated region could have been completely removed.

It has been suggested that a lobe from the Chalky Boulder Clay ice was prolonged into the Vale of Moreton[2] and Dr C. Callaway considers that the Tangley section is "inexplicable except as a product of ice-action."[3]

While some of the Drift material of the Vale of Moreton may have been transported by ice-sheets moving from the north and east, it seems improbable that a lobe travelled some distance from the main mass and then ascended about 200 feet to the Stour-Evenlode watershed—assuming that the contours in Glacial times were approximately the same as at present.

No traces of glaciation can be detected around Tangley, the greatest elevation at which undoubted Drift pebbles and flints are found *in situ*. The Drift material at that place is probably the oldest on the Cotteswolds, and appears to consist of the remnants of Tertiary river gravels preserved in a cavern fissure, but it is just possible that it may be due to a glaciation of much greater antiquity than that credited with the transport of the Vale of Moreton gravels.

Connection with the eastern ice-sheets is supposed to be indicated by the occurrence in the Moreton gravels of rocks of the Charnwood type, and the occasional appearance of red and white chalk and flints at various points between the Cotteswolds and Lincolnshire. Thus Buckland observed hard white chalk at Ridlington in Rutlandshire,[4] and Prof. P. F. Kendall informs me that he has found pebbles of red chalk at Northampton.

1 *Cf.* Dr Wright, Proc. Cottesw. Nat. F C., vol. vii., p. 5.
2 Geol. Mag. (1897) pp. 485-6. 3 *Ibid.* (1905) p. 218: see also Harmer, Quart. Journ. Geol. Soc., vol. lxiii., pp. 499-500.
4 *Reliqu. Diluv.*, p. 250.

In Shepherd's Lane, north of Heath and Reach, Bedfordshire, Dr Salter found red chalk above 400 feet O.D. in boulder clay resting on Lower Greensand. With the red chalk were hard chalk pebbles, Jurassic débris, gneiss and mica-schist.[1] He discovered also red chalk and hard white chalk on the site of the Battle of Naseby, and red chalk pebbles between Canon's Ashby and Adstone at a height of about 500 feet O.D.[2]

The eastern origin of the Cretaceous material in the district to the north and east of the Cotteswolds is considered to be proved by the occurrence of Chalky Boulder Clay at Berkswell near Coventry,[3] and at Rugby,[4] and by the remarkable assemblage of chalk and flints at Rowington.[5]

These constituents of the Drift may, however, have become incorporated with the ice-sheet at much later stages of the journey from the eastern counties than Lincolnshire, and may represent strata now destroyed.

If the red chalk had been transported by land-ice, I think it would be found more frequently in the intervening country and in the Severn Plain; but much more information is required as to the exact range of the pebbles before any definite conclusions can be formed. Their occurrence in the limited areas described, and at a great distance from their supposed source, is not in itself sufficient to establish the above-mentioned hypothesis of transport.

VII.—Local Snow and Ice

The conformation of the Cotteswolds, and the absence of proof of the necessary elevation and other favourable conditions, appear to preclude the supposition that the hills could have been the gathering grounds for large glaciers. It is probable that the only results of precipitation were extensive snowfields liable to seasonal melting, during which the greater part of the rubble formed during the Tertiary period would be removed.

The evidence is still too incomplete to permit of conclusive generalization. A better knowledge of the origin and mode of introduction of the Drift, assisted by a more accurate determination of the constituent rock fragments than has yet been obtained, will be required before it can be known to what extent the Cotteswold Hills were affected by the abnormal cold of the Glacial Epoch.

1 Proc. Geol. Assoc., vol. xix, pt. 1, (1905) p.47. 2 *Ibid*, p. 43.
3 Andrews, Proc. Warwickshire F. C. (1880) p. 1. 4. B Thompson, Quart. Journ Geol. Soc., vol. lv., pp. 81-2; S. V. Wood, jun., *ibid*., vol. xxvi., p. 224. 5 Brodie, Quart. Journ. Geol. Soc., vol. xxiii., p. 209; see also Rep. Brit. Assoc. (1865) p. 49.

ON THE OCCURRENCE OF *POLLICIPES* IN THE INFERIOR OOLITE

BY

THOMAS H. WITHERS, F.G.S.

A single imperfect plate (tergum) of a Cirripede, found by Miss H. M. Hutton in the Lower Limestone, Inferior Oolite (Aalenian), of Well House, Haresfield Hill, near Gloucester, was described and figured by Mr L. Richardson[1] in 1908, under the name *Pollicipes aalensis.* Attention was again called to this specimen in 1909,[2] but nothing further was added to the previous account.

Since it might be inferred that this is the first record of a Cirripede from the Inferior Oolite, it may be advisable to point out that more than fifty years ago, the late Rev. P. B. Brodie called attention[3,4,5] to certain remains of *Pollicipes* which he had collected from the Inferior Oolite at Selsley Hill, near Stroud. These remains consisted of two scuta and three fragments of other valves, and it is to be regretted that they were not described or figured, since it is not unlikely that they may have belonged to the same species as that described by Mr L. Richardson as *P. aalensis.*

The greater portion of the collection of the late Rev. P. B. Brodie was acquired by the British Museum (Natural History) in 1898, and although careful search has been made, the above Cirripede valves do not appear to be among them.

In the Geological Survey Museum, London, the writer has observed five valves (2 scuta, 2 terga, and a carina) from the Inferior Oolite of Great Ponton, Grantham, Lincolnshire, registered 25539 to 25543. The terga agree well with the type of *Pollicipes aalensis,* and since the other valves are ornamented similarly, they very probably all belong to the same species.

1. 1908. L. Richardson, "On a New Species of *Pollicipes* from the Inferior Oolite of the Cotteswold Hills": Geol Mag., dec. v., vol. v., p. 352, fig. [1] 2. 1909. L. Richardson, "Note on *Pollicipes aalensis* Richardson": Proc. Cottesw. Nat. F.C., vol. xvi., p. 265, fig. 1.

3. 1850. P. B. Brodie, "On Certain Beds in the Inferior Oolite, near Cheltenham": Quart. Journ. Geol. Soc., London, vol. vi., p. 243. 4. 1857. P. B. Brodie, "On a New Species of *Pollicipes* in the Inferior Oolite, near Stroud, in Gloucestershire": Rep. Brit. Assoc. (1856), pt. 2, p. 64.

5. 1857. P. B. Brodie, "On the Occurrence of some New Species of *Pollicipes* in the Inferior Oolite and Lias of Gloucestershire": Ann. Mag. Nat. Hist., 2 ser., vol. xix., pp. 102-3.

Obituary Notice

RIGHT HON. SIR JOHN DORINGTON, BART.

The death of Sir John Dorington, which occurred on April 5, 1911, has removed from our midst one who has undoubtedly been the most prominent figure in the County for more than a quarter of a century. The space accorded to personal notices in the Proceedings of the Club will allow me to do little more than enumerate his many spheres of activity, and glance at the characteristics by which he attained a position so distinguished.

He was born on July 6, 1832. In 1859, he married, and in the same year his connection with County affairs commenced, when he was placed on the Commission of the Peace. Nineteen years later he was elected Chairman of the Court of Quarter Sessions, which in those days carried on the work now done by County Councils (or rather some of it), and to this branch of its work Sir John devoted himself, leaving the presidency of the Court, when transacting judicial business, to colleagues who had had a legal training. When, by the Local Government Act of 1888, County Councils were established, he was, owing to the consummate ability which he had displayed as Chairman of Quarter Sessions during the past ten years, as a matter of course, elected Chairman of the Gloucestershire Council—a position which he held uninterruptedly till constrained by failing health to resign it in 1909. Thus from 1878 till 1909, he was at the head of county affairs—a leader not only in name, but in fact. The power which he wielded arose in part from the possession of qualities not in themselves uncommon, but seldom possessed in so transcendant a degree. He was a master of detail, he had a very clear head and a retentive memory. Though not eloquent, his power of lucid exposition made him an impressive speaker. Like Strafford, his motto was "Thorough," and whatever his hand found to do, he did it with his might. The lasting confidence which he inspired throughout his public career arose from the consciousness of those whom he was addressing that he generally knew more of the subject on which he was speaking than anyone else present, and also from the scrupulous fairness with which he always treated his opponents. But all these qualities would perhaps hardly have given him the commanding position which he occupied had he not also been largely endowed with that subtle personal influence which more than anything else separates the ʼανήρ ʼανδρῶν from his fellows. The affairs of the County of Gloucester have for generations been conducted by men of singular ability, who have devoted time and energy ungrudgingly to the public service, but if a roll of local administrators whose work is worthy of record were made up, with their names in order of merit, that of Sir John Dorington would assuredly be at the head.

It is as County Chairman that we in Gloucestershire think of him, but his services to the country at large are well deserving of mention. In 1874, for two brief intervals he represented the old Borough of Stroud in Parliament, and from 1886 till 1906 he sat for the Tewkesbury Division of the County. He seldom spoke in Parliament, but whenever he did, he was listened to with the greatest respect, indeed, there was probably no one among the comparatively silent members whose influence in the House was greater. He had, too, a great reputation among members of the Parliamentary Bar, as a Chairman of Committees.

The excellence of his local work was recognised by his Sovereign, when in 1886, he was created a Baronet, and that of his national work, when in 1902, he was appointed a Privy Councillor.

Nor was his usefulness confined to County Government and Parliamentary duties. He was a Reformatory Manager, a Guardian, a District Councillor and a Commissioner in Lunacy. In 1880, he was President of the Bristol and Gloucestershire Archæological Association, and he delivered the Inaugural Address at the Gloucester Meeting of the Royal Archæological Institute in 1890. On September 15, 1908, the Cotteswold Club visited Lypiatt Park, and were shown round by Sir John.

The County is fortunate in possessing two excellent portraits of him —real works of Art—one of which, painted by Herkomer in 1887, hangs in Judges' Lodgings, the other, perhaps even a better one, painted by Hugh Rivière in 1908, is in the Council Chamber at the Shire Hall. His bust, by Sir Goscombe John, was presented to Lady Dorington by his friends on the County Council in 1909.

F. A. HYETT

REPORT (No. 3) ON THE PROGRESS MADE IN CONNECTION WITH THE FLORA OF GLOUCESTERSHIRE

By Rev. H. J. Riddelsdell

The progress made with the work in 1910 has shown new features. There has been some tangible result in the co-operation of elementary schools. Lists have been sent in from various parts of the Forest of Dean to Miss Roper and Mr F. Dixon. They have not yet been closely examined, but they are sure to open some fresh lines of research and provide useful material. This advantage must be pushed home.

Beyond this, valuable information has come to hand from Mr Shoolbred, the Rev. Augustin Ley, Mr Day and others; and it is certain that other lists are on their way. But the chief step towards the final end—though it can only be regarded as a preliminary step—has perhaps been the effort to collate and classify much of the already accumulated material for the Flora. It must be owned that, in spite of many hours of assiduous work, the impression made on the bulk of material is slight. But though so much remains to be done before even this initial step is complete, yet enough light has been thrown upon our stores to enable us to see a few of the problems which arise for solution. A selection of these difficulties is given below. It is hoped that workers may find some help from having definite objects set before them, in addition to the general task of making complete lists for their districts.

(1) The following plants are wanted from the localities given, whence they have been once reported, and generally only once:—

Myosurus minimus, near Northleach.
Ranunculus ophioglossifolius, near Cheltenham.
Aconitum Napellus, wood on May Hill. It is desired to know whether it is a native in this locality.
Draba muralis, quarry at Henbury. Is it a native here?
Cakile maritima, sand at Beachley.
Sagina maritima, New Passage.
Arenaria peploides, Beachley.
Stellaria palustris, marsh, near Mitcheldean.
Trifolium ochroleucum, near Birdlip.
Vicia lathyroides, near the Old Passage.
Rosa pomifera, coppices at Painswick. ?Native.
Drosera anglica, heath, near Mitcheldean.
Callitriche truncata, canal in Gloucestershire.
Eryngium maritimum, Beachley and New Passage.
Sium latifolium, Lydbrook.
Tordylium maximum, Glenfall, Cheltenham.
Daucus gummifer, rocks at Beachley. St. Brody's specimen is too young for certainty, and may be only *D. Carota*.
Filago spathulata, fields at Lancaut.
Bidens cernua, ponds near Gloucester. The question is whether the species occurs in East Gloucester, *i.e.*, east of the Severn and north of the Thames and Severn Canal.
Anthemis nobilis, near Tewkesbury. Is it in Gloucestershire? Is it native?
Senecio integrifolius, Painswick.
Cnicus tuberosus, railway banks, Stonehouse.
Hieracium lasiophyllum, Leckhampton Hill: slope south of tramway, 1862.
Hieracium rigidum, var. *calcaricolum*, Stroud Valley.
H. umbellatum, Cranham Woods and Haresfield.

Jasione, Painswick Hill.
Wahlenbergia hederacea, from East Gloucester.
Campanula Rapunculus, Bromsberrow. Is it Native?
Gentiana campestris, Lassington Hill, Tewkesbury, Painswick, Ravenscote, and near Northleach.
Myosotis repens, boggy places, Brockworth, or anywhere else in East Gloucester.
Verbascum Lychnitis, Apperley. Is it native here?
Linaria repens, walls at Painswick. Is it native?
Scrophularia alata, Newent Canal.
Limosella aquatica, Newnham and near Westbury.
Rhinanthus major, near Cheltenham and fields near Stroud.
Melampyrum arvense, cornfields near Gloucester.
Calamintha Nepeta, St. Vincent's Rocks and Blaize Castle Woods.
Scutellaria minor, in the neighbourhood of Stroud, but north of the Stroudwater Canal.
Melittis Melissophyllum, Puckham Scrubs.
Polygonum minus, ponds near Gloucester.
P. mite, Newent Canal, Symond's Yat, and banks near Tewkesbury.
Oxyria digyna, walls, Tortworth. Perhaps a misnomer; but we should like to know what was meant.
Rumex limosus, Forthampton and Tewkesbury.
Myrica Gale, somewhere near Stroud.
Cephalanthera longifolia, Oakley Park, Cirencester.
Helleborine longifolia (*Epipactis palustris*), wood near Northleach.
Ophrys sphegodes (= *O. aranifera*), Painswick Beacon.
Habenaria albida, Painswick parish.
Leucojum æstivum, Toadsmoor Pond. Is it native or planted?
Ornithogalum nutans and *O. umbellatum*, Bromsberrow.
O. pyrenaicum, near Hanham.
Narthecium, neighbourhood of Stroud.
Juncus squarrosus, Painswick parish.
Sparganium minimum, Berkeley Canal, near Gloucester.
Acorus, Stroudwater Canal and Berkeley Canal. It is known to grow on the West Gloucester side. Is it also in East Gloucester?
Potamogeton alpinus, streamlet near Stroud. Is it East or West Gloucester?
P. acutifolius, Hereford Canal.
P. obtusifolius, pond near Chalford. Which side of the Canal?
P. Friesii, Canal, Stroud. East or West Gloucester?
Eleocharis acicularis and *Eriophorum vaginatum*, to be re-found for East Gloucester.
Rhynchospora alba, (apparently) somewhere near Northleach.
Carex dioica, Seven Springs, Naunton.
C. pallescens, Painswick parish.
C. extensa, (perhaps this) Lydney.
C. lasiocarpa (= *C. filiformis*), near Leckhampton, and Shortwood, near Pucklechurch.
Alopecurus æqualis (i.e., *fulvus*), banks of Severn, near Docks, Gloucester
Agrostis canina, heath by the Windrush.
Phleum arenarium, sandy fields, New Passage.
Melica montana, Lineover Wood.
Festuca sylvatica, Sevenhampton neighbourhood.
Agropyron junceum, New Passage.
Phegopteris Dryopteris, Painswick parish.
Lycopodium Selago, near Northleach.
Pilularia globulifera, Hereford Canal.
Tolypella intricata, ditches near Newent Canal.
Nitella opaca, pond, Berkeley, or Berkeley Canal (not certain which).

2. The following species should be looked for :—

Dianthus Armeria, any native Gloucestershire localities.
Stellaria apetala (= *S. Borœana*), on the Severn and Wye banks.
Potentilla palustris, especially in the Forest of Dean.
Cratœgus Oxyacantha (= *C. Oxyacanthoides*), especially in East Gloucester.
Œnanthe silaifolia, from Forthampton parish, or any other part on the West side of the Severn.
Aster tripolium, *Filago minima*, and *Senecio viscosus*, from East Gloucester.
Erica Tetralix, *E. cinerea*, from East Gloucester. I believe they are recorded thence ; but am not certain.
Monotropa Hypopitys, var. *hirsuta*, *i.e.*, with hairy floral parts.
Centaurium pulchellum, any part of the county.
Cynoglossum officinale, var. *subglabrum*.
Veronica scutellata, hairy variety.
V. Anagallis, glandular variety.
Melampyrum pratense, var. *hians*, *i.e.*, flower brighter yellow, with gaping mouth ; flower smaller
Stachys ambigua, from East Gloucester.
Lamium hybridum, from West Gloucester.
Chenopodium murale and *Plantago Coronopus*, from East Gloucester.
Daphne Mezereum.
Scirpus Tabernœmontani, from any place where tidal influence is felt.
Bromus racemosus.

(3) The following special points :—

A special look-out should be kept along the *east bank of the Severn, above Framilode*, for salt water, brackish water and tidal mud species. Hardly any such plants are recorded for East Gloucester.
Arctium specimens, representative and well dried, are required ; chiefly other than *majus* and *minus*.
Tragopogon pratense, the true plant, is wanted, *i.e.*, with the florets a good deal longer than the green involucre, &c.
Cuscuta, any species, carefully gathered along with part of the host plant, wanted. Fresh specimens, kept fresh in transit by careful packing in damp paper, are best.
Orobanche of any species should be sent, fresh.
Digitalis, in East Gloucester. Native localities wanted. It grew on Marl Hill, Cheltenham, and in Coventry Park, Winchcombe. Is it native in these places ? It grows in a quarry on Westington Hill. ?Native.
Euphrasia specimens are wanted. They should be gathered some half-dozen together, as they are a very critical genus.
Utricularias, from Head of Coombe Hill Canal, Maisemore Ham, Gloucester and Berkeley Canal, or elsewhere, are wanted. They should be gathered with sufficiency of stem leaves and good spikes of flowers.

With reference to all these points, it is desirable that specimens, dried or fresh, should be sent to the Editor (Rev. H. J. Riddelsdell, Old Registry, Llandaff) with accurate note of the locality in which they were gathered. The result aimed at is (1) the confirmation of records, many of which are doubtful ; (2) the exact determination of a locality, especially as to which of the divisions or districts it is in ; and (3) the further elucidation of the distribution of critical species. Some of the records in the first list, which want confirmation, are merely verbal ; others are supported with specimens ; but it is desirable to trace all of them further.

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[*The Editor of the Proceedings of the Cotteswold Naturalists' Field Club is directed to make it known to the Public that the Authors alone are responsible for the facts and opinions contained in their respective Papers*].

VOL. XVII. JULY, 1912 PART III.

PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB

FOR

MAY, 1911, TO MARCH, 1912

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LIST OF MEMBERS, APRIL, 1912

Honorary Members:

G. Embrey, F.I.C., F.C.S., Hill-close, 47 Park Road, Gloucester
C. Lloyd Morgan, LL.D., F.R.S., F.G.S., The University, Bristol
H. B. Woodward, F.R.S., F.G.S., 85 Coombe Road, Croydon
C. Callaway, M.A., D.Sc., 16 Montpellier Villas, Cheltenham
Rev. Canon W. Bazeley, M.A., Matson Rectory, Gloucester

Members:

Affleck, R. C., M.B., Ch.B. ..	Glendale House, Cheltenham
Ainsworth-Davis, Prof. J. R., M.A.	Royal Agricultural College, Cirencester
Bailey, Charles, M.Sc., F.L.S. ..	Haymesgarth, Cleeve Hill, Glos.
Baker, G. E. Ll., J.P.	Hardwicke Court, near Gloucester
Ball, A. J. Morton	The Green, Stroud
Bathurst, Right Hon Earl, C.M.G.	Cirencester House, Cirencester
Baxter, Wynne E., J.P., D.L., F.G.S.	Granville Cottage, Stroud
*Bellows, William	Walden, Denmark Road, Gloucester
Birchall, J. D., J.P...	Bowden Hall, Gloucester
Bowly, Christopher, M.A.I. ..	Siddington House, Cirencester
Bretherton, F. H.	Belgrave House, Gloucester
Brown, C., C.I.E.	Southend Lodge, Leckhampton, Cheltenham
Brown, O. A.	Shiel, Sandy Lane Road, nr. Cheltenham
Brown, Walter	Further Barton, Cirencester
Bruton, Henry Tew..	Newlyn, Gloucester
Bruton, H.W.	Bewick House, Gloucester
Bubb, Henry..	Ullen Wood, near Cheltenham
*Butt, Rev. Walter, M.A.	Oakwood, Chepstow
*Carles, W. R., C.M.G., F.L.S. ..	Silwood, The Park, Cheltenham
Chance, H. G., M.A...	Lynthorpe, Barnwood, Gloucester
Clark, Oscar, M.A., M.B., M.R.C.S.	Spa Road, Gloucester
Cockshott, A., M.A.	7 Pittville Crescent, Cheltenham
*Colchester-Wemyss, M. W., J.P.	Westbury Court, Newnham
Cole, R. M., M.R.C.S.	Northgate House, Gloucester
Coley, S. J.	High Street, Stroud
Collett, J. M., F.C.S.	Kimsbury House, near Gloucester

Croom-Johnson, A., J.P., F.G.S. ..	Fox Elms, Robinswood Hill, Gloucester
Coomaraswamy, Ananda K., D.Sc. F.L.S., F.G.S., M.R.A.S. ..	c/o Messrs Thos. Cook & Son, Bombay, India
*Crooke, W., B.A., F.A.I.	Langton House, Charlton Kings, Cheltenham
Cullis, A. J.	21 Park Road, Gloucester
*Cullis, F. J., F.G.S.	Barnwood, Gloucester
Currie, G. M...	26 Lansdown Place, Cheltenham
Curtis, Charles	Cainscross House, Stroud
Daniels, J. S...	Lightpill, Stroud
Davies, Rev. C. H., M.A.	Bagendon Rectory, Cirencester
Dixon, J. M., B.A., LL.B.	Mickleton, Campden
Ducie, The Earl of, F.R.S., F.G.S.	Tortworth Court, Falfield, R.S.O.
*Duke, Lieut.-Col. J. C.	Gwynfa, Cheltenham
*Ellis, T. S., M.R.C.S.	9 Denmark Road, Gloucester
Finlay, D. E., M.B., B.S.	Wells Dene, Park Road, Gloucester
Foster, R. G., J.P.	Lennox House, Gloucester
Fowler, O. H., M.R.C.S., J.P. ..	Ashcroft House, Cirencester
Fulton, Sir E. M. H., C.S.I. ..	Elmhust, Suffolk Lawn, Cheltenham
Gardiner, C. I., M.A., F.G.S., ..	The College, Cheltenham
*Garrett, J. H., M.D., F.L.S. ..	Municipal Offices, Cheltenham
Geidt, B. G.	Bayshill House, Cheltenham
*Gray, J. W., F.G.S.	6 Richmond Pk. Cres., Bournemouth
Grosvenor, W. W., B.A., M.D. ..	Granville House, The Spa, Gloucester
Guise, Sir W. F. G., Bart., J.P., D.L.	Elmore Court, near Gloucester
Haigh, Herbert	Coed Ithel, Llandogo, Mon.
Hannam-Clark, F.	12 Queen Street, Gloucester
Hartland, Ernest, M.A.	Hardwick Court, Chepstow
Hedley, G. W., M.A., F.C.S. ..	The College, Cheltenham
Hobbs, J. N.	Concord, Moorend Grove, Cheltenham
Hooker, C. Paget, L.R.C.P., L.R.C.S.	Dollar Ward House, Cirencester
Household, H. W., M.A.	Park Lawn, The Park, Cheltenham
Hume-Rothery, J. H., M.A., B.Sc..	The Pines, Tivoli Road, Cheltenham
Jones, John H.	Barrow Hill, Churchdown, Cheltenham
Keeling, G. W., J.P.	10 Lansdown Terrace, Cheltenham
Knight, H. H., M.A.	The Lodge, All Saints' Villas, Cheltenham
Knowles, H.	Egerton House, Spa Road, Gloucester
Lawrence, E., ...	Southlands, Queen's Road, Cheltenham
Little, E. P.	Amberley Court, near Stroud
McAldowie, A. M., M.D., F.R.S.E.	Glengarriff, Leckhampton Road, Cheltenham
Margetson, W.	Bright Side, Stroud
Marling, Sir William H., Bart., J.P., D.L.	Stanley Park, Stroud
Marling, W. J. Paley	Stanley Park, Stroud
Marling, S. S., J.P.	Stanley Park, Stroud
Meredith, W. L., F.G.S.	7 Midland Road, Gloucester
Mitchinson, Right Rev. J., D.C.L., D.D.	College Gardens, Gloucester
Montgomrey, A. S., J.P., ...	10 Montpellier Grove, Cheltenham

Moreton, Lord	Sarsden, Chipping Norton, Oxon.
Newton, Surgeon-Major Isaac, I.M.S.	Broadlands, The Park, Cheltenham
Norris, H. E...	Cirencester
*Paine, Alfred E. W...	The Poplars, Welford-on-Avon
*Paris, E. Talbot, Inter. B.Sc., F.C.S.	15 Montpellier Villas, Cheltenham
Pearce, F. T.	Lorraine House, Gloucester
Perkins, Vincent R.	Wotton-under-Edge
Phillips, J. G.	Barnwood Avenue, near Gloucester
*Prevost, E. W., M.A., Ph.D., F.R.S.E.,	Weston, Ross
Price, M. P., J.P.	Tibberton Court, Gloucester
Price, W. R., B.A., F.L.S. ..	Pen Moel, Chepstow
*Richardson, L., F.R.S.E., F.L.S., F.G.S.	10 Oxford Parade, Cheltenham
Rixon, W. A., J.P.	Turkdean Manor, Northleach, Glos.
*Sawyer, John, J.P., C.C.	Battledown, Cheltenham
*Scobell, Ven. E. C., M.A.	Upton St. Leonards, Gloucester
Sewell, E. C.	The Beeches, Cirencester
Sinclair, The Ven. Archdeacon ..	The Greenway, near Cheltenham
Skinner, J. W.	The Edge, Stroud
Slater, A., J.P.	Garron Dene, Gloucester
Smith, A. E.	The Hollies, Nailsworth
Smithin, James A.	Lloyds Bank, Gloucester
Stanton, A. W.	22 Henrietta Street, Cavendish Square, London
Stanton, C. H., M.A., F.R.G.S. ..	Field Place, Stroud
Stanton, Walter John	Stratford Lodge, Stroud
Stephens, A. J.	Clovelly, Denmark Road, Gloucester
Sweeny, Lieut. Col. T. H.	Hazelwood, The Park, Cheltenham
Taynton, H. J.	8 Clarence Street, Gloucester
*Thompson, W.	Lansdown, Stroud
Tunbridge, E. W., B.Sc., F.G.S. ..	Rocklands, Edgbaston, Birmingham
*Upton, Charles	Burfield Lodge, St. Paul's Road, Gloucester
Waller, F. W.	Horton Road, Gloucester
Washbourn, William	Blackfriars, Gloucester
Watkinson, A.	Mickleton, Campden, Glos.
Watson, Dep. Surgeon-Gen. G. A...	Hendre, Cheltenham
Weaver, Henry J., M.I.C.E.I., M.I.M.E., F.G.S.	Ashcroft, Churchdown, nr. Cheltenham
Wenden, Major J. G., V.D. ..	The Chantry, Dursley
*Wethered, E. B., J.P., F.G.S. ..	The Uplands, Cheltenham
Wilson, E. T., M.B.	Westal, Cheltenham
*Winnington-Ingram, Rev. A. R. ..	Lassington Rectory, Gloucester
*Winwood, Rev. H. H., M.A., F.G.S.	11 Cavendish Crescent, Bath
*Witchell, E. Northam	Lansdown, Stroud
Witts, G. B., C.E., J.P., A.M.I.C.E.	Leckhampton, Cheltenham
Witts, Canon F. E. B., B.A. ..	Upper Slaughter Manor, Lower Slaughter, R.S.O., Glos.
Wood, Walter B.	Barnwood, Gloucester
Young, C. C. C.	Godfrey House, Cheltenham

*Signifies those who have contributed Papers printed in the " Proceedings" of the Club.

(*Any corrections in this List should be notified to the Hon. Secretary*).

LIST OF SOCIETIES, INSTITUTIONS, &c.,

To whom Copies of the Club's Publications are presented.

An asterisk denotes those from whom publications are received in exchange.

*The American Museum of Natural History, Central Park, 77th Street and 8th Avenue, New York City, U.S. America, c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*†Birmingham Nat. Hist. & Phil. Society, c/o The Librarian, Avebury House, 55 Newhall Street, Birmingham

*†The Bristol and Gloucestershire Archæological Society, c/o The Librarian, Eastgate, Gloucester.

*†The Bristol Naturalists' Society, c/o C. King Rudge, L.R.C.P., 145 White Ladies Road, Redland, Bristol.

The British Museum (Natural History), The Librarian, Cromwell Road, London, W.

The British Museum (Copyright Office) London, W.C.

The British Association, The Secretary, Burlington House, London, W.

The Cambridge University Library, c/o The Librarian, Cambridge.

The Library, County Education Office, Shire Hall, Gloucester.

The Geological Magazine,The Editor of, 13 Arundel Gardens, Notting Hill, W.

The Geological Society, c/o The Librarian, Burlington House, Piccadilly, London, W.

*The Geological Survey, c/o The Librarian, The School of Mines, Jermyn Street, London, S.W.

*†The Geologists' Association, c/o The Librarian, University College, Gower Street, London, W.C.

*The Glasgow Geological Society, c/o The Librarian, 207 Bath Street, Glasgow.

The Gloucester Municipal Library, Brunswick Road, Gloucester.

Nature, The Editor of, c/o Messrs Macmillan & Co., St. Martin's Street, London, W.C.

*†The North Staffordshire Field Club, c/o W. Wells-Bladen, Stone, Staffordshire.

The Royal Society, c/o The Librarian, Burlington House, Piccadilly, W.

The Smithsonian Institution (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*The U.S. Geological Survey (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*†The Warwickshire Naturalists' and Archæologists' Field Club, The Museum, Warwick

*†The Wiltshire Archæological and Natural History Society, The Museum, Devizes.

*†The Woolhope Naturalists' Field Club, c/o Hon Librarian, Woolhope Club, Free Library, Hereford.

†The Presidents and Secretaries of these Societies are considered as Ex-officio Members of the Club, and are cordially invited to the Meetings; Programmes of Meetings to be sent to them as invitations.

INCOME AND EXPENDITURE

INCOME

	£ s d	£ s d
Balance from last Account..		22 15 4
Subscriptions to 31st Dec. 1911	72 18 0	
Entrance Fees	8 0 0	
Archæological Society—Rent of Room	8 0 0	
		88 18 0
		£111 13 4

J. H. JONES, *Hon. Treasurer.*
Gloucester, 2nd April, 1912.

FOR THE YEAR 1911

EXPENDITURE

	£	s	d	£	s	d
Secretary's Expenses, including Entertainment of Guests, Proceedings, etc.	9	7	4			
Treasurer—Expenses		15	0			
Bellows—Rent to 25th December, 1911 ..	12	0	0			
Library Expenses, Custodian, etc.	1	0	7			
Municipal Schools—Rent	2	2	0			
Pitcher—Lantern		9	0			
Coffee House Co.—Refreshments	5	10	0			
Bellows—Printing and as paid on Account of cost of "Proceedings," £55 8s. 9d. ..	45	14	1			
Norman, Sawyer & Co.—Printing	11	6	6			
Photochrom Co.	5	4	0			
Blocks for "Proceedings"	2	12	6			
H. J. Riddelsdell—"Flora"	1	6	2			
				97	7	2
BALANCE in hands of Hon. Treasurer				14	6	2
				111	13	4
				£111	13	4

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to obtain the record of all details of geological interest, to promote the preservation of all antiquities, and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member, he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club; one dissentient in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (See Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot); but the Presidentshall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in January, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and other Members forming the Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—All papers communicated to the Club shall be submitted to a Publication Committee, which shall consist of the President, Honorary Treasurer, Honorary Secretary, and two other Members appointed at the Annual Meeting. The decision of the Publication Committee shall be final. Any gentleman who favours the Club with Lectures on any subject shall be invited to furnish an abstract of the lecture for publication in the Proceedings of the Club.

13.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

ORDINARY WINTER MEETINGS

Tuesday, November 14th, 1911

William Crooke, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read, confirmed and signed by the Chairman.

The Rev. A. R. Winnington-Ingram exhibited a specimen of Kieselgurh, which is a hard white clay from the banks of the River Bann at Foome Bridge, County Antrim, between Lough Neagh and Lough Beg. For many years no notice was taken of the clay, but a man named Grant, finding that there was a market for it, has it dug, cut into pieces about the size of a large sugar-loaf, set in the fields to dry, after which it is stored or sent off by rail. It fetches 20/- per cwt.

Kieselgurh, being a good absorbent, is used in the manufacture of dynamite. It is also a non-conductor.

The following lecture was given :—

"Denmark." By *L. Richardson.*

The lecture was illustrated with lantern-views.

The following were elected Members of the Club :—

R. Cunningham-Affleck, M.B., Ch. B., Cheltenham ; A. Croom-Johnson, J.P., Gloucester ; Charles Brown, C.I.E., Cheltenham ; A. S. Montgomery, J.P., Cheltenham ; Lieut.-Col. T. H. Sweeny, Cheltenham and Arthur Watkinson, Mickleton, Glos.

Tuesday, December 12th, 1911

William Crooke, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read, confirmed and signed by the Chairman.

A Lecture, illustrated with lantern-views, was then given on :—

"The Faroes, Iceland and Island of Jan Mayen." By *William Bellows.*

Tuesday, February 13th, 1912

William Crooke, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read, confirmed and signed.

The following paper, which was illustrated with lantern-views, was communicated :—

"The Fossil Plants of the Forest of Dean Coalfield." By *E. A. Newell-Arber, Sc.D., M.A., F.L.S., F.G.S., Cambridge University Demonstrator in Palæolobotany.*

The Hon. Secretary exhibited some views of Builth Wells, the Aberedw Valley, Llangorse Lake and the Brecon Beacons.

The following were elected Members of the Club :—

O. A. Brown, Cheltenham and E. Lawrence, Cheltenham.

Tuesday, March 12th, 1912

WILLIAM CROOKE, B.A., F.A.I., President, in the Chair

The Minutes of the last Meeting were read, confirmed and signed.

The following papers were communicated :—

1. "NOTE ON A LONG BARROW, NEAR BISLEY." By *A. E. W. Paine.*

2. "A CAVE IN THE GREAT DOWARD CONTAINING HUMAN REMAINS." By *A. E. W. Paine.*

3. "THE WATER SUPPLY OF THE CITY OF GLOUCESTER."
Introduction, Geology and Water-Supply, by *L. Richardson;*
Historical Note and Appendix, by *Roland Austin.*

The Hon. Secretary exhibited a MS.-map showing the geographical distribution of the sand, gravel and clay in the neighbourhood of Cheltenham.

Mr E. Northam Witchell, in some remarks on the Cuckoo, said that he was recently shown a number of cuckoo's eggs of different colourings and markings, and he was assured that the colourings and markings of each egg were an exact imitation of the colouring and marking of the eggs of the bird in whose nest the cuckoo's egg was found.

EXCURSIONS

1911

EXCURSION TO THE STRATFORD-ON-AVON DISTRICT

TUESDAY, MAY 16th, 1911

Directors : L. RICHARDSON *and* G. W. WEBB

(*Report by* W. THOMPSON *and* G. W. WEBB)

On Tuesday, at the first Field Meeting, the Club broke fresh ground, and, although not a word was heard about geology, nor any work accomplished by the botanists, it was generally admitted that the trip into Warwickshire was most enjoyable. Mr L. Richardson, the able and energetic Hon. Secretary, aims at gratifying the tastes of all the Members, rather than of specialising for a few. With him, of course, geology stands first, but he is not adverse to providing an off-day for archæologists, and if botanists can do a little work so much the better. On Tuesday, about thirty Members journeyed to Stratford-on-Avon by G.W.R. line, thus obtaining glimpses of Winchcombe, Broadway, Toddington and other picturesque spots. At Stratford a motor 'bus, obtained from Coventry, was in readiness, to convey the party to the pretty and historic village of Kineton and thence to Edge Hills. It must be confessed that this road machine was not a conspicuous success, although it completed both journeys in safety. Members would have preferred horse vehicles, but, as twenty-eight miles had to be covered, the Secretary naturally thought that a motor would be preferable. All's well that ends well, but if the double journey could have been accomplished somewhat faster, the day's programme would certainly have been more profitable. We say this advisedly, because at Kineton Church, Members were met by Mr G. W. Webb, Headmaster of Kineton Middle School, who proved to be a veritable storehouse of local information, and who naturally regretted that owing to lack of time only a brief *résumé* of the Church's history could be given. [W. T.].

Speaking of this historic structure he said the church was built between 1315 and 1370. It has an Early English Tower and arch, with handsome dog-tooth mouldings. The church was rebuilt (except tower) in 1770, under superintendence of Sanderson Miller, of Rodway Grange, who added north and south transepts. This man designed the hall of Lacock Abbey, Wilts., and is considered the father of Jacobean Gothic. He planted the trees lining the Edge Hills, which was his estate, and is now owned by a descendant. The Rev. Francis Miller, M.A., was Vicar of Kineton from 1835-90. In 1870, he began to "restore" the church. He spent some £6,000 on its interior and exterior. The handsome open parapet around the chancel he put in memory of his first wife ; that round the nave and transept and the embattled perpendicular work at the summit of the tower to his second wife. The epitaph to each is upon the stonework on the north side of the church. He raised the arcade of the nave and the chancel arch, put in splendid oak roofs to nave, transepts and chancel (under the original roofs, which are still undisturbed), supported on handsome stone corbels. The old box pews were cut down and modernised, and all the woodwork—which is very good, including the pulpit and the carved work at the west end—was done by the village carpenter, who is sexton and clerk of the church. Mr Miller's idea was that the continuity of the services should not be broken, so the scaffolding had to be pulled down every Thursday to prepare the church for Sunday services. This caused the restoration to cover nearly twenty years, and only one Sunday during the whole time was the church not used for divine service. He destroyed every trace of the original architecture in replacing the square-headed windows of the chancel (circa., 1370), and the 18th century ones of the nave, which were of a debased and not good type, but still marking a period of architecture, with large decorated perpendicular windows all the same size and handsome. These are copied from a window in Ratley Church on the Edge Hills. The parapet on the chancel is a copy of that on the church at Tysoe. In 1906, some handsome additions were made to the interior. A fine organ case in renaissance style, chancel screen—reredos, and panelling round the sanctuary in fumed oak, the latter with linen fold carved panels. These additions were given by the members of the Warwickshire Hunt Club and members of the Willoughby-de-Broke family as a memorial to the late Nineteenth Baron Willoughby-de-Broke. A mutilated recumbent figure of a vested priest of the 14th century is in a recess at the west end of the church —probably one of the monks of Kenilworth who ministered here, and under whose guidance the church was built. The faced stonework of the windows was of Kenilworth stone.

On arriving at Edge Hill Battlefield, Mr Webb rapidly described the operations of the eventful day, and incidentally introduced matters of a more recent and topical nature.

The battlefield is about two miles from Kineton. Two farms, about 1,000 yards apart, named Battledown and Thistledon, which have been built since the battle, mark the site of the battle ground. A little nearer the hills than these farms, and between them, is the common grave, said to contain 500 soldiers who fell. As they would not be moved far away, and as in the immediate neighbourhood a great deal of *débris*—cannon balls, bullets, coins, armour, etc.—have been found, it is likely that this was the hottest part of the field. About 500 yards N.E. is the grave of the officers who fell.

Prince Rupert's videttes first discovered the whereabouts of the Parliament army on the Saturday night, when they saw the smoke of their camp fires from the summit of Burton Dassett Hill, where there is a well-built stone beacon (14th century), and from which news of the battle was flashed to Ivinghoe (Northants), then to Harrow, and so to London the same night. Rupert's impetuous charge was irresistible and decimated the left wing of Lord Essex's forces. Had he turned and attacked the centre on its flank, Edge Hill would have been a decisive victory for the Royalists, but, flushed with his initial success, he allowed his followers to ride on to Kineton, where they plundered and feasted, and toward evening went on to take the enemy in the rear. Crossing the ford at the bottom of Bridge Street, Kineton, over the River Dene, they slew the picket guarding it. Eighty years ago, when the foundations were being dug for the bridge, several skeletons were dug up, some armour and other impedimenta of a warlike nature. Rupert's disorganised force had now to reckon with John Hampden's baggage train, which was coming up from Stratford, and was repulsed. He also learned that the Parliament right wing, under Balfour, had beaten back the King's left wing; that the King's centre was pushed back towards the hill; and that the royal standard had been captured and Sir Edmund Verney slain.

Captain Cromwell was probably fighting on the Parliament *right* wing, the victorious one, and it was probably at this first battle that he noticed the immense superiority of the King's cavalry, and made up his mind to create a force that was afterwards known as his "Ironsides." Note that it was on the right wing at Marston Moor and Naseby that he was so victorious. He always fought on this wing. There can be no credence to the Dugdale story that Cromwell watched the battle from Burton Dassett Church tower, and slid down one of the bell ropes to escape from some Royalist scouts. He was on the opposite side of the field—if he was there at all. [G.W.W.]

Mr Webb was heartily thanked for his friendly services, and in reply, that gentleman expressed the hope that on a future occasion, Members would spend more time in this interesting locality.

The return journey to Stratford was much enjoyed. The prefix "leafy" has been applied to Warwickshire, and certainly not without reason. The views obtained, if not extensive, were delightfully picturesque, and it was very evident that farming was being carried on under good conditions, and in all probability with the amount of success which intelligent and energetic husbandry deserves. A few miles from Stratford, Charlecote House was passed. It is a large red brick Elizabethan mansion, standing in a magnificent park, well timbered, and through which passes the River Avon. As is well known, the name of Shakespeare has been associated with this place, and its first owner Sir Thomas Lucy, but the deer-stealing incident is possibly only legendary, although the satire on Mr Justice Shallow will no doubt continue to perpetuate it. At all events, there were fine dappled deer in the park this bright May afternoon, and it was easy to think of the melancholy Jaques, of Rosalind and Orlando, not to mention other rural characters which for generations have made "As You Like It" a play of abiding interest and enjoyment. Here, too, near the entrance gates with their heads of the wild boar carved in stone, is the tumble-down stile which has long proved amusing to unsuspicious and innocent people. Several children, fresh from school, were moving the bars up and down as if to show the occupants of the motor how easy it is to come to grief when taking a seat on the unusual stile. The road to Stratford skirts the park for a considerable distance, and soon after leaving the lordly demesne behind, the pleasure party travelled over the Clopton Bridge, with its view of Trinity Church, the Memorial Theatre, the boats and punts on the river, and people seated in the pleasure gardens. It was a fitting termination to a ride through country which to a greater portion of those present was new. [W.T.]

HALF-DAY EXCURSION

TO

CHARLTON KINGS, CHELTENHAM

Saturday, May 27th, 1911

Directors: L. RICHARDSON, JOHN SAWYER AND G. D. WADHAM

(*Report by* L. RICHARDSON)

From the G.W.R. station the party drove to the Cotswold Potteries, where they were met by the Manager, Mr G. D. Wadham. Saturday afternoon is a holiday, but the engineer and foreman very kindly came back, so that the complete manufacturing process could be shown to the Members. There are only two potteries in work now in this part of Gloucestershire—here at Leckhampton and at Greet, near Winchcombe. That at Cranham, Mr Wadham stated, was closed.

Two kinds of pottery are manufactured at Leckhampton: the ordinary red ware and the "Chelt" ware, which is green. The former is made from clay dug on the spot, but mixed with some more loamy material from Leckhampton Hill, the glaze being obtained by coating the article with red lead and then burning in the kiln. The green ware, on the other hand, is made from Cornish clay (china clay), which is coated with a mixture containing copper oxide and then burned. Each of the Members was presented on leaving with a booklet entitled "How We Make our Goods," and it was also mentioned that a full account of the works was to be found in Pt. 4 (1910) of the Proceedings of the Cheltenham Natural Science Society.

The next stop was at the large sand-pit near the Charlton Kings Laundry. The sand, which is sharp and clean, and mainly dug for builders' purposes, is traversed by irregular layers of gravel. This gravel is composed of rolled pieces of Lias ironstone and of Oolite limestone. Mr Richardson said that while the gravel had been derived from the Cotteswolds, the sand had not. It had been introduced from further North. Very little was known concerning the history of the sand and gravel deposits of the vale, although there could be but little doubt that they had been introduced during the Glacial period. Gravel was seen at the next pit at which the Members stopped—that near Charlton Kings Station. This gravel is of entirely local origin.

At the foot of Wistley Hill, Mr John Sawyer pointed out the line of the old British trackway, which became conspicuously sunk a short distance farther up the hill.

Near the Cemetery in Charlton Kings, the gardens of the Gardening Class, conducted by the Local Higher Education Authority, through the Charlton Kings Horticultural Society, were inspected, and the Members were greatly pleased at their neatness and utility. Mr Richardson explained that it was not the object of the education authorities to make what he would call professional gardeners, but to afford those who wished facilities for acquiring information as to how to run allotment or cottage gardens of their own. He added that it was soon found that there were many little requisites for garden work that could be made with the aid of a little knowledge of rough carpentry and joinery, and it was their hope that in the near future it would be possible to run, in connection with gardening classes, a class that would afford opportunities for acquiring practically such information.

As there was a little time to spare, a brief visit was paid to the church, under Mr Sawyer's guidance.

Thence the Members drove to the President's residence, Langton House, where they were entertained at tea by Mr and Mrs Crooke.

EXCURSION TO KNIGHTSFORD BRIDGE

Tuesday, June 13th, 1911

Directors: THE REV. A. M. MANLEY, L. RICHARDSON and T. L. WALKER

(*Report by* L. RICHARDSON)

The Members met at Shrub Hill Station, Worcester, at 10.6 *a.m.*

Thence they drove to Leigh Court. At Leigh Court Church the Members were met by the Rev. A. M. Manley and his Churchwarden, Mr Holmes. Mr Manley showed the Members over the Church, which possesses some fine Renaissance tombs, and on the outside of the north wall a niche, consisting of a small Norman arch, within which is a figure of the Saviour. This forms one of the illustrations in Parker's *Gothic Architecture*.

Before lunch, Mr T. L. Walker conducted the Members over one of his hop-yards and drying-kilns. The hops were being sprayed with a solution of soft soap and quassia, to kill the blight. The drying-kilns consist of two

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER

rooms—an upper and a lower. The hops are distributed over the floor of the upper room, which is covered with a horsehair mat, and is so constructed that the hot air of the room below can pass up through the floor and the horsehair mat, and so dry the hops arranged upon it. The hot air is driven in to the lower room by a fan from an engine. The hops take about twelve hours to dry, and are then ready for pressing into bags, to be sent to market.

After lunch at the Talbot Hotel, Knightsford Bridge, the Members ascended Ankerdine Hill. This hill is composed mainly of May Hill Sandstone, and is one of the most prominent eminences of the hills that, geologically and geographically, are a continuation of the hills in the neighbourhood of Malvern and Ledbury. Further north, the more prominent hills are the Woodbury and Abberley Hills. At the foot of the eastern slope of the Ankerdine Hill is a fault by which the Trias has been let down against the Silurian. The Silurian rocks have been thrust up, and in places, from beneath there appear patches of Archæan rocks, as at Martley. To the west are the Old Red Sandstone Beds, synclinally arranged, for from beneath them on the west rise up Silurian rocks again. The diversified scenery where the Lower Old Red beds occur is in a large measure due to the presence in them of harder bands—"Cornstones." The valeland between the hill and Worcester is richly wooded, and the red ground of the Trias on the east, and the Old Red on the west, is to a large extent covered with well-kept hop gardens. On the western side of the hill is the River Teme, pursuing a meandering course, amid alluvial flats, before rushing through the Knightsford gap into the Lower Severn Valley.

The Members drove back to Worcester and left by the 6.24 *p.m.* train.

HALF-DAY EXCURSION TO THE ROYAL AGRICULTURAL COLLEGE, CIRENCESTER

Saturday, July 1st, 1911

Director: PROF. J. R. AINSWORTH-DAVIS, M.A., F.C.P.

The Members met at the College (Plate XXX.) at 4.15 *p.m.*

The Principal, Prof. Ainsworth-Davis, and Miss Ainsworth-Davis gave them a hearty welcome and kindly entertained them to tea.

After tea, a tour of inspection was made of the College, beginning at the Dining Hall, where the names of Diploma students from Henry Tanner, the first on the list, in the year 1847, are inscribed on the walls. The chemical laboratory, with its 15th century oak beams, the building having probably originally been an old tithe barn, was the object of much interest. The Principal's house, adapted from an old Tudor farmhouse that existed when the College was built in 1845, and which contains a fine specimen of Jacobean oak panelling in the dining-room was much admired. The visitors signed their names in the Visitors' Book, which contains the signature of the late King, when he visited the R.A.C. as Prince of Wales, on the occasion of the jubilee of the College; whilst on the same page are the signatures of two former students, who figured in the Coronation honours, *i.e.*, the Marquess of Houghton and Sir John B. Bowen Jones, Bart.

The party were shown the College Chapel, dedicated to St. George the Martyr in 1909, and which contains the brasses to the memory of R. Jeffreys Brown, Edward Holland, Langston of Sarsden, Sotheron Estcourt, the fourth Earl Bathurst (first president), the fifth Earl Bathurst, the second Earl of Ducie (first vice-president), Principal Haygarth (to whom the reredos is also a memorial), and Principal Constable. Other interesting objects in the Chapel were some William Morris glass in the upper part of the east window, presented by Sir Arthur Church, and also the stone and wood carving by Florentine workmen.

The party then visited the Meteorological Station, an item of interest being the set of soil-thermometers. In the Botanical Gardens some time was spent, where the Members were shown some English and Chilian dodder, sown with clovers, the former being the most robust, while the latter was more vigorous with American than with English clovers. There are several plots of Soya bean, the most vigorous being from uncleaned seeds imported from Manchuria. In this case the necessary bacteria for forming root nodules no doubt were present in the adherent earth. Other interesting specimens were Chinese lucerne, and plots planted up with cleanings from seeds to show the nature of the impurities.

The Club also visited the Model Dairy, poultry runs, experimental orchard and the arable plots.

A vote of thanks was passed to Principal Ainsworth-Davis for his hospitality and the interest which he and members of his staff had imparted to the visit.

EXCURSION TO BRECON

Tuesday, July 4th to Thursday July 6th

Director : L. RICHARDSON

(*Report by* L. RICHARDSON)

This year the long Excursion was to Brecon, and three days were spent exploring the country around Llangorse Lake, the far-famed Beacons and Brecon town. Arriving at Brecon early on Tuesday afternoon, the party drove to Llangorse Lake, and *en route*, obtained fine views of the Brecon Beacons. The lake (502 feet above ordnance-datum) is the largest sheet of water in South Wales, being 350 acres in area and over five miles round. Owing to its being situated in the midst of a rather flat stretch of ground and its shores being covered with reeds, it is not possible to obtain (from this place) a true idea of its size. " Gors " means a swamp, and the surrounding low ground is in places quite soft, and suggests that the lake was once much more extensive. On the island on the lake have been discovered the remains of pre-historic lake-dwellings, which circumstance no doubt gave rise to the local legend that a city lay buried beneath its waters. The River Llyfni flows in at the south end and out at the north-west, and there is a tradition that the fish of the river do not mix with those of the lake—doubtless because they prefer to remain in the fresh-running stream-water.

In the churchyard of Llangorse Church has been discovered a rude sepulchral slab, bearing the inscription, supposed to be Saxon, "*Hic jacet Sigfred filius ulma.*"

After tea at the Hotel, the drive was continued *via* Cathedine to Bwlch. " Bwlch " means a gap or a defile, and here a deep cutting allows the Abergavenny road to pass through the ridge. The Members went through the cutting and saw the Valley of the Usk with the Sugar Loaf Mountain (a mass of Old Red Sandstone, 1955 feet high) in the distance, and the outcrop of the Carboniferous Limestone on the north-western rim of the great South Wales Coalfield. Leaving Bwlch, a place was very shortly reached where the road was carried over a small valley by an embankment with stone

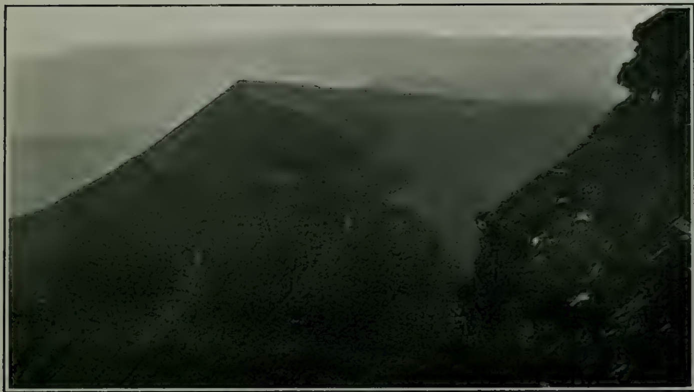

Photo. O. Jackson

Fig. 1.—VIEW OF CRIBYN FROM PEN-Y-FAN, BRECON BEACONS

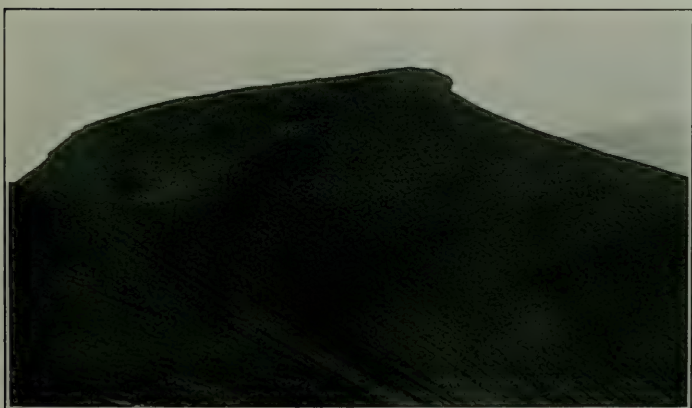

Photo. O. Jackson

Fig. 2.—FAN CORN DU, BRECON BEACONS

Photo. P. Morton

Fig. 1. –LLANGORSE LAKE.


Photo. P. Morton.

Fig. 2.—OLD BRIDGE AT TAL-Y-BONT

(Blocks lent by E. J. Burrow

retaining-walls. On the south side was the valley of a tributary of the deeply sunk River Usk; on the north, that of the Llyfni, the stream that finds its way through Llangorse Lake into the River Wye. The return drive to Brecon was *via* Talybont, where there is an interesting old bridge.

On Wednesday the party left Brecon by the Brecon and Merthyr Railway to Torpantau. The railway runs along the sides of a magnificent valley, and is justly claimed by the local guide-books to be "one of the loveliest railway rides to be had anywhere in Wales." From Torpantau Station (1,300 feet) the old road from Merthyr to Brecon arcoss the moorland was followed. A mile away down the valley was seen the Pentwyn reservoir at Dol-y-gaer with the chimneys of Dowlais beyond; while in front, in the valley, lay the reservoir that supplies Merthyr and Dowlais.

Arrived in the gap on the east side of Cribyn (Plate XXXI., fig. 1), lunch was partaken of, after which the Members skirted the peak and climbed to the summit of Pen-y-Fan, 2,905 feet. Wind-driven clouds of mist prevented a continuous view over the surrounding country; but from time to time glimpses were caught of the cwms with their precipitous head-walls. Descending a short distance, the party came out again into the sunshine and saw the moraine-contained tarn called "Llyn-cwm-Llwch," the long cwms, and the smooth grass-covered dividing spurs which project northwards like long fingers. In the distance lay Llangorse Lake with Mynydd Troed beyond.

Mr Richardson explained that the Brecon Beacons and the Black Mountains are composed of Old Red Sandstone, and that while in pre-glacial times the outlines of the Beacons were probably much more rounded, in Glacial

Fig. 1.—Cwmllwch Falls, Brecon Beacons.

times moving ice effected considerable sculpturing. He had gone into the matter in a paper published in the Proceedings of the Club. Descending from the hill-spur called Allt Dhu, Members boarded a brake and arrived back in Brecon about 7.30 *p.m.*

The Rev. H. J. Riddelsdell, who was unable to be present at the Meeting, sent the following notes on the Flora of the Beacons :—

We must distinguish (1) the glens and meadows of the lower levels ; (2) the exposed moorlands, generally comprising much bogland ; and (3) the cliffs and summits of the hills.

(1) Glens. The most interesting plants to look out for are *Trollius* (Globe-flower), *Meconopsis* (Welsh poppy; also occurs on cliffs), *Vicia Orobus, Geum rivale* (Water Avens), *Pyrus Aria* (very rare and perhaps planted) ; *Saxifraga hypnoides* and *hirta*, which have descended from the cliffs ; *Chrysosplenium alternifolium, Lonicera Xylosteum, Gnaphalium dioicum*, high up in Cwm Llwch ; *Hieracium scoticum, H. pellucidum, cinderella, petrocharis, clivicolum, septentrionale, strigosum* ; *Vaccinium Vitis-idæa, Lathræa, Polygonatum multiflorum* (Solomon's Seal) *Carex lævigata, Hymenophyllum Wilsoni* (Filmy Fern), Beech and Oak Ferns.

(2) The wet and open Moorlands show a Flora of their own. *Ranunculus Lenormandi* in a peculiar form, *Caltha minor, Drosera* (rare here) ; *Carduus pratensis*, not climbing very high ; Ivy-leaved *Campanula*, very rare ; *Erica tetralix*, but not *cinerea* ; Bog bean ; *Veronica scutellata* ; *Myosotis repens* and *Pinguicula*, frequently ; *Empetrum*, Crowberry (plenty) ; *Narthecium*. In mountain-pastures occur *Gymnadenia Conopsea*, and *Habenaria albida* and *H. bifolia*, but sparsely. The two common Cotton-grasses and several *Carices* are frequent. Beech and Oak Ferns in exposed stony hill-sides ; Adder's Tongue here and there.

(3) Cliffs and Summits. *Thalictrum minus, Silene maritima* (very abundant), *Alsine verna* (less abundant) ; *Sedum Rhodiola* and *S. Forsterianum* ; *Saxifraga oppositifolia, S. hypnoides, S. hirta* ; *Valeriana officinalis* ; many Hawkweeds, some very rare, and a few confined to this locality ; Cowberry (small and stunted) ; *Salix herbacea*, in almost its only locality in South Wales. *Aira flexuosa* var. *montana* ; *Hymenophyllum Wilsoni* and *Asplenium viride*, The whole Flora is characteristically montane. *Erica cinera*, Common Heath, is rare on the Beacons, if there at all. It seems to like proximity to the sea. *E. tetralix*, the Cross-leaved Heath, is not abundant on the Beacon range, although there is plenty on the moorlands. *Calluna vulgaris*, the Heather, is not abundant on the Beacons, although it *is* there.

Thursday morning was devoted to seeing the town. First the remains of the Castle, which adjoined the hotel that was the party's headquarters, were investigated. Brecon Castle was erected by the Norman Bernard de Newmarch, probably mostly of stones obtained from the old Roman fort of Bannium which stood close by. All that now remains of the Castle is the Ely Tower, from the top of which a magnificent view is obtained, and a portion of the wall, it having been "dismantled by the townsfolk in the Civil Wars to prevent the miseries of a siege." Next the Priory Church was visited. It is the third largest church in Wales, being exceeded only by the Cathedrals of St. David's and Llandaff, and was founded by the builder of the Castle—Bernard de Newmarch. It contains a fine Norman font ; but that is about all the Norman Work, the main portion being Early English. The Choir (plain Early English) is particularly fine and contains many regimental brasses.

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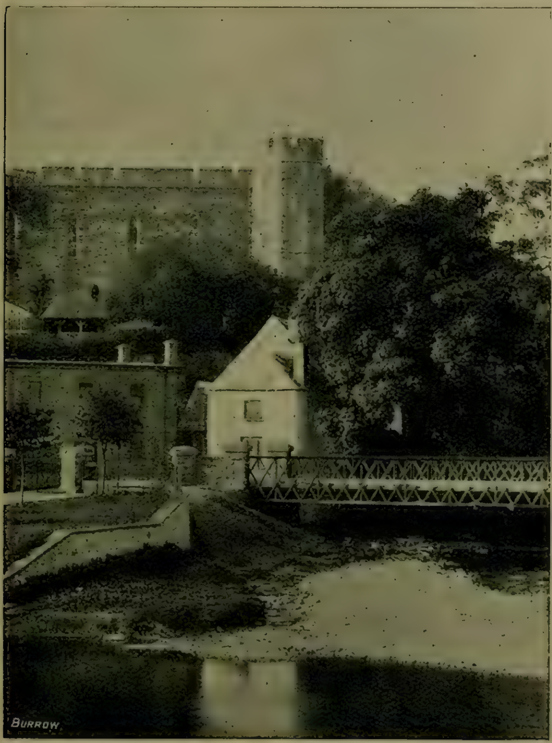


Fig. 2.—Brecon Castle from Usk Bridge.

(*Block lent by E. J. Burrow.*)

EXCURSION TO LEDBURY AND EASTNOR

Tuesday, September 12th, 1911

Directors: THE REV. F. W. CARNEGY, S. BICKHAM AND L. RICHARDSON

(*Report by* L. RICHARDSON)

The Members met at Ledbury Station at 11.21 *a.m.* Thence they drove to the Church, where they were met by the Rector, the Rev. F. W. Carnegy, and Mr S. Bickham.

The tower of the Church is separate from the rest of the building. In the Church is some excellent Norman work, but the most interesting feature

Effigy of a Priest in Ledbury Church.

is an effigy of a priest. In Bloxham's "Companion to Gothic Architecture" it is stated:

> "Till the fourteenth century sculptured sepulchral effigies of ecclesiastics who had attained no higher grade than that of priesthood are rare. A fine and interesting example of the thirteenth century is, however, preserved in Ledbury Church, Herefordshire. This, a recumbent

effigy of a Priest in the Eucharistic vestments, within a pointed-arched canopy, trefoiled in the head, and springing from two lateral shafts, with moulded bases and caps, had been removed from its original position, and was, when my notes were made, placed upright against a wall in the north transept of the Church. This effigy is in a better state of preservation than we usually find to be the case in effigies of so early a period. The head reposes on a lozenge-shaped cushion; the face exhibits the moustache over the upper lip, and sharp crisp beard over the chin. The hair appears cut close round the forehead. The Priest commemorated is vested with the Amice folded about the neck without any apparent parure; in the Alb, which is plain and devoid of any parure in front of the skirt; over the Alb appear the extremities of the Stole, which are long and plain; the Maniple, which is worn over the left arm at the wrist, is also plain. The sleeves of the Cassock, *toga talaris*, are visible beneath the folds of the Chasuble, and are cuffed at the wrists; the hands are conjoined on the breast as in prayer. The Chasuble, which is well-defined, is of moderate length, and is covered with the Orphery, coming over the shoulders and disposed in front somewhat like an archiepiscopal pall. Few effigies of the kind are indeed more interesting than this, as will be seen by reference to the illustration. Of whom it is commemorative I have no knowledge."

The old black and white half-timber Town Hall and Market Place is the finest remaining example in this part of the country.

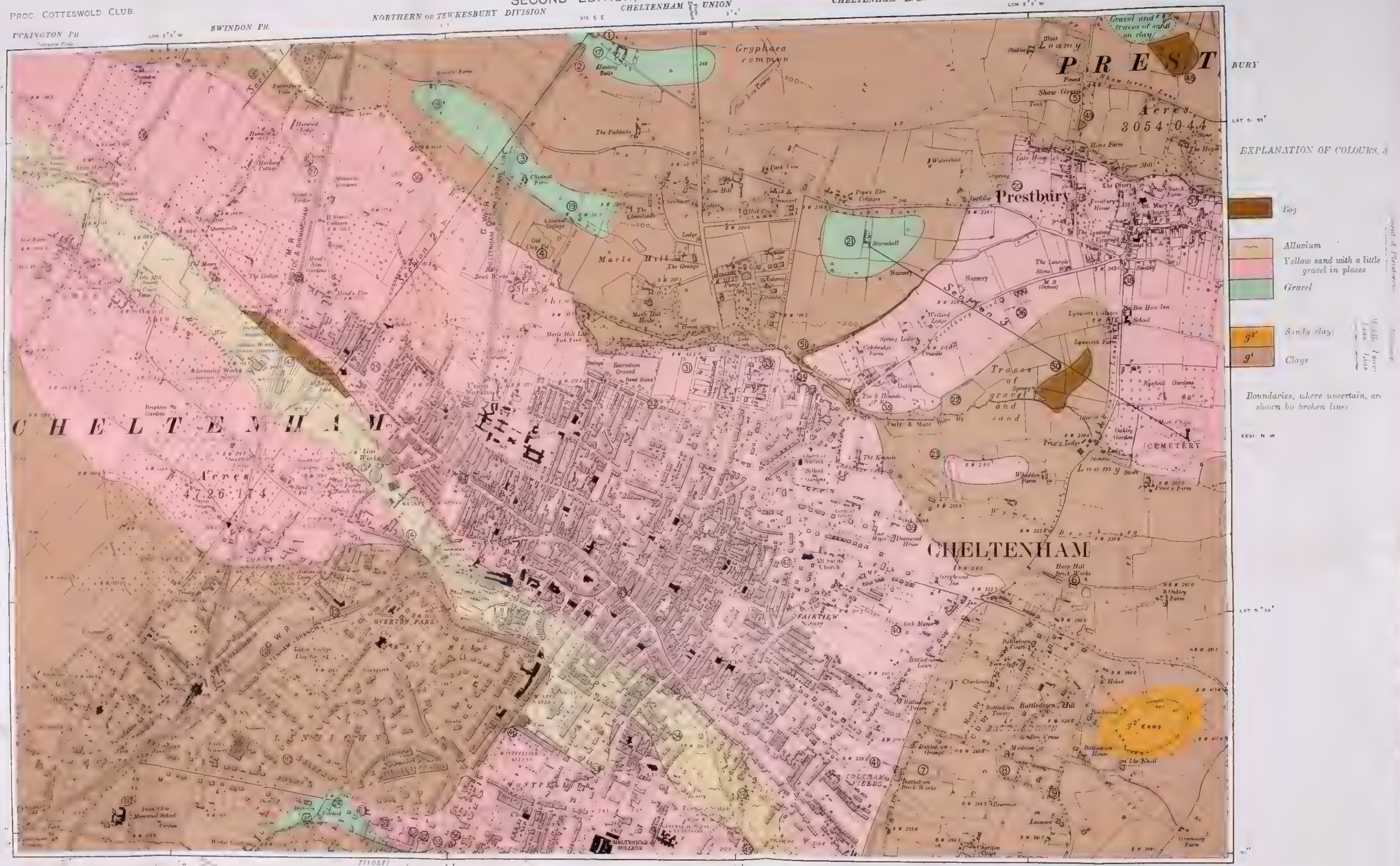
After lunch at the Feathers Hotel, the Members drove to Eastnor Castle, special facilities for seeing which had been granted by Lord Somers.

The gardens and lake are very beautiful, and inside the Castle some are fine paintings, armour, and specimens of old French and Italian tapestry.

The Members returned from Ledbury by the 4.22 *p.m.* train.

SECOND EDITION, 1903.

GLOUCESTERSHIRE. SHEET XXVI. N. E.



Geologically surveyed by L. Richardson, F.R.S.E., F.L.S., F.G.S., 1902-12

Scale: Six Inches to One Statute Mile or 880 feet to One Inch

Heliozincographed from 2500 Plans and Published by the Director General at the Ordnance Survey Office, Southampton. N.B. — The representation on this map of a Road, Track or Footpath, is no evidence of the existence of a right of way.

The Altitudes are given in Feet above the assumed Mean Level of the Sea at Liverpool, which is 0.650 of a Foot below the general Mean Level of the Sea.

MEMOIR EXPLANATORY OF A MAP OF A PART OF CHELTENHAM AND NEIGHBOURHOOD, SHOWING THE DISTRIBUTION OF THE SAND, GRAVEL AND CLAY

BY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

[Plates XXXIII.-XXXVI.]

This Memoir is in explanation of the geology of that portion of Cheltenham and neighbourhood which is represented on Sheet xxvi. N.E. of the 6-inch series.

This map shows the geographical distribution of the clay, gravel, sand, alluvium and peaty tracts in the district mentioned and is the first—giving this information—to be published.[1]

The details have been acquired little by little over a period of at least ten years. Their acquisition has been gradual because much of the ground is built over and temporary excavations in the roads had to be awaited in order to see what was the nature of the underlying deposit—whether it was sand, gravel, clay, etc.

1 It should be stated that there are two MS.-maps in existence which show, in a general way, the distribution of the clay and Superficial Deposits (that is, sand, etc.) in the neighbourhood of Cheltenham. Both maps are now in the Cheltenham Public Library.

One of these maps was formerly in the possession of Dr J. H. Garrett, Medical Officer of Health for Cheltenham. It has written upon it in ink the date 1864. It is thought to have been prepared by Dr Thomas Wright, the well-known geologist (who was also at one time Medical Officer of Health for the town), on information supplied by a Mr Knight of the then firm of Messrs Knight and Chatters. The other map was in Dr E. T. Wilson's possession and was made by him from one lent to him by Wright about the year 1864. Dr Wilson's map is on tracing-paper and is much larger than that formerly in the possession of Dr Garrett, so that at first sight it would seem doubtful if the latter was the map lent Dr Wilson by Wright. Nevertheless, I think it probable; but there are differences between these two maps—the one of which was formerly in Dr Wilson's possession and the other in Dr Garrett's.

On the map formerly in Dr Garrett's possession a tract in the neighbourhood of the Chelt is coloured, presumably to represent alluvium and so is that, represented as sand on my map (Plate xxxiii.), which lies to the south of the Electricity Works. On the map made by Dr Wilson, however, the tracts mentioned above are similarly coloured to those where the sand occurs.

Again, on the former (*olim* Dr Garrett's) map the southern boundary of the sand is drawn from near the house now called "Ravensworth" in a westerly direction so as to pass along the *north* side of the lake in Lake-House grounds, along Union Street, through Tivoli and to the south of Hatherley Court. The presence of the outlier of sand, whose north-western portion terminates in The Park, is also noted.

On the latter (*olim* Dr Wilson's) map, however, the boundary-line of the sand is drawn along Naunton Crescent, Norwood Street, Painswick Lawn, Suffolk Road and Suffolk Lawn, while a westerly-directed tongue of Superficial Deposit from the Tivoli district is not shown.

Fig. 1.—Section along the line marked "Section 2" on the map.

The blue clay, which is so frequently exposed in excavations in the roads in the Lansdown and Marl-Hill districts and the lower slopes of Battledown, belongs to the formation called by geologists, the " Lower Lias." If the topmost portion is of a dirty yellow colour it is because the finely-disseminated iron-pyrites (FeS_2) in the clay has oxidized and become hydrated.

This Lower-Lias clay everywhere in the district under consideration underlies the deposits of gravel, sand, etc. (figs. 1 and 2) : they rest in hollows excavated out of the Lias clay.

A very little consideration will make it clear that before the gravel and sand was laid down, the surface of this district was in places more undulating than it is to-day. In its deepest part the Superficial Deposit cannot be far short of 50 feet thick. On the other hand, tracts that have at the present time clay at the surface have undergone a considerable amount of lowering by denudation. This means that before the Superficial Deposits were laid down, the area under consideration was furrowed with relatively deep valleys. Along these flowed streams which sprung from the hill-sides and brought down with them, and rounded in their onward progress, pieces of Liassic and Oolitic limestones. It may be that as these streams deepened their channels they left in sporadic fashion on their valley-sides deposits of hill-derived gravel : it may be also that in early Glacial times more gravel than formerly was swept downwards by the swollen brooks. Anyhow, the evidence at present to hand certainly seems to indicate that there was gravel present in the district *before* the yellow sand was introduced and that this gravel was rather sporadically distributed.

The yellow sand was introduced from somewhere else—from a distance and not from the neighbouring Cotteswold Hills, because there is and never was any deposit in those hills from which it could have been derived. The sands on the top of Cleeve Hill, the " Harford Sands " as they are called, are much finer-grained than the yellow sands at Cheltenham.

C. Upton, photo.

Fig. 1.—VIEW OF CLAY-PIT AT THE BATTLEDOWN BRICK WORKS.

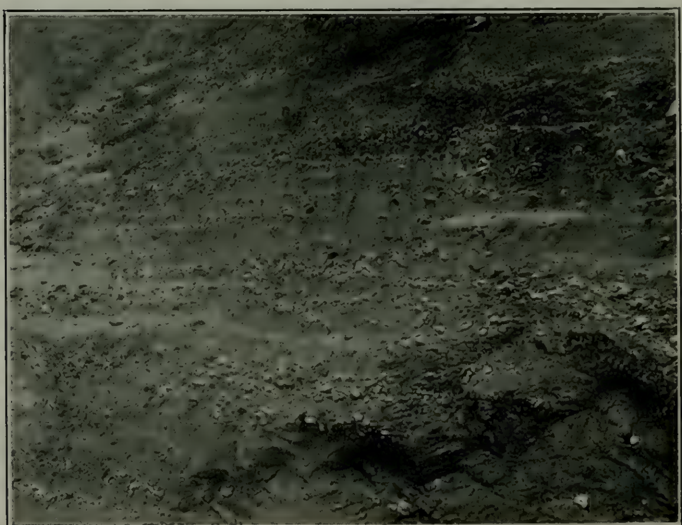
R. J. Webb, photo.

Fig. 2.—AMERICAN DRYER, BATTLEDOWN BRICK WORKS.

(Block lent by Messrs Webb Bros., Ltd.)

C. Upton, photo.

Fig. 1.—VIEW OF THE SAND-HOLE AT THE BATTLEDOWN BRICK WORKS, SHOWING THE SAND RESTING ON THE LOWER LIAS CLAY.



C. Upton, photo.

Fig. 2.—VIEW OF A PORTION OF THE FACE OF THE SAND-BED SEEN IN THE PIT NEAR THE CHARLTON KINGS-LAUNDRY, TO SHOW THE GRAVEL IN THE SAND-BED.

In some places, as in the " sand-hole " at the Battledown Brick Works (Plate xxxv., fig. 1), the yellow sand is singularly free from gravel ; but, in others, as in the sand-pit near the Laundry, Charlton Kings (Plate xxxvi.) there is a considerable amount of well-rolled and almost bleached-looking gravel present (Plate xxxv., fig. 2). This gravel is formed of pieces of Inferior-Oolite and Upper-Lias limestones and along with it are numerous fossils that have been derived from these rocks.

Since the yellow sand was laid down removal of a considerable amount of that deposit has been effected—principally by the River Chelt and its tributaries. This sand obviously once extended over the now essentially clay-area in the immediate neighbourhood of the Malvern-Road Station, and its scattered grains amongst the gravel exposed in the cutting near Chestnut Farm (number 3 on the map) show that there also it once overlaid the gravel. But now it has been removed from considerable areas and the Chelt has hollowed out of it for itself a broad channel, which it has subsequently largely filled up : first, mainly with gravel, bog and loam, and later with alluvial matter—sometimes rather sandy, but generally clayey.

Lower Lias.—The Lias clays, as already mentioned, are usually blue ; but near the surface are sometimes of a dirty-yellow colour. In this district they contain few limestone-nodules, except at one horizon, namely, the upper part of the *Striatus*-Beds and no limestone-beds with the exception of the two impure bands in the *Capricornus*-Zone, which zone participates in the formation of Battledown Hill, but is not seen in any opening at the present time.

As is well-known the Lias admits of division into a number of zones, each zone being characterized by a particular ammonite which gives its name to the zone.[1] The details given below concerning certain exposures of the Lias may be of interest to some geologists :

1. In the railway-cutting clays belonging to the *Raricostatus*- and *Armatus*-Zones were exposed.

1 For a complete list of the Liassic zones see the author's " Handbook to the Geology of Cheltenham " (1904), or Prof. S. H. Reynolds' " Geological Excursion Handbook to the Bristol District " (1912), Table II.

2. The clay exposed in the cutting and southern portion of the tunnel was of *armati* date. In that portion near the entrance to the tunnel specimens of *Ammonites* (*Microceras*) *subplanicosta* Oppel, were most abundant.
3. The clays exposed in this cutting were also of *armati* date. Above them, in the southern portion of the cutting, the gravel-deposit was clearly displayed, measuring, in its thickest part, 8 feet.
4. In the well-known, but now closed Folly-Lane pit, the lower portion of the *Armatus*-Zone was formerly exposed, the *Montlivaltia-rugosa-* and *Hippopodium*-Beds (which occur about the junction of the *Armatus-* and *Raricostatus*-Zones), and the *Raricostatus*-Beds. Crowds of small fossils could once be collected from the weathered clay-faces, together with many small ammonites (principally *Microceras subplanicosta*). Wright has referred to this section (Lias Ammonites, p. 55, Pal. Soc.), and so have several other authors (H.B. Woodward, "Jurassic Rocks of Britain—The Lias, etc.," vol. iii. (1893), p. 143; L. R., "Handbook Geol. Cheltenham," (1904), p. 43).
5. Here higher beds, the *Valdani*-Beds, were exposed when a deep trench was cut along the road between the brook and the Pound. One thin conspicuous white layer was literally made up of the crushed valves of *Inoceramus ventricosus* (Sowerby).
6. The *Valdani*-Clays were the last clays dug at the Harp-Hill Brick Works. Fragments of *Acanthopleuroceras valdani* and allied forms abounded. In times past, higher beds, the *Striatus-* and *Capricornus*-Beds have been worked here (*vide* Quart. Journ. Geol. Soc., vol. lxii., 1906, p. 585—footnote).
7. This is the only clay-pit in work in the area under consideration (Plate xxxiv., figs. 1 and 2). The clays exposed belong to the *Valdani-* and *Striatus*-Zones; but the latter zone also includes the "Yellow Lias"—that is, the yellow clay, which is so crowded with richly-fossiliferous nodules. The *Valdani*-Beds also contain beautiful pyritized specimens of *Ammonites* (*Rhacoceras*) *ibex* Quenstedt. This is interesting, for Mr H. B. Woodward, F.R.S., states, "so far as I know the zone of *A. Ibex* is nowhere distinctly to be recognized in this country." ("Lias of England and Wales, etc." p. 67).
8. Yellowish micaceous clays with ferruginous nodules were seen in a temporary excavation, but no evidence was obtained wherewith to date them precisely.
9. An excavation here revealed very tough blue clay, but as no fossils were obtained, it was not possible to determine the date.
10. Specimens of *Ammonites* (*Oxynoticeras*) *oxynotus* Quenstedt, were obtained here from a temporary excavation and also from near Dean Close School (11). When the railway-cuttings near the Midland Station were made, a number of fossils indicative of the *Oxynotus*-Beds were obtained.
12. In this cutting, near the place indicated, ammonites indicating *Raricostatus-* and *Armatus*-Zones were obtained.
13. The cutting under St. George's Road is through the *Armatus*-Beds.
14. Clay dug out of excavations made to receive the foundation of the piers supporting the arch over Millbrook Street yielded *Zeilleria, Spiriferina, Serpula, Chlamys, Gryphæa* and belemnites. It is of about *raricostati* hemera.
15. A large number of fossils have been obtained from time to time from excavations made on the Gas-Works grounds. They indicate deposits of *oxynoti, raricostati* and *armati* hemeræ.

The following analysis of a piece of hard blue clay from the *Valdani*-Beds has been kindly made for me by Mr George Embrey, F.I.C., F.C.S., County Analyst :—

CHEMICAL ANALYSIS OF LOWER LIAS CLAY

(*Valdani*-Beds) from Battledown Brick Works.

	per cent.
Water (free)	6·78
Loss on Ignition (on dry portion)	6·62
Nitrogen	·28
Carbonates (reckoned as Carbonate of Lime, $CaCO_3$	9·37
Potash (K_2O)	·193
Phosphoric Acid (P_2O_5)	1·92
Phosphoric Acid rendered available by 1% solution of Citric Acid	1·02

The tracts where the Lower Lias clay occurs, which are not covered with houses and their gardens, are, for the most part, laid down to pasture. The ground is heavy, in winter waterlogged and cold, but in summer shrinks badly, originating cracks. So much does it contract in periods of drought that houses built upon it frequently have their walls cracked and their drain-pipes shifted.

Before anything can be done with the land it must be drained and, if intended for garden purposes, it is desirable to make the soil more open and porous. This process is best accomplished by autumn cultivation and the working in of gritty matter, such as road-scrapings, garden-refuse, wood ashes or charred clay. Farmyard manure is also good for improving this class of soil. The application of lime is desirable as it assists in improving the texture of the clay and renders active the dormant nitrogen and potash in the clay. In the way of concentrated fertilisers phosphatic manures like basic slag and bone manures produce good results on the Lower Lias clay. Basic slag should be occasionally applied to pastures, as it encourages the growth of clovers and fine herbage; while periodical dressings of lime are also good.

Elm-trees grow well upon the clay as may be seen from the fine specimens in the vale and the area of land devoted to orcharding proves that apple-trees also do well, provided the land is adequately drained.[1]

1 I am indebted to Mr G. H. Hollingsworth, Instructor in Horticulture for the Gloucestershire Education Committee, for assistance in preparing these paragraphs.

Water.—Dealt with in Appendix.

Commercial Uses.—In times past, the clay has been extensively dug for brickmaking, as at Folly Lane, Harp Hill and other places ; but at the present time the extensive Battledown Brick Works are the only ones open. By itself the clay here is too strong to make good bricks, so yellow sand is ground up with it to make a suitable loam.

In brief, the process of brickmaking at these Works is as follows :[1]

> After the clay has been dug (Plate xxxiv., figs. 1 and 2) it is loaded on to trucks which are taken to the top-storey of a four-storied building. Here it is tipped into a large hopper. Giant steel teeth chew it up and pass it through rollers, situated on the third floor, which still further reduce the size of the lumps of clay. After passing through two pairs of smooth rollers on the second storey the clay goes into the " mixer," where it is stirred with water by means of revolving beaters. From the mixer it passes through a final pair of rollers set " iron and iron " and thence into the " pug," where it is compressed and pushed through a mouth-piece (the size of a brick) on to the cutting-table." A frame-work on this table cuts off ten bricks every ten seconds or 36,000 per day.
>
> The green bricks are next dried, either in the American Dryer (fig. 4) or, in summer time, in open-air hacks. When sufficiently dried, by either means, the bricks are placed either in the large German Kiln or in the smaller Round Kilns. The German Kiln at these Works holds over a quarter-of-a-million bricks. The fire never goes out, but travels, year after year, round and round the long oval-shaped tunnel, being fed by the coal poured into it through the little holes at the top. Far away at the rear of the retreating fire the bricks are cool enough to be taken away. Far away in front of the advancing fire the dried bricks are being continually set for it to burn in its round.

Gravel.—Gravel, formed of waterworn pieces of limestone derived from the bands and nodules in the Upper Lias, but principally from the Inferior Oolite, is often found to underlie the yellow sand. The superposition of sand on gravel was very clearly seen in an excavation for a sewer in the Tivoli district (60) of Cheltenham.

The portion of the gravel exposed in the railway-cutting at Chestnut Farm was certainly once overlaid by sand. That this was so is obvious from the fact that sand-grains occur with the gravel. The gravel over the greater part of this outlier, however, is free from sand and so is that composing the Hunting-Butts and Starvehall-Farm outliers. The former

1 This account is derived from Messrs Webb Bros.' booklet " Brickmaking without Straw." A full description of the Works will be found in Proc. Cheltenham Nat. Sci. Soc., vol. 1., pt. 4 (1910), pp. 264-269.

much greater extent of the sand and gravel over the present essentially clay areas was proved by the discovery of sand and gravel in a ramifying fissure in the blue clay at Dean Close School (11) and on top of the clay-bank near the Malvern-Road Station (12).

The following are some notes relative to exposures of the gravel :—

17 and 18. Gravel is exposed in the sides of both these ponds.

19. The gravel is very noticeable in the arable ground here and again around Starvehall Farm (21). The area represented as gravel to the north-west of the peaty tract numbered (48) was difficult to map, because gravel and sand occur in a pockety fashion in the clay-surface. Gravel, however, predominates over the sand and the land is under the plough.

20. There is a considerable amount of Oolite gravel here and it was once well-displayed in a deep trench.

22. Here the gravel appears from beneath the sand. Many of the component pebbles are covered with ferruginous matter, derived doubtless by the action of carbonated waters upon the yellow sand-grains, for the sand-grains owe their colour to a thin pellicle of iron oxide.

Gravel occurs in the neighbourhood of (35), but is too mixed up with the clay to render possible its representation by its distinctive colour. In a trench near the Prestbury Road it was clearly seen to underlie the yellow sand.

23. Traces of gravel were noticed here.

24-25. The area represented as being gravel around Polefield is probably too great; but it was found impossible to represent it otherwise for cartographical purposes. At (56) sand was exposed to a depth of 6 feet without the base being reached. At (55) the blue Lias clay comes to the surface. At (57) 3 feet of sand was seen resting upon three feet of coarse gravel and at (59), 1 foot of sand on 1 to 2 feet of gravel. Between (24) and (60) there was 4 to 6 feet of made ground and then 0 to 3 feet of well-rolled oolite-gravel mixed with a little ordinary yellow sand. Along the road between (24) and (25) the sewer-trench showed intermittent patches of gravel mixed with some yellowish-green clay.

In the clay tract between the boundary line with the sand and St. Stephen's Church, excavations along St. Stephen's Road and Lypiatt Street showed occasional patches of well rolled gravel in hollows and fissures in the blue Lias clay. Concerning the excavations in Lypiatt Street to the north of the boundary-line of the clay and Superficial Deposits, Mr E. T. Paris recorded :—"these excavations showed from 4 to 5 feet of Superficial Deposits. As in Tivoli Road the general sequence was sand overlying oolite gravel. The deposits were very irregular and the thickness varied considerably. The junction with the Lias clay was also very irregular and in places tongues of gravel intruded downwards into the clay."

SOILS.—Reference to the map (Plate xxxiii.) will show that Starvehall, Chestnut and Hunting-Butts Farms are all situated on gravel-beds. This is mainly due to the fact that water was available by sinking into the gravel and the gravel-soil gave rise to good arable land. The gravel-land around the Hunting Butts is now down to pasture, but that around the other two farms is still under the plough ; while near the first-mentioned farm, market-gardens are spreading from off the gravel-patch on to the clay.

Water.—The water contained in the gravel-bed is naturally hard, because the constituents of the gravel are limestone-pebbles.

Commercial Uses.—The gravel from these beds has not been put, to my knowledge, to any commercial use.

Sand.—The yellow sand is frequently turned out of excavations in the High Street and in the Pittville district of Cheltenham. Sometimes sections are available, as they were recently in Tivoli, in which the sand can be seen above the gravel ; but in others, as in the sand-hole at the Battledown Brick Works, the sand is seen reposing directly upon the Lias clay.

This section at the Battledown Brick Works is very interesting. In the sand-hole the sand is singularly free from gravel and 16 feet thick. In the south side of the cutting, through which the tram-incline rises, the sand is seen thinning out as the clay-slope of the hill rises. There is, however, nothing of interest to record concerning the junction.

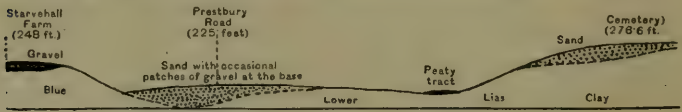


Fig. 2.—Section along the line marked "Section 3" on the map.

At Hopwood's Nurseries, on the Prestbury Road, the sand is said to be in places 40 feet thick. There are pits in it at Sandford Gardens and Ryeworth (Charlton Kings) ; but the best idea of it is obtained in the large pit near the Diamond Laundry, Charlton Kings (Plate xxxvi.), which is, however, outside the district under consideration.

In places, as already remarked, the sand is fairly free from gravel, but often there is a considerable quantity of

C. Upton, photo.

SAND-PIT NEAR THE LAUNDRY CHARLTON KINGS. CHELTENHAM

stratified gravel associated with it. This gravel is formed of well-rolled fragments of Upper-Lias and Inferior-Oolite limestones. Some idea of the appearance of this sand-gravel deposit will be obtained from the photograph reproduced in Plate XXXV., fig. 2.

The sand has not been derived from local sources, but has come from a distance.

A sample taken from the sand-deposit exposed in the sand-hole at the Battledown Brick-Works, was submitted to Mr H. H. Thomas, M.A., B.Sc., Sec. G.S., who reports :—

"The sand is fairly uniform in grain, non-calcareous, and consists chiefly of sub-rounded quartz with a subordinate amount of orthoclase. The heavy residue is small, but interesting ; it consists of pink garnet, staurolite, and well-rounded tourmaline, and a few grains of the usual minerals of sedimentary rocks which have no value for the purpose of tracking a sand to its source.

"The relative abundance of staurolite in the heavy residue would certainly lead me to infer that the Trias had furnished most of the material, and this supposition is strengthened by the absence of many characteristic minerals which are common in rocks of the Cretaceous, Tertiary and western Glacial drifts.

"I have not examined any of the Jurassic rocks of the West of England, so the above remarks must not be taken too literally.

"Another point in favour of the Trias, as I know it is that all the Red Rocks of the Somerset region contain abundant pink garnet and rounded tourmaline ; this evidence, however, is not so good as that supplied by the staurolite."

The following details have been obtained concerning the sand-deposit :—

26. Here numerous small pebbles of Lias and Oolite limestones are associated with the sand.
27. Clean yellow sand is often dug in these gardens.
28. The pit in work here belongs to Messrs Webb Bros., and sand is sold at 1/3 a load.
29. Trenches for drains in the Waterloo-Street district proved at least 14 feet of sand.
30. The sand here is only 1½ feet thick.
31-32. The section of the Wyman's-Brook Sewer between these numbers is in sand at least 14 feet thick.
33. Formerly there was a sand-pit here.
34. Formerly there was a clay-pit here, but in the stoke-hole for a greenhouse 4 feet of sand and gravel was exposed above the Lias clay.
35. This district has been recently extensively built over and the inequalities alongside the brook have been filled up. It is one in which the gravel appears from beneath the sand on a clay bank and there is the consequent washing down and co-mingling of deposits. Between the positions of the number (35) on the map and the road, excavations showed a few feet of sand (which rapidly thickens to the north) separated by a foot or two of gravel from deep blue-Lias clay.

36. The junction of the sand and clay in Coronation Road was observed in a trench for a sewer. At the Prestbury-Road end 6 feet of sand was proved without reaching the Lias clay.
37. Formerly there was a small sand-pit here. Along the boundary-line between (37) and (20) the gravel and sand occurs in very irregular patches.
38. The sand is seen here in the bank alongside the road.
39. The area between Lynworth Farm and Oak Bank was a difficult one to map because here and there are thin deposits of gravel in pockets and "veins"; while in places near the margin of the clay-area the ground is loamy. On the other hand sand has been obtained from the Cemetery and put on the clay-ground of the garden of Prior's Lodge. The boundary-line to the north of Prior's Farm owes its unnatural look to the fact that the ground at the southern end of the Cemetery is made ground—sand has been tipped there.
40. A well here shows a thickness of 20 feet of sand.
41. The junction of the sand with the clay is well seen here.
42. Sand, 16 feet thick, was observed. Its base was not reached.
43-44. The Cheltenham main sewer (5 feet high) between (43) and (44) revealed 15 feet of sand all the way, without the base being seen. At the corner of Cambray sand, over 20 feet thick, was seen without any indications of the base.
45. Sand with gravel-layers similar to that seen in the pit near the Charlton-Kings Laundry was temporarily worked here. At "Hazlewood" College Road, 30 feet of sand was noted.
46. Sand, 15 feet thick, on clay.

Excavations on the site of the Gloucester-Road Council Schools showed that the sand was from 3 to 6 feet thick and rested upon blue Lias clays of *varicostati* date.

The pit in Sandfield Gardens is in work. Sand, traversed by irregular and intermittent layers of gravel, is exposed to a depth of 15 feet. The following "derived fossils" were collected: *Dactylioceras* sp., *Belemnites, Cardinia attenuata, Chlamys priscus* (*armati*), *Pteria inæquivalvis* (*capricornus*) *Terebratula fimbria, Rhynchonella subangulata, Montlivaltia* (Lower *Trigonia*-Grit), etc. The sand-pit in Brighton Gardens showed a similar deposit to a depth of 6 feet.

Where the words "sand thin" are printed on the map the blue Lias clay is very near the surface. An account of the sections revealed during the construction of the Arle Sewer will be found in the Proceedings of the Club, vol. xvii., pt. 1 (1910), pp. 53-56.

In certain places around the margin of the sand-bed considerable difficulty has been experienced in arriving at a decision as to where precisely the boundary-line of the sand-bed should be drawn on the map. To take a particular case: fig. 3 is a sketch section along the line marked "Section I." on the map. Here the sand, with its underlying, sporadically-distributed gravel, once extended up to and rested upon the clay-bank on the north side of the brook. The brook, however, has carved out a hollow, with a bank on its south side, of which the lower portion (*b-c*) is clay and the upper portion (*a-b*) sand and gravel. Some of the sand and gravel has been washed down the bank partially covering the clay-portion. In the field marked (16) pure yellow sand is often found on top of the ridges and yellow clay and gravel in the furrows.

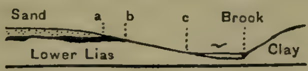


Fig. 3.—Sketch Section along the line marked "Section I" on the map.

SOILS.—Where not built over, the tracts where the sand occurs are, for the most part, covered with market and nursery gardens. Owing to the light nature of the soil it can be worked in almost any conditions of weather and its open texture encourages the growth of fibrous roots, but naturally all crops suffer in dry seasons. Spring-sown onions are difficult to grow owing to the prevalence of onion maggot in the dry sandy soils. In the market-gardens, fruit, in the shape of half-standard apples, pears and plums, is mostly grown as a top crop with gooseberries and currants beneath. Strawberries do well, except in dry seasons and the conditions are suitable for producing early vegetables (cabbage, asparagus, cauliflower and early potatoes). Salad crops, such as lettuce and radishes, are largely grown for early consumption.[1]

The principal manure is dung, but as there is little mineral matter in the deposit, it is well to add concentrated fertilisers which make a complete manure and contain phosphates, potash and nitrogen. Owing to the character of the soil, water rapidly runs through, and therefore manures should be added only a short while before the crops. Top-dressings are also helpful to maintain the supply of plant food and to conserve moisture in dry seasons. Mulching with stable litter and surface hoeing are advised.

Owing to the sandy nature of the soil weeds grow quickly upon it, particularly the Horsetail (locally called " Cat's-tail ") which is very difficult to eradicate because its roots go deep down into the sand-bed in search of water. Annual weeds, Chickweed, Groundsel, etc., are of common occurrence.[1]

1 I am indebted to Mr G. H. Hollingworth for assistance in preparing these paragraphs.

COMMERCIAL USES.—The sand in this neighbourhood is mainly dug for sale to builders, for making concrete for foundations and mortar for building purposes. It is not necessary to wash the sand in any way before using it for mortar-making. At the Tewkesbury Road Pits (Messrs Webb Bros.) it is sold at 1/3 per load.

The sand dug at the Battledown Brick Works is used solely for mixing with the clay for brick making.

ALLUVIUM, ETC.—As will be seen on reference to the map, a tract in the neighbourhood of the Chelt is represented by a separate colour. This tract is where clayey matter deposited by the Chelt occurs.

In times past, the Chelt scoured out for itself a course through the sand-bed and has subsequently filled up the broad hollow it thus created with a deposit of gravel, loam and bog, overspread by fine-textured, sometimes sandy, but generally clayey, alluvium. The maximum thickness of this deposit made by the Chelt is probably about 50 feet.

A good idea of the gravelly loam that participates in the formation of this Chelt deposit was to be obtained in a small pit in the private grounds of Glendouran House, and of the clayey alluvium (quite 10 feet thick) in excavations for houses at the place marked 54 on the map. At the latter locality this clay overlies some 30 to 40 feet of gravel and bog.

When excavations to receive the foundations of the new retort-house at the Gas Works were being made, an excellent idea was obtained of the nature of the Chelt deposit in this particular neighbourhood. Beds of loam, gravel, soft blue clay (with roots, etc.), yellow clay, dark running sand and bog were encountered, all intermingled in the fashion that one associates with recent river-deposits.

When the Arle Sewer was being put in near the Sewage Works the relationship of the clayey alluvium to the sand was very clearly shown (*vide* Proc. Cotteswold Nat. F. C., vol. xvii., pt. 1, 1910, p. 56).

Some difficulty was experienced in obtaining information with regard to the precise nature of the deposits underlying Imperial Square. It has been ascertained, however, that the Queen's Hotel is on "blue [Lias] clay," the stables on "yellow [alluvial] clay," below which is sand and then "blue [Lias] clay"; while the Winter Gardens and Town Hall are on yellow clay. The wells in the stable-yard of the Queen's Hotel contain an abundance of water.

In the neighbourhood of Vittoria Walk and Oriel Road, yellow clay rests upon gravel; while in the immediate neighbourhood of the house called "Fairholme" (53), clay and sand are said to occur in a "pockety fashion."

A bore-hole put down between Cambray House and the Chelt proved about 20 feet of gravel, mixed with clayey matter, resting upon the blue Lias clay. The rest-level of the water in the bore-hole was 9 feet down.

SOILS.—Where not built upon, the alluvial ground is chiefly under pasture. It is heavy in places.

WATER.—"The water from wells sunk in the gravel near the Chelt is hard, and this is not surprising when the composition of the gravel is remembered—mainly limestone pebbles.

"At the Sandford Road pumping-station is a well in this Chelt gravel 24 ft. deep and 18 ft. in diameter, with a tunnel from the bottom running in the direction of the hospital. It is said to be capable of yielding 200,000 gallons per day in ordinary weather. The baths of Cheltenham College derive their supply from five wells sunk in the sand-gravel bed, and four are generally drawn upon. On an average they are 25 ft. deep, six feet in diameter, and yield on an average 150,000 gallons per week. The water is said to be satisfactory and sufficient in quantity."[1]

PEATY-BOGS.—Peaty patches occur in five places in the area under consideration, namely :—

1. Near the Electricity Works (47 on the map);
2. Between Pittville Lake and the Oaklands (51);
3. Between the Oaklands and the Cemetery (50);
4. Near Shaw Green, Prestbury (49); and
5. To the north-east of Shaw Green.

These peaty patches have originated through water collecting on the clay-ground and not running away. Plants, as they have died, have decayed in the wet soil, and little by little the black peaty mould has increased in thickness.

If any of the yellow sand-grains get associated in any way with the peaty matter they very soon become deprived of their thin coating of iron oxide: they become bleached. This is

1 L. R., Proc. Institute Water Engineers for 1912, A. C. p. 9.

because the carbonated waters produced by the decomposing vegetable matters are acidic and act on the iron oxide, dissolving it and causing the reddening of the standing waters near the peat-moss. But in this district all the peaty bogs have been drained with the exception of those near Shaw Green, Prestbury (49) and Cakebridge Farm (51).

The presence of the first peaty patch is readily shown by the extremely black soil in the market-gardens near St. Peter's Church, and in those on the other (west) side of the Midland Railway.

The second patch (51) is a long drawn out one and occurs on the clay between the clay and sand areas. A stick, 10 feet long, was easily pushed down up to its end in the bog at the spot just below the figure (51) on the map. The acid nature of the water in a part at least of the sand-bed is shown by the ferruginous water that issues from the deposit and which has caused the incrustation of many of the pebbles with irony matter in the neighbourhood of the spot marked (22).

The extent of the third patch (50) is also readily shown by the rich black soil. It is not thick, however, because yellow clay shows through it here and there and *juncus* grows in tufts. An interesting fact in connection with this locality is that snipe congregate in the winter around the pool at the south-western end of this peaty tract.

The fourth piece is a curious little piece of damp boggy ground.

The fifth patch (48) is very similar to the third.

Marine Shells and Mammalian Remains in the Superficial Deposits.—Hull, in the Geological Survey Memoir on "The Geology of the Country around Cheltenham" (1857), writes (p. 92) concerning what he calls the "Estuarine or Mammaliferous" gravels, that

> as they approach the hills [they] are almost exclusively composed of liassic and oolitic fragments, [but] in the opposite direction, towards Cheltenham, give place to fine siliceous sand *containing fragments of marine shells.*

The italics are mine. I have not found, neither have I heard of anyone else who has found, fragments of marine shells (other than of derived fossils from the Lias and Oolite) in the Superficial Deposits of this district. The authors of the second edition of Murchison's "Outline of the Geology of the Neighbourhood of Cheltenham" (1844), write (p. 60) :

> "These beds of detritus . . . appear to contain no organic remains of contemporary date with themselves."

Nor have I found, or heard or read of anyone else who has found, remains of mammoth, etc., in the Superficial Deposits of the area under consideration ; but they have been procured in the continuation of the same deposit in the railway-cutting between Charlton Kings and Leckhampton Stations. Mr S. S. Buckman informs me that a deer horn was obtained from the same place.

APPENDIX
ON THE LOCAL WATERS OF THE TOWN OF CHELTENHAM

BY

J. H. GARRETT, M.D., F.L.S.,

Medical Officer of Health.

Mr Richardson's map of the surface geology of this locality shows the Lias clay overlain in places by considerable patches of sand. This sand varies in depth from a foot or two, where it shelves off on to the exposed argillaceous surface, to 50 feet or more in its central or deeper parts.

The certain source of local water-supply which beds of sand lying in such situation afford, have very generally decided the site for a village, and there can be no doubt that the village of Cheltenham occupied its original position as the result of a recognition of this convenience. The extension of the town on to the surrounding clay was an after event for the main part, which took place after the introduction of a general water-supply conveyed from a distance in pipes, the clay ground being a much less reliable source of local water supply than the sand by means of wells.

Geologists think it probable that the yellow sand was derived directly or indirectly from the Triassic sandstones. There is, however, in places a considerable amount of gravel in the sand. This gravel consists of well-rolled pieces of Oolite and Lias limestone and has the effect of considerably hardening the water that passes through the deposit. Gradually the Carbonate of lime in this sand must be reduced until the whole will be dissolved, and presumably this process of washing the lime from the sand has been in long and continuous operation.

The solution of the carbonate of lime, being dependant upon the presence in the water of free carbonic acid to form a soluble bicarbonate of lime, is assisted by the production upon the surface of the sand of the required carbonic acid by decomposition of the various organic materials that pertain to the refuse matters of human occupation. These refuse matters also supply much nitrogen, which, by decomposition of the compound organic bodies in which this element occurs, is destined to pass through the form of ammonia to appear ultimately in the water as fully oxidised nitrate, and the proportionately large quantity of nitrate contained in the water yielded by wells sunk in the sand within the region of streets of houses with their accompanying sewers, drains and great surface pollution is characteristic, and constitutes a rough means of estimating the relative degree of pollution to which the water has been locally subjected. Upon analysis, better results are obtained from water yielded by wells towards the edge or upper part of the sand-bed as a rule, than that yielded by wells in the middle and lower parts of the town where the oxidation of the nitrogen is also frequently found to be less complete.

Accompanying the excess of nitrate an increase in the amount of chloride is invariable, as well as a large addition to the hardness and the general solid content of the water. The dissolved mineral matter in the water derived from these wells often includes a considerable proportion of sulphate and some amount of magnesia. These may be chiefly derived from the clay that underlies the sand, by reason of the well being sunk some distance into the clay, or by a saline spring issuing from the surface of the clay in the neighbourhood of the well.

In passing, it may be mentioned that the wells situated in the sand bed and subjected to the polluting sources above set out, have all been closed within the last twenty years in favour of the general town service, which has been extended to nearly all the houses in Cheltenham formerly supplied by wells.

Beyond the borders of the beds of sand, wells have often been sunk into the clay ground, though never, as in the case of the sand, with the practical certainty of striking a good store of water, but always on the hazard of obtaining a supply that might be sufficient in quantity and in quality for all domestic purposes including fitness to drink. Supplies of fresh water of mediocre quality have thus been obtained from shallow wells in the clay, but very often the water struck has been too highly mineralised for ordinary drinking purposes, having more or less the character of those medicinal springs with which the name of Cheltenham is associated. The clay in this locality is generously productive of mineral waters. It is sometimes capable of yielding a small quantity of ordinary water to a shallow well sunk into its surface, but it is always a dangerous expedient to deepen the well with the view of increasing the quantity, as any further supply obtained by blasting through a layer of hard rock, or otherwise deepening the well is extremely likely to be too highly mineralised for domestic use, and it is probably true to say that any deep well sunk into the clay in this immediate locality, if it yield any considerable quantity of water at all, will supply a water more or less of the quality of a mineral water.

The mineralisation varies considerably both in quality and strength, sometimes the sulphates predominating, sometimes the chlorides, the quality of the yield of no two wells being alike but often quite distinct and different, though the wells be only a short distance apart. Sometimes the water has an odour of sulphuretted hydrogen, though this is not very permanent, and not to be compared with the malodorous water of Harrogate and other spas. The same well will yield the same kind of mineral water in approximately the same strength and relative proportion of dissolved salts for long periods of years, when considerable quantities of water are being drawn from it, though it cannot be mixed with a water yielded by another well a hundred yards away, owing to differences in quality, properties and flavour. Sometimes it is Sulphate of Soda with Sulphate of Magnesia which is responsible for the mineral quality. Sometimes Chloride of Magnesia takes the place of the Sulphate, and sometimes the Magnesia is in negligible quantity, sodium chloride combined with more or less sodium sulphate making up the chief constituents. One class of water is also rendered distinctly alkaline by the presence of bicarbonate of sodium. The amount of chloride of sodium varies very much : from a few grains per gallon up to 400 grains or more, such a quantity as this last mentioned being sufficient to render the water decidedly brackish to taste. Other mineral ingredients besides those mentioned are contained in the water, but these are in minor amount, and of relatively small importance.

The origin and mode of formation of the salts contained in these mineral waters is uncertain, though the subject has for long afforded material for much interesting contemplation and discussion. Generally it has been surmised that the chlorides are derived from a deep source below the lias, whilst the origin of the sulphates is more local and nearer at hand in the lias clay itself.

The map shows that following more or less regularly the course of the small river Chelt through the centre of the town and, dividing sand from sand or sand from clay, goes a band of deposit formed of gravel, bog and loam capped with alluvium. This bears water copiously to wells sunk into it, as perhaps might be expected from the fact that it occupies the lowest position in relation to the neighbouring surfaces, and is adjacent to the river.

Considered as a water-bearing subsoil, the upper part of this band of deposit is superior to the sand in regard to the quality of water yielded. From a well situated in this riverside deposit at Sandford Mead, near the upper border of the town, an important part of the original public water-supply of the town was derived, and, in fact, this well is still available for use, and was in use during the dry season of last year, when it yielded about a quarter-of-a-million gallons of water a day for several months without intermission, or sign of exhaustion, and formerly it yielded as much during the whole year round, the supply being of excellent organic purity, though considerably harder than the water derived from the pure springs that issue at the base of the Inferior Oolite on the neighbouring hills, or of the water of the upper Chelt. This water compares altogether favourably with water derived from the house-wells in the sand-bed at first alluded to. A similar water is supplied from a well in the same locality for the use of the Cheltenham College Swimming Bath. The Corporation Swimming Bath at the Montpellier Baths in Bath Road was supplied from a local well sunk in the same deposit, until a change was made, not long since, for economical reasons, which led to the disuse of the well. The well water, when seen in bulk in these two swimming baths at their refilling was of good appearance, being very clear and of a prevailing blue tint. The water at the Montpellier Baths, however, being derived in a more central part of the town, contained more solid matter, chloride, nitrate, etc. The origin of this water may be in part the clean sand that stretches from the gravel bed up towards Charlton Kings and the district of the Old Bath Road, and which conveys a pure and well-filtered water from localities comparatively bare of houses. From a river-side, you also expect to draw water derived from the river-bed, and where an area of gravel or sand outlies the river this may be expected to be full of water nearly to the level of water in the river. Wells sunk into such river-side gravel usually yield a purer water than the river itself, so far as organic constituents are concerned.

At the Cambray Spa there is a genuine chalybeate water, containing, like all such waters, iron in the form of carbonate held in solution by excess of carbonic acid. This water is said to be derived from a streak of ferruginous peaty earth which crosses the Bath Road in the neighbourhood of the Spa.

The tables of analyses appended give an idea of the quality of the mineral waters at present available, and the quality of the fresh waters above mentioned.

MINERAL WATERS

1.—*Types of Mineral Waters owned and supplied by the Cheltenham Corporation*

	Grains per Gallon		
	Chadnor Villa Well	Lansdown Terrace Well	Pitville Pump Room
Sodium Chloride	27·980	391·710	466·470
,, Bromide	0·015	0·001	0·388
,, Iodide	0·037	0·021	0·099
,, Sulphate	60·893	155·720	115·095
,, Silicate	1·469	1·763	2·961
,, Bicarbonate	—	—	38·961
Potassium Sulphate	4·779	9·990	4·520
Lithium Chloride	traces	traces	traces
Calcium Carbonate	36·372	27·200	4·583
,, Phosphate	—	—	traces
,, Sulphate	63·460	2·447	—
Magnesium Sulphate	117·659	22·667	—
,, Carbonate	—	14·115	10·866
Manganous ,,	0·023	traces	traces
Ferrous ,,	—	0·021	0·056
Ammonium Phosphate	0·011	traces	traces
,, Bicarbonate	—	—	0·078
,, Nitrate	0·018	—	—
Organic Matter	traces	traces	traces

The precise site of the Chadnor-Villa Well is indicated by the letter " W " on the map near the junction of Well Place with Christ Church Road. It is about 70 feet deep.

Prof. T. E. Thorpe in his Report to the Town Improvement Committee of the Town Council of Cheltenham in 1893, in connection with the above analyses made by him, wrote:—[1]

> *Magnesia Saline Water No.* 1 (*Chadnor Villa Well*).—This well contains about 313 grains of saline matter in the gallon, the principal constituents of which are magnesium sulphate (Epsom Salts) to the extent of about 118 grains, and sodium sulphate (Glauber's Salts) to the extent of about 61 grains per gallon. It contains relatively little sodium chloride, and the amount of ferrous carbonate is too small for the water to be regarded as chalybeate. The proportion of bromides and iodides is also very small. The amount of lithia is too minute to be quantitatively estimated.
>
> The water has probably considerable therapeutic value on account of the relatively large proportion of the aperient salts it contains.

The Lansdown Terrace Well is situated at the back of that Terrace. Concerning its waters, Prof. Thorpe reported :—

> *Soda Saline Water No.* 1 (*Lansdown Well*).—This water contains about 625 grains per gallon of saline matter, more than half of which consists of common salt, and about a fourth of sodium sulphate (Glauber's Salts). The quantities of bromides and iodides are small, and only spectroscopic traces of lithia could be detected. The amount of iron is about the same as in the Cottage Well.

The Cottage Well of Prof. Thorpe's Report is situated at the house called Fulshaw Lodge, Christ Church Road. Prof. Thorpe's general remarks concerning its waters were :—

> *Magnesia Saline Water No.* 2 (*Cottage Well*).—This water contains about 390 grains of saline matter per gallon, about one-third of which consists of Epsom Salts, and rather more than a fourth of which consists of sodium sulphate, together with notable quantities of gypsum, chalk and common salt.
>
> It contains only minute quantities of ferrous carbonate, much too small in amount for it to be classed as a chalybeate water. Bromides and iodides are absent, and the amount of lithium is too small to be quantitatively determined. This water has considerable resemblance to that of Chadnor Villa, and the same remarks apply as to its therapeutic value.

The main well at Pittville, which is situated under the Pump Room is 90 feet deep.

> *Soda Saline Waters Nos.* 2, 3 *and* 4 (*Pitville Wells, I., II., III.*).—The Pittville Wells, Nos. I. and III., bear a close resemblance to each other, the first contains about 662 grains per gallon of saline matter, the second about 644 grains, by far the largest constituent in each case being common salt. Both the waters contain notable quantities of bromides and iodides, and each contains sodium bi-carbonate to the

1 Pamphlet: "Professor Thorpe's Report and Analysis of the Cheltenham Mineral Waters, November, 1893.

extent of rather more than 30 grains per gallon, which gives to the water on standing a marked alkaline reaction. The amount of sodium sulphate is, in round numbers, rather more than 100 grains per gallon. In both the amount of lithia is so minute that it can be detected only by the spectroscope. The proportion of ferrous carbonate is distinctly higher than in the Magnesia saline waters, but is still insufficient to allow us to regard the Pittville springs as chalybeate. The general character of these waters as represented by the samples sent to me, although not absolutely identical, is still so very similar that, for all practical purposes, they may be regarded as substantially of the same composition. The waters in all probability are derived from the same gathering grounds and the differences in their composition are not greater than may be ascribed to accidental variations, such as all mineral waters are liable to exhibit.

2.—*Mineral Water Supplied at Alstone Spa.*

	Grains per Gallon
Total solid residue	345·04
Lime	23·91
Magnesia	48·80
Soda	93·47
Potash	2·15
Sulphuric Acid	8·16
Nitric Acid	Nil
Nitrous Acid	Nil
Chlorine	210·00
Bromine	traces
Iodine	traces
Iron..	0·013
Silica	0·70

NOTE OF ANALYST :—This water contains considerable amounts of chloride of sodium, chloride of magnesium, and chloride of calcium, together with a smaller quantity of sulphate of lime, also distinct traces of iodides and bare traces of bromides. Analyst: Lawrence Briant, F.C.S.

3.—*Mineral Water Supplied at Cambray Spa.*

	Grains per Pint
Muriate of Soda	51·06
,, Lime	8·60
,, Magnesia	a trace
Sulphate of Soda	17·04
Carbonate of Lime	·80
,, Iron	a mere trace

This old analysis is by Michael Faraday, F.R.S.

4.—*The Chalybeate Water Supplied at Cambray Spa.*

	Grains per Gallon
Carbonate of Iron	7·05
Muriate of Lime and Magnesia	15·50
,, and Sulphate of Soda	24·00
Sulphate of Lime	9·00
Carbonate of Magnesia and Lime	8·95
	64·50

Old Analysis by F. Accum.

FRESH WATERS

The following are mineral analyses of the water supply to the town from the hill source.

		Grains per Gallon
1.	Carbonate of Calcium	8·8
	Sulphate of Calcium	4·9
	,, Magnesia	·9
	Chloride of Magnesia	1·5
	,, Sodium	·2
	Nitrate of Sodium	·4
	Oxide of Iron and Silica	·3
		17·0

		Grains per Gallon
2.	Calcium Carbonate	9·90
	Magnesium Carbonate	0·79
	Calcium Sulphate	1·46
	,, Nitrate	0·74
	Potassium Chloride	0·50
	Sodium Chloride	0·77
	Silica	0·13
	Matters undetermined	0·10
		14·39

These two analyses were made at different times by two different London Analysts both doing a large practice. Probably the first most nearly represents the water derived from Dowdeswell Reservoir, being the head water of the River Chelt; the latter that derived from Hewlett's Reservoir being spring water from the base of the Inferior Oolite.

The following is a mineral analysis of water from a well in the sand bed situated in the middle of the town.

	Grains per Gallon
Calcium Carbonate	13·61
Magnesia Carbonate	0·29
Calcium Sulphate	28·97
,, Nitrate	14·50
Magnesium Sulphate	5·49
Sodium Sulphate	2·91
,, Chloride	7·15
Potassium Chloride	2·86
Silica	0·28
Combined water and matters not determined	1·92
	77·98

The following items of analysis of wells in the sand-bed, etc., give an idea of variations in the quality of the water derived from the wells situated in various localities.

	Grains per Gallon		
	Solid residue upon evaporation	Chlorine	Nitric Acid
Wells in Main Sand-Bed			
Thirlestaine Road	40	1·7	2·5
Coltham Fields	60	2·2	2·9
Marle Hill Road	44	4·5	2·0
Kings Road	59	3·0	4·5
Princes Street	83	4·0	4·0
St. James Street	119	7·5	7·0
Queen Street	146	10·2	15·6
Elm Street	124	6·5	16·6
Granville Street	160	17·0	25·0
Wells in the Clay			
Francis Street	88	4·5	1·0
Haydon	292	39·0	0·2
Wells in River-Side Gravel			
Sandford Mead (Corporation Well)	52	1·8	3·1
At Montpellier Baths	78	4·9	10·3
Springs at base of Oolite			
Supplying Hewlett's Reservoir	14	0·8	0·9
Water of Upper Chelt			
At Dowdeswell Reservoir after Filtration	20	1·4	0·2

THE FOSSIL PLANTS OF THE FOREST OF DEAN COALFIELD

BY

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[Plates XXXVII.-XXXIX.]

(*Read February* 13*th*, 1912)

The labours of members of the Cotteswold Naturalists' Field Club among the Mesozoic rocks of the West of England form important contributions to the geology of the district. It may be, however, that some members seeking " fresh woods and pastures new," wherein to find another outlet for their energies, are unaware of the work which still remains to be done among the Carboniferous rocks of the Forest of Dean, the nearest coalfield which lies at hand, with the single exception of the little basin of Newent. In these days, when renewed attention is being devoted to the Carboniferous rocks of this country, it is much to be hoped that our knowledge of the Gloucestershire coalfields will keep pace with that of other districts The object of the present paper is, if possible, to stimulate some renewed interest in the resources of the Forest of Dean coalfield, from a geological point of view, among the members of the Club. The author, as the result of a few weeks' work, during each of the last five or six years, has obtained large collections of fossil plants from this coalfield, many of which are beautifully preserved. There is little doubt that many species still remain unknown from the Forest, and that the ground is far from exhausted. The variety of plants which can be obtained by collecting on the large colliery heaps of this district, varies from time to time, since large supplies of fresh material are constantly being made available for the collector. There is thus little doubt that those resident in the district could, as the result of repeated visits to the collieries, not only obtain excellent examples of the species already recorded, such as those figured on Plates XXXVII.-XXXIX., but also add considerably to the known flora of the coalfield. All that is required is a strong hammer and chisel, with a bag for carrying the spoils. The waste-heaps, with their enormous supply of shales (for the shales, and not the sandstones, yield the best specimens) are infinitely more favourable for collecting purposes than the roofs of the seams underground. It is thus quite unnecessary to go " below ground." But it is extremely important that the specimens obtained should be marked on the spot, either with a diamond or a blue pencil, with the name of the colliery, and that as soon as possible afterwards they should be properly labelled as regards the exact locality. Hundreds of specimens from the Forest of Dean exist in museums in this country, which bear no record whatever, beyond the name of the coalfield. For purposes of studying the distribution, both vertical and lateral, of the plants of this coalfield, such specimens are quite useless, for want of proper labels. The names of the seam or seams worked at each colliery are very commonly known, or can be obtained from the Crown office in Coleford. Thus, the name of the colliery on a specimen implies that it came from one or other of a group of coals worked by that particular colliery, or even in some cases from a single seam.

The plant-remains in the shales of the Forest are often extremely well preserved, and well repay the labour of collecting. They consist of casts or impressions of plants, the plant itself having decayed away altogether, or become converted into a thin film of coal. It is sometimes difficult to expose the specimens fully, for the shales tend to split unevenly, and many a good specimen has been broken in attempts to unearth it. With a little experience, however, and some study of the ways in which the rocks tend to split, this difficulty can be overcome. All the shales do not contain plants, and many of the large lumps found on the waste-heaps of the collieries are quite barren. After some practice however, the eye soon learns to detect those slabs which are full of plants, either by some small fragment projecting, or by the exposed face of a bedding-plane showing portions of fronds or stems. The slab should then be split up, layer by layer, with a chisel. Repeated visits to the same waste-heap form the secret of success in fossil plant-collecting.

I do not propose to discuss the geology of the Forest of Dean here. The subject has been dealt with repeatedly by others in the Proceedings of the Club. We are concerned here solely with the Productive Coal Measures, that is to say, the measures in which the coal-seams occur. It will suffice to point out that these seams fall naturally into three divisions, an Upper, Middle and Lower, according to their outcrops, as is shown on any large scale geological map of the Forest. In the centre of the field, we find two closely associated seams, the Woorgreens Coals, which together form the First Division of the Productive Measures. These are separated from the next seams below by a considerable thickness of barren rocks, about 116 yards in all, consisting chiefly of shales with some beds of sandstone. We next find eight seams of coal, closely associated and with parallel outcrops. These form the Second Division. The Crowdelph Coal is the highest of these, and the Churchway High Delph the lowest. The beds between the seams are chiefly shales. The lowest or third Division consists of a group of six coals, of which the No Coal is the highest and the Trenchard Coals the lowest. This division is very different to those above. The coals are more widely separated, and their outcrops are very irregular, and much less nearly parallel. Further, while shales and sandstones prevail in the higher portion, the lower consists of a very massive series of sandstones without shales, which form the well-known Forest of Dean Stone.

With this short summary of the Productive Measures, I propose to enumerate briefly the plants found at the principal collieries working the coals of one or other of the three divisions.

The First Division Coals

WOORGREENS COLLIERY

The two Woorgreens seams, separated by 24 feet of sediment, are only worked at Woorgreens Colliery, a short distance West of Cinderford Bridge Station, on the road to the Speech House. No other seams are worked here, so the place of origin of the plants to be found on the comparatively small heap of this colliery is perfectly definite. The shales, however, are very soft and wet, and crumble away rapidly, so that it is not easy to procure good specimens. For this reason repeated visits, after spells of fine weather, are likely to meet with greater success than a casual visit, perhaps on a showery day. The commonest species to be found here are the Calamite foliage, *Calamocladus equisetiformis* (Schloth.) Plate XXXVII, fig. 5, the fronds *Sphenopteris* (*Renaultia*) *chærophylloides* (Brongn.) and *Pecopteris polymorpha*, Brongn. (Plate XXXVII., fig. 3) with the Lycopod stem *Lepidodendron lanceolatum*, Lesq.

Among the rarer plants are

Annularia galioides (L. and H.)
A. sphenophylloides (Zenker).
Neuropteris ovata, Hoffm., Plate XXXVII., fig. 6.
Pecopteris Miltoni (Art.), Plate XXXVII., fig. 2
Lepidodendron Wortheni, Lesq.

The Second Division

The coals of the Second Division are thin seams, the Lowery Seam (2 ft. 1 inch) being the thickest. The Starkey and the Rockey Coals are the other chief coals. As a rule, the collieries working the coals of the Second Division do not work those of the First or Third, but they mine several seams belonging to the Second Division together. The partings between the seams consist of shales and sandstones, the former predominating. In order to win these thin seams, enormous quantities of these rocks have to be removed, brought to the surface and thrown on the waste heaps. The collieries working these coals are the largest in the Forest, and consequently the waste heaps take the form of very high hills, even exceeding those of the Radstock Coalfield in elevation. These heaps offer abundant opportunities for plant collecting. The materials are very mixed and belong to several different seams, but, as these coals are closely associated, and as they all belong to the second Division, they may be regarded as forming one large seam, the Second Division.

I now propose to indicate the floras obtained from the chief collieries of the Second Division.

TRAFALGAR COLLIERY

Trafalgar Colliery, at Drybrook Road Station, has long been famous for the fossil plants obtained from its enormous spoil-heaps.

The following are the commoner species. The Calamites are represented by several species of pith-casts, including *Calamites Suckowi*, Brongn., and *C. undulatus*, Sternb., while *C. varians*, Sternb., is somewhat rarer. The commonest type of Calamitean foliage is *Calamocladus equisetiformis* (Schloth.) Plate XXXVII., fig. 5. The fronds of *Sphenopteris pneuroteroides* (Boulay) Plate XXXIX., fig. 17, *Neuropteris ovata*, Hoffm., Plate XXXVII., fig. 6 and *N. Scheuchzeri*, Hoffm., Plate XXXIX., fig. 12 are frequent. The chief Pecopterids are *Pecopteris polymorpha* (Brongn.), Plate XXXVII., fig. 3, and *P. Miltoni* (Art.) Plate XXXVII., fig. 2. The large seed *Trigonocarpus Nœggerathi* (Sternb.), Plate XXXIX., fig. 15, is frequent. Among the Lycopods the stems of *Lepidodendron aculeatum*, Sternb., Plate XXXIX., fig. 16, and the cones of a *Lepidodendron* (*Lepidostrobus*) are not infrequent. The Cordaitean leaf *Cordaites angulosostriatus*, Grand'Eury, Plate XXXVIII., fig. 11, is abundant.

Among the rarer plants are the great Calamitean cones *Macrostachya infundibuliformis* (Brongn.), a very rare and interesting plant. The less frequent fronds are *Neuropteris fimbriata*, Lesq., and two species of *Alethopteris*, *A. aquilina* (Schloth.), Plate XXXVIII., fig. 10, and Plate XXXIX., fig. 13, and *A. davreuxi* (Brong.) Three interesting Sigillarian stems occur occasionally, *S. elongata*, Brongn., *S. lævigata*, Brongn., Plate XXXVIII., fig. 7, and the rare *S. Brardi, var. denudata*, Gœpp. *Lepidodendron dichotomum*, Sternb. is met with.

CRUMP MEADOW AND FOXE'S BRIDGE COLLIERIES

These two collieries, the heaps of which are close together and lie a short distance South of Trafalgar Colliery, proved much less prolific on the occasions of my visits than that at Trafalgar. Some of the commonest species of the coalfield occur in both cases. Crump Meadow Colliery proved to be particularly barren, though specimens of *Mariopteris muricata* (Schloth.), Plate XXXVII., fig. 1, *Alethopteris davreuxi* (Brongn.), and *Sigillaria lævigata*, Brongn., Plate XXXVIII., fig. 7, were obtained here. At Foxe's Bridge, *Cordaites angulosostriatus*, Grand'Eury, Plate XXXVIII., fig. 11, is particularly abundant, and among the rarer plants found here were *Calamostachys tuberculata* (Sternb.), *Annularia radiata* ? (Brongn.), *Neuropteris macrophylla*, Brongn., and *Sigillaria rugosa*, Brongn., Plate XXXVIII., fig. 8.

LIGHTMOOR COLLIERY

The waste heaps of the different collieries, no doubt, vary from time to time as regards fertility, from the point of view of fossil plants, and it does not follow that a colliery, which proved nearly sterile during a certain visit, is not worth visiting on a future occasion. However, of all the collieries working the Second Division, I found that at Lightmoor, near Cinderford Bridge, the least productive of fossil plants.

Neuropteris ovata, Hoffm., *Pecopteris polymorpha*, Brongn., Plate XXXVII., fig. 3, *Sigillaria lævigata*, Brongn., Plate XXXVIII., fig. 7, and *Lepidodendron lanceolatum*, Lesq. were the chief species obtained there, and most of these are common elsewhere.

NEW FANCY COLLIERY

The heap of New Fancy Colliery, which lies nearly two miles due south of the Speech House, has a character all its own. The large heaps here are not perhaps so prolific as those of other coalfields, but they have yielded very complete and excellent specimens of several plants, especially of *Calamocladus equisetiformis* (Schloth.), Plate XXXVII., fig. 5, and of species of *Sigillaria* and *Alethopteris*. Most of the species common in this coalfield can be obtained here, notably *Neuropteris ovata*, Hoffm., Plate XXXVII., fig. 6, *Pecopteris polymorpha*, Brongn., Plate XXXVII., fig. 3, and *Pecopteris Miltoni* (Artis), Plate XXXVII., fig. 2 Among the rarer plants are *Alethopteris Grandini* (Brongn.), Plate XXXVII., fig. 4, *A. davreuxi* (Brongn.), *A. aquilina* (Schloth.), Plate XXXVIII., fig. 10, and Plate XXXIX., fig. 13, *Sigillaria rugusa*, Brongn., Plate XXXVIII., fig. 8, and the very rare *S. trigona*, Sternb.

PARKEND COLLIERY

Parkend Colliery in the Southern part of the Forest has also furnished a fair number of plants, including *Calamites ramosus*, Artis and *Annularia sphenophylloides* (Zenker).

THE THIRD DIVISION COALS

Of the six coals of the Third Division, only the Yorkley, the Coleford High Delph and Trenchard Coals are of workable thickness. The higher beds of this series are alternations of shales and sandstones, but, below the Yorkley Coal, the strata consist of massive sandstones, which yield the well-known Forest of Dean Stone, which is so largely exported from the Forest. These beds are quarried in many parts of the Forest. There are several very large quarries, on or near the road from Speech House Road Station to Coleford. One of them, Oak Quarry, must be over 200 feet deep and consists almost entirely of massive sandstones. This essentially arenaceous series is one of the most striking features of the Productive Measures of the Forest. Unfortunately these sandstones do not contain fossil plants, or rather, where such impressions occur, they are too badly preserved to be recognisable. In only one case have fossil plants been obtained from above the Coleford High Delph Coal, and here it happened that, by an almost unheard-of occurrence, a small bed of shale suddenly appeared above the coal, as we shall see presently.

The Yorkley Seam

The Yorkley Seam is worked *alone* at two collieries, Park Gutter Colliery, close to Whitecroft Station, and at Flour Mill Pit, another colliery also belonging to the Princess Royal Collieries Co., and situated about a mile N.W. of Park Gutter, with which it is connected by a cable tramway. So far as I am aware, the heaps of these collieries are the only localities in the Forest at the present time where the rocks associated with this seam can be studied. That at Park Gutter is very rich in fossil plants, which are often exceedingly well preserved. On the two occasions when the author visited Flour Mill Pit in different years, plants appeared to be very much less abundant than at Park Gutter.

One of the commonest fossils at Park Gutter is the frond of *Sphenopteris neuropteroides* (Boul.), Plate XXXIX., fig. 17, of which beautiful examples can usually be obtained, many of which show casts of *Spirorbis* attached to the pinnules. Good specimens of the rare Calamitean cone *Macrostachya* also occur. The following plants are also common here :—

Sphenopyllum emarginatum, Brongn., *Neuropteris ovata*, Hoffm., Plate XXXVII., fig. 6, *Mariopteris muricata* (Schloth.), Plate XXXVII., fig. 1, *Pecopteris polymorpha*, Brongn., Plate XXXVII., fig. 3, and *Lepidodendron aculeatum*, Sternb., Plate XXXIX, fig. 16. The following are among the rarer fossils :— *Sphenophyllum majus* (Bronn), *Neuropteris macrophylla*, Brongn., and *Pecopteris* (*Dactylotheca*) *plumosa* (Artis), Plate XXXIX, fig. 14.

Several of these plants also occur at Flour Mill Colliery, with the addition of *Neuropteris Scheuchzeri*, Hoffm., Plate XXXIX., fig. 12, *Odontopteris Lindleyana*, Sternb., and *Lepidodendron dichotomum*, Sternb. The two last-named species are very infrequent in the Forest.

The Coleford High Delph Seam

As we have pointed out, the roof of this important seam consists, with very rare exceptions, of sandstones, which do not contain fossil plants. In April, 1909, however, Mr John

Morris, the Manager of the Lydbrook Colliery, noticed when working this seam that a small bed of shale occurred about 3 feet above the seam. He very kindly at once communicated with me, and saved as much of the plant-bearing material as possible. When I arrived a few days later, I was able to collect a number of species from it. I would express my sincere thanks to Mr Morris for the alertness with which he made such good use of this unique opportunity, and for his personal kindness to me in this matter.

The following is a list of the species obtained, many of which are rare elsewhere in the Forest.

Annularia stellata (Schloth.)
Calamostachys tuberculata (Sternb.)
Macrostachya sp.
Sphenophyllum emarginatum, Brongn.
Neuropteris ovata, Hoffm, Plate XXXVII., fig. 6.
N. macrophylla, Brongn.
N. fimbriata, Lesq.
Pecopteris arborescens (Schloth.)
P. polymorpha ? Brongn, Plate XXXVII., fig. 3.
P. Miltoni ? (Artis), Plate XXXVII., fig. 2.
Cordaites angulosostriatus, Grand'Eury,
Plate XXXVIII., fig. 11.

The Horizon of the Productive Beds of the Forest of Dean

If the floras of the three divisions of the Productive Measures of the Forest of Dean are compared, it will be found that they are to a large extent identical, and undoubtedly they all belong to the same palæobotanical horizon, which is the Upper Coal Measures. In all, 44 species are known from the Forest, none of which are new to Britain, though some of them, such as *Sigillaria trigona,* Sternb., and *S. Brardi, var. denudata,* Gœpp., are very rare in other coalfields. There is a close correspondence with the Upper Coal Measures (Radstock and Farrington Series) of Radstock, and with the Upper Coal Measures of Bristol. These Measures yield the most abundant, varied and best preserved fossil plants of Carboniferous age found in Britain. Those from the Forest of Dean are a very good second. At the same time, there are differences in detail between these three floras, which are probably to be accounted for as local variations in the distribution of the flora of the period.

The Forest of Dean is not an outlier of the South Wales coalfield, as has often been supposed. It is more closely related to the Radstock and Bristol coalfields. There are no equivalents in the Forest of Dean of the Middle Coal Measures (White Ash Series) or Transition Coal Measures (Pennant Grit) of South Wales, and the massive Forest of Dean Stone belongs to a higher horizon than the Pennant Grit, with which it has been often correlated.

I do not propose to discuss here the rocks below the coal bearing series. I have elsewhere shown that there are good reasons for believing that no true equivalents of the Millstone Grits are present in the Forest, and that in all probability the Productive Measures overlie, unconformably, the Carboniferous Limestone series, the higher beds of which, between the Whitehead Limestone and below the Trenchard Coal, have here, as at Bristol, an arenaceous facies. This is a point on which much further work remains to be done, and a special study of these rocks, wherever exposures can be found, will repay the investigator, and throw additional light on this important point. The Eastern and Northern, and especially the North Eastern boundaries of the field, from Upper Soudley to Cinderford, Mitcheldean, and then across to Drybrook, will be found to offer the most promising field for such inquiries, and may result in the discovery of a section showing the unconformity, as has been recently discovered in the Clee Hills in Shropshire.

In conclusion, I may remark that a fuller account of the fossil flora of the Forest, with figures of many other plants, as well as a full bibliography on the geology of the Coal Measures of this coalfield, will be found in my paper " On the Fossil Flora of the Forest of Dean Coalfield (Gloucestershire) and the Relationships of the Coalfields of the West of England and South Wales," which has recently appeared in the Philosophical

Transactions of the Royal Society of London, Ser. *B*, Vol. 202., p. 231, 1912. Photographs of many typical Upper Coal Measures plants are also given in my little sixpenny "Fossil Plants" (Gowans and Gray's Nature Books, No. 21, 1909). A discussion on the many problems which remain unsolved in connection with the subject of Coal, will be found in my "Natural History of Coal," one of the shilling Cambridge Manuals of Science and Literature, 1911.

I wish here to add my thanks to the owners and managers of the various collieries in the Forest for the facilities which they have always given me, in the kindest way, for collecting fossil plants at their collieries. I am particularly indebted to Mr Frank Brain of Trafalgar, Mr C. Cooke of the Princess Royal Collieries, and I would gratefully acknowledge the help and influence of Mr T. A. Llewellyn of the Crown Office, which has always been most willingly placed at my disposal. I would also add that part of the cost of collecting the flora has been defrayed by means of grants from the Government Grant Committee of the Royal Society.

EXPLANATION OF THE PLATES

(*All the specimens figured are in the Carboniferous Plant Collections of the Sedgwick Museum, Cambridge, to which the numbers refer. The negatives are by the author, the prints by the author and Mr Tams, of Cambridge*).

PLATE XXXVII.

FIG. 1. *Mariopteris muricata* (Schloth.), from the Second Division, at Crump Meadow Colliery. No. 1782. *Slightly reduced.*

FIG. 2. *Pecopteris Miltoni* (Artis), from the First Division, Woorgreens Coal, Woorgreens Colliery. No. 1801. *Slightly reduced.*

FIG. 3. *Pecopteris polymorpha*, Brongn., from the First Division, Woorgreens Coal, Woorgreens Colliery. No. 1958. — $\times \frac{7}{5}$.

FIG. 4. *Alethopteris Grandini* (Brongn.), from the Third Division, Yorkley Coal, at Park Gutter Colliery, No. 1598. — $\times \frac{6}{5}$.

FIG. 5. *Calamocladus equisetiformis* (Schloth.), from the First Division, Woorgreens Coal, Woorgreens Colliery. No. 1725. — $\times \frac{3}{2}$.

FIG. 6. *Neuropteris ovata*, Hoffm., from the Third Division, Coleford High Delph Coal, Lydbrook Colliery. No. 2095. *Slightly reduced.*

PLATE XXXVIII.

FIG. 7. *Sigillaria lævigata*, Brongn., from the Second Division, New Fancy Colliery, No. 1659. — $\times \frac{4}{5}$.

FIG. 8. *Sigillaria rugosa*, Brongn., from the Second Division, Foxes Bridge Colliery. No. 1747. *Slightly reduced.*

FIG. 9. *Sigillaria ? Scutellata*, Brongn., from the Second Division, New Fancy Colliery. No. 1724. *Slightly enlarged.*

FIG. 10. *Alethopteris aquilina* (Schloth.), from the Second Division, Trafalgar Colliery. No. 1600. — $\times \frac{4}{5}$.

FIG. 11. *Cordaites angulosostriatus*, Grand'Eury, from the Second Division, at Foxes Bridge Colliery. No. 1736. *Slightly reduced.*

PLATE XXXIX.

FIG. 12. *Neuropteris Scheuchzeri*, Hoffm., from the Second Division, at Trafalgar Colliery. No. 1980. *Slightly enlarged.*

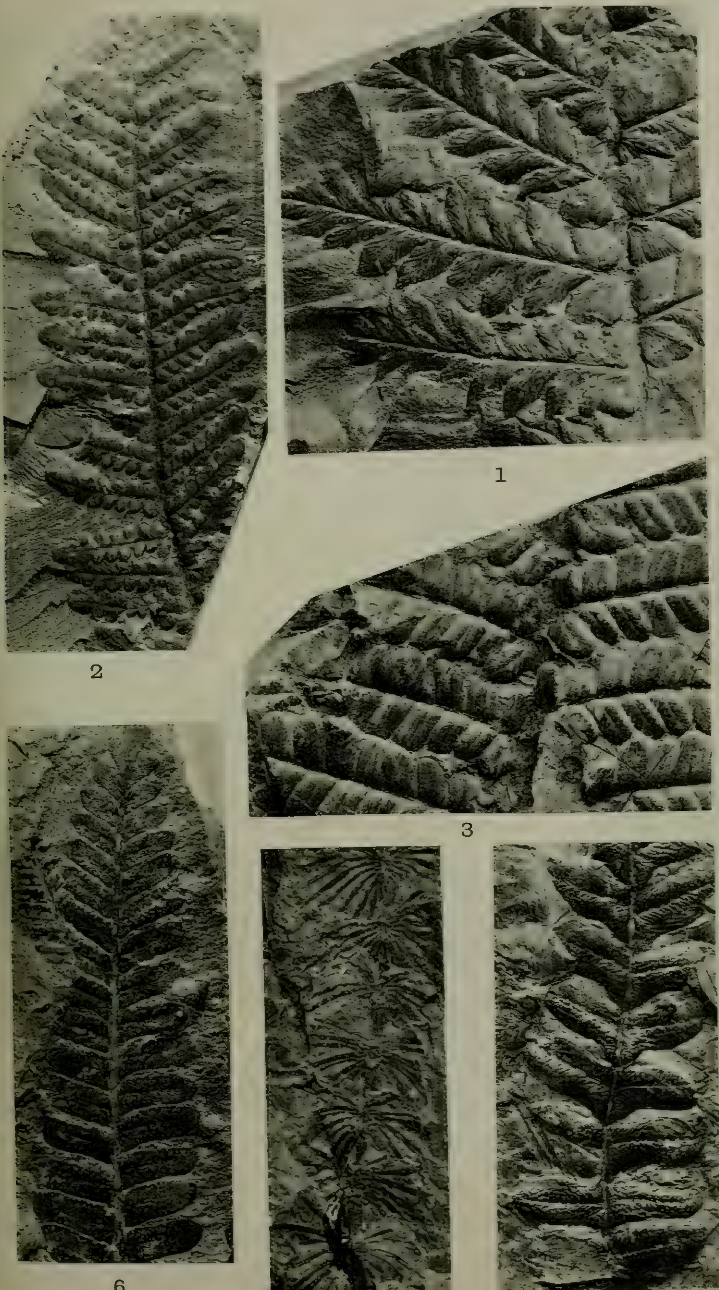
FIG. 13. *Alethopteis aquilina* (Schloth.), from the Second Division, Trafalgar Colliery. No. 1670. — $\times \frac{6}{5}$.

FIG. 14. *Pecopteris* (*Dactylotheca*) *plumosa* (Art.), from the Third Division, Yorkley Coal, Park Gutter Colliery. No. 1981. — $\times \frac{8}{7}$.

FIG. 15. *Trigonocarpus Nœggerathi* (Sternb.), from the Second Dvision, at Trafalgar Colliery. No. 1668. *Slightly enlarged.*

FIG. 16. *Lepidodendron aculeatum*, Sternb., from the Second Division, at Trafalgar Colliery. No. 1504. *Slightly enlarged.*

FIG. 17. *Sphenopteris neuropteroides* (Boul.), from the Third Division, Yorkley Coal, at Park Gutter Colliery. No. 1588. — $\times \frac{7}{9}$.



E.A.N.A. Photo.

FOSSIL PLANTS FROM THE FOREST OF DEAN

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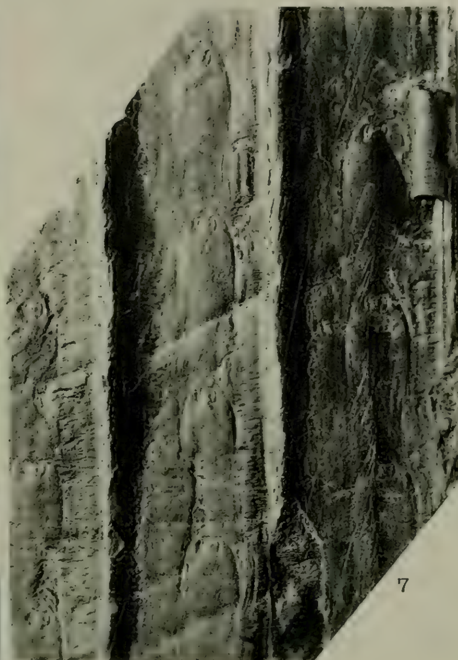

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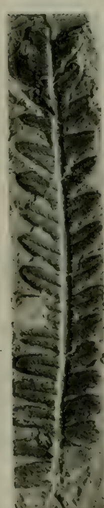

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E.A.N.A. Photo.

FOSSIL PLANTS FROM THE FOREST OF DEAN

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E.A.N.A. Photo.

FOSSIL PLANTS FROM THE FOREST OF DEAN

Panoramic Photo by
H. V. Davies

CLIFFS AND LAVA BEDS　　DRIFTWOOD BAY　　(BEERENBERG concealed by clouds)　　EGG BLUFF

THE ISLAND OF JAN MAYEN (From the S.E.)

THE ISLAND OF JAN MAYEN

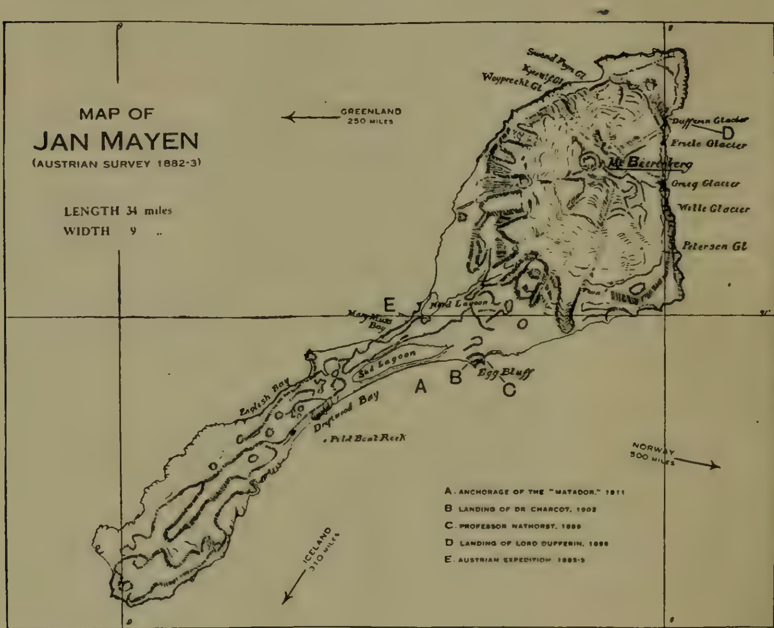
BY

WILLIAM BELLOWS

[Plate XL.]

It is a far cry, certainly, from the green slopes of the Cotteswolds to the glaciers of Jan Mayen, but as our Club has not infrequently followed with a kindly interest the experiences of its members straying far from home, I offer for the benefit of my fellow-members a brief account of this lonely island in the Arctic Sea, and of an attempt to land upon it in the summer of 1911.

Jan Mayen (uninhabited, and now but rarely visited) is a spot which must ever appeal to sea-travellers in northern waters on account of its very solitude, and because, also, of its remarkable physical features. The island, which is entirely volcanic, lies 250 miles eastward from the Greenland coast, 650 miles westward from the North Cape, 310 miles from Cape Langanes in Iceland, and is bisected by the 71st degree of north latitude. It is 34 miles long and has a varying width of from 2 to 9 miles. As will be seen by the accompanying map, it is formed of two definite portions of land connected by an elongated strip. The northern portion is a huge volcanic snow-clad mass culminating in Mount Beerenberg (a virgin peak rising to 8350 feet above the sea); the southern part is a rolling piece of gloomy hill-country, covered with innumerable volcanic cinder-cones and craters, and marked by dark green stretches where vegetation still holds its own amid desolate wastes of volcanic ash and patches of snow. The coast-line is extremely striking, and at the proper season is the haunt of countless sea-birds. Rugged cliffs descend into the water at many points, intercepted at the Beerenberg end by glaciers which come down steeply to the sea, and at other places by sombre valleys which were evidently once the beds of now "extinct" glaciers. On the eastern coast lies "Driftwood Bay" with its seven miles of dark strand ; here may be seen the drifted timber from the forests of Siberia, tree-trunks and logs which have finally found a lodgment after their long voyage down Siberian rivers and westward, current-driven, through the Arctic Sea. The landward pressure of the polar-ice drives this timber further and further up the beach till it finally lies at some distance from the water's edge.



Jan Mayen was discovered by Hudson in 1607—and re-discovered four years later by the Dutch navigator whose name it has ever since borne. In 1633 it was the scene of a tragedy. The Dutch Government, wishing to establish a whaling-station on the island, induced seven men to remain there for a whole winter. Huts were made and the men were supplied with provisions for several months. But, alas, the return of their Dutch friends in the following spring was timed too late, and some weeks before their arrival the last of the seven men had succumbed to scurvy.

Jan Mayen must often have been visited by passing whalers in the succeeding years, but I must skip a couple of centuries and come down to 1856, when Lord Dufferin in his little sailing-yacht "The Foam," landed on the island for two brief hours,[1] and was almost kept a prisoner there by the drifting ice. For ice and fog are the twin arch-enemies of the would-be visitor to these waters, and fortunate is the navigator who sees nothing of either of these evils. The southward-drifting floes hug Jan Mayen in their cold embrace for a large portion of the year, and often quite block up the 250 miles of sea between it and the coast of Greenland.

In 1882 the Austrian Government (as a participator in the International Circumpolar Conference of 1879) sent an expedition to the island, which set up its head-quarters at Mary Muss Bay on the 71st parallel, and remained there for twelve months, making meteorological and other observations. The wooden erection which served as the home of this expedition may still be seen there, and contains (for the benefit of shipwrecked sailors) a store of tinned provisions ; whilst close at hand is a stack of twenty tons of patent fuel to be used by those who may come to need it. The average temperature throughout the year was ascertained to be 27·8° Fahrenheit. To this visit of the Wohlegemuth expedition it may be due that Jan Mayen is shown on certain maps as Austrian territory ; in actual fact, however, the island is the property of no one.

An interesting report on Jan Mayen was made by the French "*La Manche*" expedition in 1892, and a visit was paid to the island by Professor Nathorst of Stockholm in 1899, in 1900 by the Swedish Kolthoff expedition, and again in 1902 by Dr. Jean Charcot. The latter was nearly caught in the quick-sands at the end of Driftwood Bay, but he succeeded in landing and he visited the Austrian headquarters in Mary Muss Bay. The tinned provisions deposited there twenty years earlier, were still remarkably well preserved:

1 See the brilliant account of this exploit in his "Letters from High Latitudes."

and the carcases of birds half eaten by foxes were found upon the floor of the wooden cabin.

I was one of a party of nineteen[1] which made an attempt (alas, an unsuccessful attempt!) to land on Jan Mayen in the summer of 1911. Under the leadership of J. Foster Stackhouse, F.R.G.S., we chose the month of August for our voyage, for there are only three months in the year of possible open water round the island. Leaving Newcastle-on-Tyne on the little S.Y. "Matador" (230 tons) we steered our course due north to the Orkneys, and thence through increasing fog to the Faroes, and onward to Seydisfiord on the north-east coast of Iceland. At the latter point we landed and took in provisions—during which operation our little party dispersed in various directions, some visiting the ancient glacier-bed and beautiful falls three miles inland, some collecting plants and geological specimens, and some replenishing the simple larder by fishing in the fiord. The absence of trees, and the presence of day-light far on into the hours of the night were perhaps the most noticeable features here. The Icelanders were much interested in our project, and would come down in the rain to watch from the wooden wharf, our doings on the "Matador."

A day or two later found us sheltering from a violent north-westerly storm under the headland of Langanes[2] (the extreme north-easterly point of Iceland, ten miles south of the Arctic Circle). For thirty-six hours it lasted, and the sea outside was no place for the "Matador" or ourselves. Driving fog, and chilling sleet and snow were our portion as we lay at anchor in Eithisvik. To southward the imposing coast-line was soon lost in the gloom; to northward extended the sharp-cut cliffs of Langanes. Some of us risked a wetting and landed on the boulder-strewn beach, where the surf was breaking. The loneliness of the spot was impressive. A few fishermen's huts by a lagoon and that was all: beyond that, dreary moorland lost in mist. A group of Arctic terns were playing gracefully in the wind near the shore, and we also saw eider-ducks, black guillemots, and snipe (*tringa striata.*) The

1 Three Germans, two Swedes, two Americans, twelve British; with the skipper and a crew of eight.

2 Cf. *Langness* in the Isle of Man.

latter especially appeared quite tame and unsuspicious, and circled round close to our feet. On the shore were logs of the Siberian drift-timber which we saw later in greater quantities on the coast of Jan Mayen.

While at this anchorage a division of opinion arose among us as to our future course. This led unfortunately to a regrettable delay, for it was not till we had steamed many miles down the coast that our better senses gained the upper hand and we retraced our " steps " upon the foggy sea. Crossing the Arctic Circle we steered a straight course north-north-east. A careful watch was kept for polar-ice but although there were traces of ice-blink from time to time upon the horizon we were fortunate in meeting with none. Near the coast of Iceland we passed through frequent banks of dense sea-fog. Kittiwakes and fulmars came and went, and once, far north, we saw a Solan goose flying southward. We felt considerable anxiety on account of the smallness of our vessel, and the soft coal we bought in Iceland was burning away more rapidly than we wished it to. The temperature of the sea was taken hourly by day and night—starting at 7·2° Centigrade near Cape Langanes and finally falling by gentle stages to 3·5° on the north coast of Jan Mayen.

We sighted the first rocks of the latter some thirty hours after leaving the coast of Iceland. As we drew nearer the precipices forming the southern end of the island, large numbers of fulmars flew around us, and the young of the black guillemot could be seen on the water close to the " Matador." But the bird-specialists on board quickly saw that we had arrived too late in the season to see the bird-life at its best, the young ones having already largely departed for the south. Polar bears come here in winter on the pack-ice from Greenland, and there are Arctic foxes on the island. The French scientists on " La Manche " were met on the shore by three of these foxes coming down unsuspiciously to see the strangers. They found that the sea-birds were in the habit of building high up on the cliffs just out of reach of these foxes, ever on the look-out for their young.

The sun came out as we approached the shore and somewhat dispelled the gloom; it certainly helped to make the austere coast-line seem a little more inviting. We came in close to the shore, passing a little way from the "Pilot Boat Rock" of the Austrian map—a natural reproduction in dark volcanic rock of a boat under full sail. After some manœuvring, and due care being taken on account of the more or less uncharted coast, we anchored in Driftwood Bay about one thousand yards from the shore. The line of contact between sea and land was marked everywhere by surf. The lower slopes of Mount Beerenberg were already visible to the northward, the crevasses of a huge glacier being plainly visible through glasses from the deck. Gently-moving masses of impenetrable fog and cloud obscured for the present the upper slopes and summit of the imposing mountain which we were to see to such advantage a few hours later.

We lowered a boat with a landing-party—carrying provisions, guns, cameras, sleeping-bags, &c. Very anxiously we watched its progress from the deck and bridge. That fine white line of surf was to be our undoing, however! The boat[1] approached the shore, but at each attempt to secure a landing the same difficulty was met with—dangerous surf; the fatal white line was there to tell its own tale to the rest of us out on the "Matador." We were not in a position to run any risks by smashing a boat. There was of course no life-boat station handy in case of trouble; nothing but the irresponsive cliffs and shore, with a line of sea-birds sitting upon the latter and holding perhaps their final parliament before rising for the south. This beach was of dark volcanic sand. Upon it, besides the aforesaid sea-fowl, was a large quantity of the driftwood previously referred to. The shore at this point was protected by a submerged barrier of black rock, over which the surf and spray were driving.

To return to the "Matador" (which, alas, is just what the boat and its occupants now had to do!). The surf had proved too obdurate to be overcome, and with hearts sinking

1 The boats of the "Matador" were unfortunately too heavy for landing on an open beach like that of Jan Mayen. There is no protected anchorage to be found there.

as we realized what it meant, the little craft came back to us, rising and falling with the increasing swell.

We weighed anchor and departed northward. Skirting the outermost point of "Egg Bluff" (easily recognised by us to be the remains of a partially-submerged crater) we came opposite the lower or seaward end of the South Glacier, whose huge crevasses thrilled us all with their imposing aspect. The upper end of the glacier climbing serenely towards the higher slopes of huge Beerenberg, was still lost in the rolling mists gathered over the summit of the mountain. Evening was now setting in, but a rather deceptive kind of evening, for the light "held up" till next day, to say nothing of the day after.

The general "lie" of Jan Mayen is from the south-west to the north-east; we accordingly steered a north-easterly course (or rather N.E. by E.) for a few miles till we came off the "S.O" Cape shown on the Austrian map (1882-83), where we turned due north for some ten miles or so up the eastern coast-line of Mount Beerenberg. This proved perhaps the most impressive portion of all our voyage of three thousand miles. One by one the five great eastern glaciers came into view, and were seen in their entirety as they rose from the very edge of the sea in huge ice-steps to the snow-fields thousands of feet above.

Far up towards the summit a snow-storm was evidently raging, and one was tempted to compare the comfort of our little saloon with the rigours of those upland wastes. The sea, protected somewhat by the precipices of Mt. Beerenberg, had become calmer by this time, and upon the gloomy waters behind us the pale full moon was shining: an intruder, as it were, upon the daylight of midnight, but an intruder so beautiful to behold that it will take years to efface the memory of the scene.

That night we turned south. The rising sea and wind bade us begone. Mists hung along the coast, and water was coming on deck from time to time. As we rounded the northern end of the island we passed in nearer to the Beerenberg glaciers, whose ice-falls, ending abruptly in the sea, stood out prominently on our starboard beam. At Mary Muss Bay we signalled to shore in case a shipwrecked crew might have made it their temporary home, but without response.

With our diminishing supply of coal, anxiety began to increase in many minds. The captain, too, was anxious ; we must be getting south. One or two of us remained up all night to watch the western coast-line ; by 3 *a.m.* we were passing once more the bold cliffs which form the southern cape, and which we had hailed the day before. Fulmars flew silently at our side, gracefully keeping time with the swell of the increasing sea. The wind howled in the rigging, and the gloom upon the water was with us still. At last the faint coast-line disappeared to northward and with it the last vestige of Jan Mayen !

NOTE ON A LONG BARROW, NEAR BISLEY

BY

A. E. W. PAINE

(*Read March 12th,* 1912)

In the autumn of 1863, a long Barrow near Bisley was opened by my father, Dr W. H. Paine, who was assisted by Dr Henry Bird. The Barrow was situated rather less than half a mile to the south-east of the village, and was close to the road leading to Water Lane. It is now entirely destroyed. Dr Paine and Dr Bird appear to have sent the notes they made on the opening to Dr Thurman,[1] so unfortunately I am unable to describe the Barrow fully or to state whether anything else was found besides the few bones that are now in my possession. These bones were labelled by Dr Paine, but I never saw them during his lifetime or heard any account of the Barrow from him.

Dr Thurman in his paper on "British Barrows"[2] says :—

> "In addition to the above [that is, a description of barrows opened by himself], there are other chambered long barrows in this part of England of the opening of which we have only meagre and imperfect accounts, or none at all."

He then gives a list of those opened in Somerset, Wiltshire and Gloucestershire, and continues—

> "In this county (Glos.), also on the Cotswolds, so prolific in the chambered tumuli—is that of Ablington, of the partial exploration of which the Rev. S. Lysons has given an account, and that at Bisley, opened by Dr W. H. Paine of Stroud in 1863, for a report of which, not published, I am indebted to a brief note from Dr H. Bird."

In the table that he gives summarising the results of the explorations of chambered tumuli, is the following—[3]

No.	Locality and Name	Result of Exploration		Reference
		General Result	Primary Interment	
19	BISLEY ..	Successful in part, 1863	Remains of Skeletons	Letters from Dr H. Bird and Dr W. H. Paine

1 Archæologia, vol. xlii., p. 203. 2 *Ibid.*, p. 201. 3 *Ibid.*, p. 203.

The Barrow is mentioned by Mr G. B. Witts in his "Archæological Handbook of Gloucestershire"[4] and is shown on his map—being number 4 of the Long Barrows—but no details are given; and also by Dr Bird in a paper on "The Aryan Migrations to Stroud and Neighbourhood"[5] in which he says—

> "The Barrows opened by Dr Paine at Bisley afforded some evidence of cremation and a mixture of the bones of the thick skulled race with the bones of the Long Barrow race."

while in the discussion following the paper, Dr Paine said—[6]

> "As Dr Bird had mentioned him in connection with the opening of a Barrow near Bisley, he (Dr Paine) wished to put himself right to this extent, that there was no evidence of cremation within the Barrow, but there were the burnt bones of a horse near it."

I regret that this is all the information I have been able to gather regarding the Barrow, as the remains found in it are of considerable interest as shewing a mixture of races in the primary interment—at least two individuals, though found in a chambered long barrow, being of a round headed Bronze Age race—and from the fact that one of the skull bones shows evidence of an attempt at trepanning (Plate XLI). I shewed this bone to Dr Keith, who described it to me as the frontal bone of an old man of a Bronze Age race, and wrote me as follows respecting it:—

"Both Mr Shattock the pathologist and I are puzzled over that specimen. The circular trephine? The trepan opening is designedly made—but when? We think at, or soon after death, but there is no mark of inflammation or disease on the bone. I think it was probably done just before death."

The attempted trephine is a circular ring just over an inch in diameter, roughly pecked or chipped out by some blunt instrument, probably of flint. The width of the ring varies from $\frac{1}{8}$ to $\frac{5}{16}$ of an inch, and it penetrates, on the average, about one-third the thickness of the bone, though in one place it nearly pierces it.

The other bones in my possession, which belong to at least three individuals, a man, a woman and a child, consist

4 Page 75. 5 Trans. Bristol and Glos. Archæol. Soc., vol. v., p. 31. 6 *Ibid*, p. 33.

SKULL BONE SHOWING EVIDENCE OF TREPANNING.

Measured on the flat the dimensions of this bone are $4\frac{3}{8}'' \times 3\frac{3}{4}''$.)

of 17 fragments of skull bones, a portion of the lower jaw of an old man, a complete lower jaw of a child, six vertebræ, three clavicles, three ribs, a portion of a femur and an *os calcis*, the lower jaw of the child being of a Bronze Age type. All the bones are unburnt.

THE WATER SUPPLY
OF THE
CITY OF GLOUCESTER

(*Read March 12th*, 1912)

INTRODUCTION

BY

L. RICHARDSON, F.R.S. Edin.

In the latter part of 1910, and the early part of 1911, a deep boring was put down at Ketford, near Newent, by the Gloucester Corporation with the view to obtaining an additional supply of water for the City. The diameter of the bore-hole down to a depth of 353 feet from the surface was $18\frac{3}{4}$ inches and from that depth down to 359 feet, $14\frac{1}{4}$ inches.

Realizing how very desirable it is that the geological details of all such borings should be recorded and portions of the core, if necessary, preserved, I visited the Ketford boring in company with Mr R. Read, A.M.I.C.E., the City Surveyor, examined the cores, made notes and selected portions of the cores to be brought to Gloucester. These have now been dressed and are to be seen in the Gloucester Museum.

During the progress of these investigations, it seemed to me that it would be interesting to have collected together in one paper details of the whole of the water-supply that is available for the City of Gloucester, together with a history of the development of the scheme of supply. Therefore, the scope of the enquiry was enlarged and I am greatly indebted to Mr Read for most kindly supplying me with all the details that I required; to Mr Roland Austin for undertaking the necessary historical research; and to Mr Sheffield Blakeway for his kindness in facilitating the initial stages of the enquiry.

The map given below (fig. 1) will give an idea of the relative positions of the Robinswood-Hill Reservoirs, the Witcombe Reservoirs, the Newent Well, Madams-Wood Reservoirs and the Ketford Bore-hole. The water gravitates to the City from

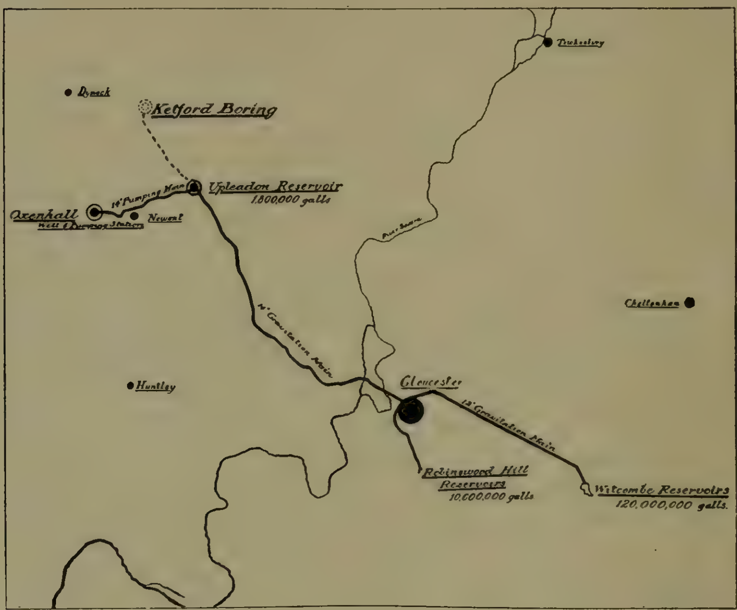


FIG. 1.—Map to show the relative positions of the reservoirs, Ketford bore-hole, Newent well and courses of the mains.

the reservoirs, and the houses are connected directly with the water-mains.

GEOLOGY AND WATER SUPPLY

BY

L. RICHARDSON.

ROBINSWOOD HILL RESERVOIRS.—These reservoirs, as stated above, were constructed by a Company in 1837-8, and were purchased from the Company by the Corporation, under the Gloucester Water Act of 1855, for £18,500.

Storage capacity :	upper reservoir ..	9,000,000 gallons
	lower ,, ..	1,000,000 ,,
	TOTAL	10,000,000 gallons

The gathering-ground has an area of 260 acres. Part of it is a depression in the side of the hill (commencing about the horizon of the *Capricornus*-Beds of the Lower Lias), which extends and narrows upwards between two shoulders of Marlstone, terminating at the foot of the slope where the Cotteswold Sands begin; but a considerable quantity of water is collected and brought round the contours of the hill in pipes to the reservoirs. Most of the water is derived from two horizons—(1) the base of the sandy beds of the Middle Lias and (2) the base of the Cotteswold Sands.

The springs have a minimum flow of about 25,000 gallons per day.

Permanent hardness ..	9·1 degrees
Temporary ,, ..	11·2 ,,
TOTAL	= 20·3 degrees

WITCOMBE RESERVOIRS.—These reservoirs (fig. 2) were constructed under the powers of the 1855 Act.

The formal opening of the Witcombe Works took place on September 20, 1860, when the water was turned in from the upper to the lower reservoir, the works being completed by 1863. A third reservoir was commenced in 1868, and completed in 1870.

Storage capacity :	No. 1.	60,000,000 gallons
	No. 2.	30,000,000 ,,
	No. 3.	30,000,000 ,,
	TOTAL =	120,000,000 gallons

The gathering-ground has an extent of 1,500 acres and is on the slopes of a bay-like hollow in the western face of the

J. W. Gray, photo.

Fig. 2.—View of the Witcombe Reservoirs

Cotteswold Hills, some five miles to the east of the City. The principal geological horizons from which the springs issue are the same as those at Robinswood Hill. The minimum yield of the springs is 150,000 gallons per day.

Permanent hardness ..	6·3 degrees
Temporary ,, ..	7·7 ,,
TOTAL =	14·0 degrees

Newent Pumping Station. —The water-supply from Robinswood and Witcombe met all requirements until in 1894, when it became desirable to seek for an additional source of supply, which was found near Newent. In 1895, the Corporation obtained Parliamentary sanction (58 Vict. ch. xci.) to construct a well and a pumping-station and other works in the parish of Oxenhall, and a reservoir at Madams Wood in the parish of Newent.

The rocks in the Newent district are of Triassic age.

The first boring that was put down by the Corporation was commenced on January 19, 1893, and was carried to a depth of 290 feet, commencing with a 12-inch diameter and finishing with a 9-inch. This boring was continued by the Onslow Trustees down to a depth of 1190 feet from the surface, finishing with a 7-inch diameter. The bottom-piece of this 7-inch core is also in the Gloucester Museum. It was hoped that the Coal Measures would be proved ; but this was not the case.

At 890 feet down, the water was slightly saline, so the bore-hole was filled up with gravel up to within 719 feet of the surface. On the gravel a wooden plug 6 feet long was placed, and on this concrete up to within 453 feet of the surface.

The Newent Well, which was sunk at a place about 50 yards to the west of the bore-hole, was commenced on October 8, 1894. The works were completed and water delivered to the City on July 1, 1896.

The well is 168 feet deep. The first 60 feet is lined with bricks and has an internal diameter of 12 feet. The next 90 feet is lined with cast-iron cylinders and the internal diameter is 11 feet. The cast-iron cylinders are rings, each 5 feet deep, made of up three segments bolted together. From the last ring but one, that is, at 145 feet from the surface, two headings, each 6 ft. 6 ins. × 4 ft. 6 ins., are driven—one in a westerly direction 145 feet long, and the other in a north-easterly direction 117 feet long. These headings are not lined.

An analysis of the water was made by Sir Edward Frankland, who said it was one of the purest waters he had ever analysed.

Permanent hardness	..	7·9 degrees
Temporary ,,	..	17·2 ,,
Total	=	25·1 degrees

The bore hole proved only Triassic rocks : sandstones with occasional beds of conglomerate, especially in the upper portion. The well proved very similar beds so far as it went. Detailed records of the rocks passed through are preserved in the City Surveyor's Office.

MADAMS WOOD RESERVOIRS.—These reservoirs are situated three miles from the Newent Pumping-Station and eight miles from Gloucester. The top water level is 250 feet above Ordnance-datum. The first reservoir was constructed in 1894-95 : the second in 1901.

Storage capacity :	No. 1.	600,000 gallons
	No. 2.	1,200,000 ,,
	TOTAL	1,800,000 gallons

KETFORD BORING.—Although a very large supply of water is obtained from Newent, in order to make provision for the future requirements of the City, and ensure that as the population increases, there shall be a corresponding supply, further powers were sought and obtained (2 Geo. V. ch. xcii.) in 1911, for the construction of additional works at Ketford, in the parish of Pauntley.

A boring (fig. 3, page 351) was commenced near Ketford Bridge on October 7, 1910.

The cores down to a depth of 353 feet had a diameter of 18 inches ; but from 353 to 359 feet they were smaller, as a 14¼-inch crown was used for the drilling. Portions of the core were ground to sand ; but the specimens of the hard portions that I selected for preservation in the Museum are typical examples of the beds from which they were derived.

KETFORD BORING IN TRIASSIC BEDS

Ground-level of B.H. 90·92 feet above O.D.

Water-level in R. Leadon on Dec. 2nd, 1910.

Do. Oct. 7th, 1910 & on July 3rd, 1911.

i., ii.—*Specimens in Gloucester Museum from between* 31½-32 and 32¾-33 ft.

iii.—*Specimen from about* 84′ 6″-86′.

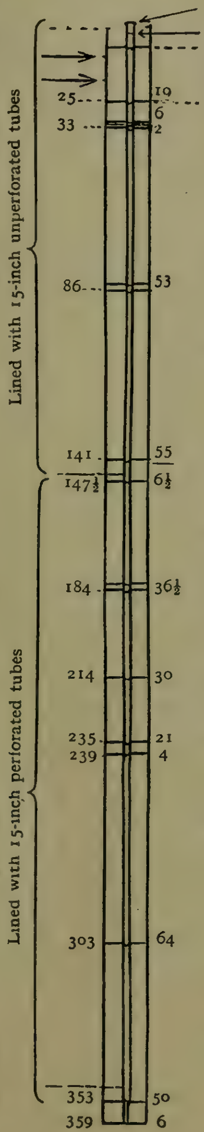
iv., v.—*Specimens from* 183′ 4″-184′

vi.—*Specimen from* 271-2 *ft.*

vii.—*Specimen from* 322′ 8″-324′ 2″.

viii. — *Specimen from* 351′-352′ 6″

x.—*Specimen from* 356′ 9″-358′.



Iron cap.

On Aug. 1st, 1911, the water-level was 2′ 11″ below top of iron cap

Percussion boring commenced Oct. 7th, 1910.
(Diameter of bore-hole 18¾″)

Reddish sandstone-beds with pebbly layers.

Rotary boring commenced Oct. 28th, 1910.

Sandstone.

(i.)—Sandstone with pebbles (1 ft.) overlying (ii) conglomerate (1 ft.)

Sandstone-beds (in some places finer grained than in others) with pebbly layers at various horizons.

Cores all ground to sand.

(iii.)—Sandstone-bed with more numerous and larger pebbles than in the solid core at 32 ft.

Sandstone-beds with pebbly layers.

Cores all ground to sand.

Sandstone without pebbles (1′ 6″).
Hard Sandstone with more and larger pebbles than usual (5′).
Core drawn solid in four pieces.

Sandstone-beds.
Cores usually ground to sand

(iv.)—Sandstone-bed overlying (v.) conglomerate.
Core drawn solid in three pieces.

Sandstone and conglomerate beds.
Cores drawn solid as a rule.

Sandstone-beds.
Cores usually ground to sand.

Sandstone with a thin bed of marl and a little conglomerate.

Sandstones and conglomerates.
Cores usually drawn solid.

Sandstones with varying quantities of pebbles.
Cores drawn solid.

Commenced boring with a 14¼″ crown, May 31st, 1911.

Conglomerate. Pebbles larger than those in the higher beds. Clay "nodules" present.

Ketford is situated upon the Waterstones of the Keuper —the sandstones that occur immediately below the Red Keuper Marls. The nearest outcrop of the Bunter Sandstone is three-quarters of a mile away to the north-west. No changes, however, were observed in the lithic structure of the rocks drawn up, not even in those composing the bottom-portions of the core, to suggest that the Bunter Sandstones had been reached. Indeed, there is nothing of geological interest to note beyond what is recorded alongside the vertical section on page 351.

The works at Bromsberrow in connection with the Malvern Corporation's Waterworks are situated about one and three-quarter miles to the north-by-east of the Ketford bore-hole. The Malvern Works, Mr W. O. Thorp, C.E., Engineer and Surveyor to the Malvern Urban District Council informs me, consist of two 18-inch diameter bore-holes and one 6-inch diameter bore-hole, all three carried to a depth of 200 feet or 19 feet below Ordnance-datum.

The Bunter and Keuper Sandstones of the Bromsberrow-Newent district without doubt contain a great quantity of water. They are, of course, porous and therefore can readily hold water. On the west side they are in juxtaposition for a considerable distance with the relatively impervious Old Red Marls and Coal-Measure clays, and on the east side with the New Red or Keuper Marls. Many wells have been sunk into the sandstone to supply farms and cottages, one of the deepest being that at Nutham House, between Newent and Ketford, which is 170½ feet deep.

In conclusion, it may be stated that the City Corporation has been wise in going well afield for their water, and of recent years in a north-westerly, instead of a south-easterly direction. Attempts to find good drinking-water by means of borings in or near the City are not likely to be attended with much success, for, even if quantity be obtained, there are doubts as to quality—water from the Lias of this neighbourhood is generally saline and hard.

HISTORICAL NOTE

By ROLAND AUSTIN

Until nearly the middle of the fifteenth century, Gloucester must—so far as any supply to the community was concerned—have been dependent for water on the River Severn, and on shallow wells sunk into the gravel. Extant records show, however, that from an early date these sources did not meet the requirements of the Monastic Houses in the City, and evidence exists of the use of the springs at Matson and the neighbouring hill of Robins Wood from early in the thirteenth century. It seems reasonable to suppose that for communities such as the Abbey of St. Peter's, the Grey Friars, and others, it would be necessary to secure an adequate supply of fresh water, and probably very early in their history the springs of Matson were drawn upon, for the Abbey was possessed of the Church of "Mattesdon" in the time of William the Abbot (William Godeman, 1113-1130)[1], and in the reign of Henry III. held the Manor from the Crown. The Cartulary of the Monastery of St. Peter records a grant made by Henry I., permitting the monks the use of

> "the water which is called Fulbrook, which runs beside their Abbey, that they may turn and dispose it and draw it off through their offices at their pleasure."[2,3]

and also that a conduit was made by Helias of Hereford, who was sacrist in 1222, and till 1237.[4] The Fullbrook was an overflow from the Twyver, which crosses the present Cattle Market and runs down the Black Dog yard. The brook took the line of the ditch on the north side of the City and turned the Abbey mill-wheel in Miller's Green, now Palace Yard.[5] Another almost contemporary record concerns the Friars Minor, or Grey Friars, of Gloucester. Among the City muniments is a copy of a grant from

> "William Gerard, of Matesdon, to the Friars Minor of Gloucester, of the use of the spring on his land of Matisnoll in the place called 'Breresclowe'."[6]

This copy is stated by Mr W. H. Stevenson to be in a late fifteenth century hand, and from the witnesses' names it is evident that the original dated from about 1220-1260.

1 W. Bazeley, Trans. Bristol and Gloucs. A. S., vol. ii., p. 243.
2 "Historia et Cartularium Monasterii Sancti Petri Gloucestriæ," ed. W. H. Hart (Rolls Series), vol. i., p. 78. 3 St. John Hope, "Notes on the Benedictine Abbey of St. Peter at Gloucester." Archæological Journal, vol. liv., p. 115.
4 "Hist. et Cart." vol. i., p. 28. 5 W. Bazeley, Trans. Bristol and Gloucs. A. S., vol. xvi., p. 198. 6 "Calendar of the Records of the Corporation of Gloucester." Ed. by W. H. Stevenson (1893), p. 351.

The proceedings which took place in 1357, to be referred to later, and the coincidence in period of the construction of the conduit by Helias with the probable date of the grant made by Gerard, make it appear possible that the two supplies were established at the same time.

The White Friars, situated, according to Fosbroke, without the Lower North Gate, not far from Brook Street,[1] appear to have taken water from another source, for also among the Records of the Corporation is an Agreement, dated July 1, 1347, between the Prior of the Hospital of St Bartholomew and Brother John, Provincial of the Order of St Mary of Mount Carmel (White Friars), by which the Prior granted to the Friars the use for ever of the

> "aqueduct running through a leaden pipe from the spring called 'Gosewhytewell' to their enclosure, the said pipe being covered in the ground in the Hyde, which extends from the King's highway called 'Kangestrete' on the east to the land of the Abbot and Convent of St Peter's on the west, and in breadth between the footpath leading from the cross called 'Kangescroice' towards Brokestrete on the South . . . on condition that the Friars make good any damage caused by their digging up the said pipe for purposes of repair."[2]

The "Kangestrete" here mentioned would be the road to Kingsholm, now known as Worcester Street, while "Brokestrete" was between the Postern Gate and Morin's Mill, which was by the North Gate. The spring called Gosewhytewell was probably near the "Goswite-Mill" mentioned in the list of freeholders and copyholders in King's Barton, temp. Edward I., given in the Cartulary of the Abbey of Gloucester.[3] The "Gooseditch" occurs in Cole's Rental of Gloucester, 1455, from which one gathers that it lay beyond the Eastgate. The Postern Gate was at the market end of St Aldate Street.

The next record extant relating to water-supply in Gloucester is a copy of a licence from King Edward III., dated June 4, 1355, granted at the request of Edward the Black Prince,

> "for the Guardian and Convent of the Friars Minor (the Grey Friars) to carry water to their house at Gloucester by an underground leaden pipe from the aqueduct of the Abbot and Monastery of St Peter at Breresclyf, in the fields of Mattesdon, the said pipe being a third of the the size of the pipe of the aqueduct."[4]

1 Fosbroke, "History of Gloucester" (1819), p. 300.
2 "Calendar," p. 343. 3 "Hist. et Cart.," vol. iii., pp 67-76. 4 "Calendar." p. 350.

From this and the earlier evidence cited, it is probable that water had been obtained from Matson for the use of the Abbey for many years, and an agreement, dated October 28, 1357, makes it clear there had been some dispute as to the right of user, for the agreement was made between the Abbot and the Guardian and Convent of the Friars Minor as to the right to the water coming from

> "a spring at Breresclyft in the field of Mattesdone . . . and as to the right of the Friars to lead the said water by subterranean pipes to their house at Gloucester."

The agreement records that Edward the Black Prince, who came to Gloucester to settle this dispute, decided that the wants of the Friars required a larger supply of water, and obtained a grant from the Abbot and Convent to the

> "Friars for ever the right of leading the water through a leaden pipe into a pool or reservoir of water running from the said spring newly constructed below the said spring, near the pipe of the said Abbot and Convent, lying in a line with their pipe, or two pipes equal in size to the pipe of the Friars."[1]

Under this agreement the Friars renounced all former rights, wishing to enjoy their privilege from the new grant now obtained.

Though relating to what may be termed private supply, these early records are of interest as showing that Matson and the neighbouring Hill were the primary source for obtaining water, and this agreement of 1357 is of further importance, as the right therein granted to the Grey Friars was ultimately to benefit the whole City. On August 10, 1438, an agreement was entered into

> "Between Brother John Godewyn, Guardian of the Friars Minor of Gloucester, and the Convent of the same place, on the one part, and John Streynesham and Richard Dalby, Bailiffs of Gloucester, and the Community of the same town, on the other part, whereby the Friars, on account of their affection towards the Community of Gloucester . . . grant to the said Bailiffs and Community three-quarters of their water running in a leaden pipe in the ground from the hill called 'Matteskoll' to the garden of the said Convent within the walls of the said town: to have and to hold to the said Community from a certain place in the garden aforesaid where the water is divided into four parts to the high cross . . . and at other places where they will . . . by a leaden pipe in the ground to be put in at the cost of the said Community; reserving to the said Guardian and Convent their fourth part of the water aforesaid."[2]

1 "Calendar," pp. 352-353. 2 "Calendar," pp. 391-392.

It was further provided that the Friars would keep in repair all the pipes, etc., the City paying three-fourths of the cost, and that neither party was to do anything to lessen the supply of the other. This agreement provides for the first public supply of water to the City, and for over 400 years the springs of Matson and Robinswood were the chief sources of that supply.

The earliest drawing of the High Cross is in the Rental of the City compiled in 1455 by Robert Cole, Canon of Llanthony, and here are shown the conduit taps for the use of the inhabitants.

Leland, who visited the City in the middle of the 16th century (c. 1540-1550), says

> "at the place of the midle metynge, or quaterfors of thes stretes, is aquaduklyd incastellid."[1]

In 1556 we find another reference to this supply from the Grey Friars, for on April 1 of that year, a demise for 500 years from March 25 was granted by Thomas Payne, Alderman of Gloucester, to Thomas Pyrye (or Pury) Alderman, and his wife Joan, of the site and property of the Grey Friars, including

> "all that pipe or conduit of lead stretching under the ground from Mattesknoll otherwise called 'Mattestonehill' paying therefor yearly to the said Payn 30*s*. and 3*s*. 4*d*. to the Crown and 1*d*. to the Mayor and Burgesses of Gloucester, if it be asked."[2]

On the same date a bond in £100 from Thomas Payne for performing the conditions of his lease, so far as it concerned the conduit of water, was entered into.[3] The last of the Records relating to this supply is a grant, dated March 22, 1623-4,

> "from John Guye and Abel Kytchyn, to Thomas Purye, of Gloucester, of all the waters and springs, and heads of springs, channels, pipes, etc., in the ground of the hill called 'Mattesknoll' or 'Robinhoodes Hill' in the County of the City of Gloucester, and also the leaden pipe going from the said hill to the garden of the Grey Friars in Gloucester, and the fourth part of the water conveyed by the said pipe."[4]

In August, 1630, the Corporation purchased from Thomas Pury the whole of his interest and control of Grey Friars, as well as in the pipe from Robinswood Hill, for the sum of £50, this giving the Corporation power over the public supply. In 1634,

1 Leland's "Itinerary," ed. by Miss L. Toulmin Smith, vol ii., p. 57.
2 "Calendar" pp. 441-442. 3 *Ibid.*, p. 442. 4 *Ibid.*, p. 452.

Alderman John Scrivens, who served as Mayor 1642, intimated his desire to improve the supply of water for the benefit of the Citizens, and his offer to build a conduit at the south end of the Wheat Market "was accepted and applauded" and the use of a pipe connecting with the one supplying the Cross was granted.[1] The Conduit was erected in 1636, and served its purpose until 1784 or 1785, when it was removed under the Act of 1750. It is now at Edgeworth Manor, near Cirencester. Both the Conduit and Wheat Market are shown on Hall and Pinnell's plan of the City, drawn 1780. The former has been fully described by Mr Henry Medland.[2]

Though we know from direct evidence that the Abbot of St Peter's had enjoyed the use of water from Matson for nearly 200 years—and had probably enjoyed it for nearly as much again—it appears to have been thought necessary after the Dissolution to place the matter on a legal basis, for in 33 Henry VIII. (1542-3) "An Act concerning the Conduits of Gloucester" was passed, which empowered the Mayor and Dean of Gloucester to break ground in "Matstone's Hill otherwise Robin Hood's Hill," for the conveyance of water to the City and Minster.

Towards the end of the seventeenth century it became necessary to supplement the existing supply, for at the Meeting of the Corporation held on April 6, 1692, it was agreed that certain of the Councilmen should be deputed to

> "treate with Mr Nicholls or any other workeman touching proposalls of carrying water into all parts of this City and to make their report touching the same to this house with what speed they can."

The report so made, as subsequent proceedings show, was evidently to the effect that water could be supplied from the Severn. On December 23, 1692, articles were read between the Mayor and Burgesses of the City and Thomas Nicholls for the building of a water-house and engine for serving the inhabitants with water, and ordered to be engrossed and passed under the City Seal. Matters progressed slowly, for the next mention of this matter occurs in the Minutes of June 7, 1694, when it was agreed that

1 C. H. Dancey, in Trans. Bristol and Gloucs. A. S., vol. xxiv., pp. 293-307, has extracted from the Corporation Minutes some interesting particulars relating to the Water Supply.
2 Trans. Bristol and Gloucs. A. S., vol. xiii., pp. 241-246.

"Mr Thomas Nicholls shall have liberty to build an engine and waterworks below the Westgate Bridge in this City, and that the same be soe expressed in his articles from the Mayor and Burgesses thereof,"

and on August 13, that Nicholls should

"have liberty to build a cisterne for his Water works upon the King's Board in this City,"

the proper repair and upkeep of the King's Board being further provided for. Fosbroke states that the upper part of the King's Board was taken down in 1691, but careful search through the Corporation Minutes does not corroborate this, and it is far more likely that it was taken down after the permission given for placing the cistern. On January 7, 1695-6, the grant of the water works to Nicholls and others, who were afterwards called the proprietors, was read and duly sealed.

Martin speaks of the King's Board as

"a small market-house, over which was a cistern of Severn-water"

and also states that

"an Engine, by which the Severn-water was forced to the Western parts of the Town, is destroyed, as unnecessary."[1]

This was evidently the result of the improved supply obtained from Robins Wood Hill under the Act of 1741, to which reference is made below. That it was still in use in 1743 is evident from a Minute of February 11, in that year, appointing certain persons

"to view the King's Board or Butter Market and give notice to the Proprietors of the Water Works to repair."

The King's Board stood at the upper end of Westgate Street, and is considered by Mr Medland[2] to have been used originally as a preaching cross or chapel. In later times it was used for the sale of butter and cheese, and eventually removed, with other buildings, under the Act of 23 George II., 1750.

According to Sir Robert Atkyns, the population of Gloucester about 1710 was just under 5000, and though it cannot have increased much during the next 30 years the water furnished by the means of supply then existing was not sufficient for the requirements of the inhabitants. On December 15, 1740, the following Minute is entered in the proceedings of the Corporation:—

1 "Natural History of England," 1759, vol. i., p. 354.
2 Trans. Bristol and Gloucs. A. S., vol. xxvi., pp. 339-344.

"Whereas this City is very ill supply'd with Water and a proposall is now on foot for the Corporation to obtaine a Sufficient Supply from Robinhood's Hill But it being impossible to execute that Proposall or designe without Authority of Parliam[t] which must be attended with great expense to this Corporation And the Honble John Selwyn Esq having been requested for the benefit of this City and the Inhabitants thereof to procure such an Act to be pass'd If therefore the said John Selwyn doth or shall procure this present Sessions of Parliam[t] such Act as afores[d] at his owne expense to enable this Corporation to execute the said designe Whether this Corporation will agree with and promise and accordingly doe now agree with and promise to transferr and assure the sole power and benefit to be to them granted by said Act to him the said John Selwyn and his assignes in such manner or as the Counsell of the sd John Selwyn shall advise He beginning the same within Six Months and completing it within Two Years next Ensuing the date of said Act And that a copy of this vote be sent to the said John Selwyn under the Seal of this Corporation as their request to procure the said Act and undertake the bringing the water as afores[d]."

Eighteen were "for" and two "against."

In the following year an Act was passed "For supplying the City of Gloucester with fresh water," and on August 10, 1741, a deed was sealed vesting the powers of the Corporation mentioned in the Act in John Selwyn, "the said Mr Selwyn paying reasonably for the same." This Act empowered the Mayor and Common Council to contract for the conveyance of water from the "springs issuing out of or near to Matson's Hill, otherwise Robin Hood's Hill" and to make reservoirs and lay the necessary conduits and pipes.

From later Acts it is evident certain works were constructed, and the "Gloucestershire Directory" of 1820 speaks of "two large Reservoirs on Robinswood Hill." Martin[1] states

"a few years ago [*i.e.*, before 1759], Col. Selwyn, many years the worthy representative of the City, at his sole expence, caused a capacious Reservoir to be dug at the foot of the above-mentioned hill [*i.e.*, Robin's Wood], from whence the water is brought in pipes to all parts of the town; and every family, who will, may have it brought by leaden-pipes into their houses, at an easy Rent,"

and he mentions that the County Infirmary, "very lately finished," is supplied from this Reservoir. Martin was evidently not aware that Selwyn, though making the reservoir at his own cost, was able to recompense himself by the charges levied for the supply given. Mr Read, the City Surveyor, is of opinion that the reservoir constructed by Col. Selwyn was situated above the existing reservoirs, to the left of the cottages there standing. This was filled in some 25 years ago.

1 "Natural History of England," 1759, vol. i., p. 354.

These reservoirs met the wants of the city for nearly 100 years, though evidently the need for still further supply had been felt for some time. An Act of Parliament, passed 6 William IV., states that the City of Gloucester had for many years past been partly supplied with water by means of certain works constructed under the powers contained in the Act of 14 Geo. II.,

> " and that the works were out of repair, were inadequate for the wants of the city, and required a large sum of money spent on them."

It was also considered desirable to extend the supply of water to the suburbs, to maintain the existing, and construct additional, waterworks, the view being expressed that these purposes would be more effectually accomplished by the establishment of a Company, with adequate powers. By this Act was formed the Gloucester Water Company, which purchased and took over the works then existing, and constructed the present reservoirs on Robinswood Hill. In 1837 the Company were prepared to contract for the supply of water, for in the *Gloucester Journal* of October 7, 1837, they advertised " Notice is hereby given, that the works of this Company, for the supply of the City of Gloucester and the suburbs, are nearly completed," and the rates to be charged are given. These rates were rather less in the case of houses of lower rental and slightly higher for those of greater value than those existing to-day. The Company were prepared to make allowance, in calculating rates, for shops in the principal streets which derived enhanced value by reason of their position.

By the following year it is evident that the Company had completed the works required, for in the report of a fire which occurred in Northgate Street, the *Gloucester Journal* of July 21, 1838, observes that " few towns in the kingdom have such a facility of obtaining water as this city has at present, owing to the spirited and useful undertaking of the Gloucester Water Company."

APPENDIX

Acts of Parliament, Reports, and other Papers relating to the Water-Supply of the City of Gloucester *

By ROLAND AUSTIN

* Copies of all of these may be seen at the Gloucester Public Library.

ACTS OF PARLIAMENT

33 HENRY VIII. c. 35.
An Act concerning the Conduits of Gloucester.

14 GEORGE II. c. 11.
An Act for supplying the City of Gloucester with fresh water.

23 GEORGE II. c. 15.
An Act for the taking down several Buildings and enlarging the Streets and Market Places in the City of Gloucester.

6 and 7 WILLIAM IV. c. 67.
An Act for better supplying with water the City of Gloucester, and Parishes and Places in the County of Gloucester near thereto.

19 VICTORIA. c. 89.
An Act for the better supply of the City of Gloucester and the neighbourhood thereof, with water, and for other purposes.

58 VICTORIA. c. 91.
An Act to empower the Corporation of Gloucester to construct additional water works . . . and for other purposes.

1 and 2 GEORGE V. c. 92.
An Act to empower the Corporation of Gloucester to construct additional water works . . . and for other purposes.

REPORTS AND PAPERS

1854. The Report of Mr Bateman, C.E. (Engineer of the Manchester Water Works, etc.) on extended Water Supply for Gloucester. 1854. Pp. 8.

1858. The Report of Mr John Hanvey, C.E. (City Surveyor, Gloucester) on the proposed construction of Reservoirs at Witcomb, for the Gloucester Water Works. 1858. Pp. 8.

1863. The Report of W. McLandsborough, Assoc. Inst. C.E., City Surveyor, Gloucester, on the proposed Reparation of the Water Works at Robins Wood Hill and Matson. 1863. Pp. 9.

1865. The Report of Mr Clegram (Engineer of the Gloucester and Berkeley Canal Company) on the Reservoirs at Witcomb, for the Supply of the City of Gloucester with Water. 1865. Pp. 8.

1866. Gloucester Water Works. The Report of Mr Bateman, C.E., upon the Witcomb Reservoirs, and as to Works proposed by him for strengthening and extending the same. September, 1866. Pp. 7.

1875. Gloucester Extended Boundary. Report by Mr James Mansergh, M.I.C.E., on a System of Sewers and Water Mains for the districts added to the City of Gloucester, under the Gloucester Extension Act, 1874. June, 1875. Pp. 16.

1879. Corporation of Gloucester. Report of the City Surveyor upon Waste Water Prevention. Gloucester, 18th July, 1879. Pp. 8.

1880. Report of the Water Works and Finance Committee as to providing additional Water Supply for the City of Gloucester. To be presented to the Council at their Meeting on the 4th day of May, 1880. Pp. 4.

—— Gloucester Water Works. The Report of Mr Bateman, C.E., upon increased Water Supply for the City of Gloucester, as the Boundaries have been extended under the Extension and Improvement Act of 1874. 25th August, 1880. Pp. 7.

1881. Reports of Mr Bateman, C.E., *re* increased Water Supply for Gloucester. 26th April and 20th September, 1881. Pp. 4.

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[1890.] City of Gloucester. Corporation Waterworks. Regulations as to the Supply of Water. [26th June, 1888, with Water Charges dated 15th April, 1890]. Pp. 8.

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—— Report of Mr William Fox, C.E., on the best means of increasing the Water Supply of the City of Gloucester. 1st June, 1891. Pp. 16.

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THE LOWER SEVERN PLAIN DURING THE GLACIAL EPOCH

BY

JOSEPH W. GRAY, F.G.S.

CONTENTS

I.—Introduction

The position and extent of the plain between the Cotteswolds and the Malverns indicate a greater antiquity than that assigned to it by Lucy who referred the principal part of the denudation of the Oolitic rocks to an early part of the Glacial Epoch.[1] Symonds was of opinion that the area underwent enormous denudation following on the Ice Age and subsequent submergence.[2] Ramsay suggested that after a marine submergence of the Cotteswolds, the Severn cut a channel through an accumulation of boulder-clay in the original valley, the shaping of the contours of which commenced in Miocene times.[3]

There are no data upon which a satisfactory estimate of the extent of the Post-Pliocene denudation of this district can be based, but I think that lowering of the surface attributable thereto has not been considerable except, perhaps, in that part of the Severn Valley which was exposed to Glacial floods from the north. When we consider the enormous length of the Tertiary Period, during which the surface was exposed to

1 Proc. Cotteswold N.F.C., vol. v., pp. 110-11.
2 Severn Straits, pp. 17-18.
3 Physical Geology and Geography of Great Britain, p. 143.

atmospheric denudation, and the comparatively short time occupied by the Glacial Epoch, it may safely be inferred that the greater part of the work of excavation had been accomplished before the advent of glacial conditions. The changes by which the Severn river system was developed during the Tertiary Period include the formation of the Warwickshire Avon which cut across the course of a river that once drained a part of the Trent Basin and flowed towards the south through the Stour—Evenlode Valley. Another change was the diversion of the Teme from its southerly course west of the Malverns to a junction with the Severn below Worcester. During the Glacial Epoch the drainage of the upper Dee area was probably added to that of the Severn,[1] and the course of the Avon appears to have been temporarily diverted to the south of Bredon Hill. A gap in the ridge of Keuper and Liassic rocks that extends for a long distance near the centre of the Valley indicates a possible junction of the Teme and Severn to the north of Wainlode Cliff.[2] That the ridge was then considerably eroded is probable, since it was exposed to the full force of torrents that flowed from melting snow-fields and the great ice-sheets. The wreckage may be seen in the irregular masses of Keuper rock in the gravels at Upton-on-Severn.

Within the area under consideration the Severn receives two important tributaries, the Teme and the Avon, which must both have contributed largely to the superficial deposits during the Glacial Epoch. The Severn now winds through a valley filled with alluvial deposits, except in a few places where it flows over Keuper rocks.

Indications of elevation and depression in the Severn Estuary and the Bristol Channel in comparatively recent geological times have been described by various authors,[3] but there appears to have been no appreciable change of level since the Roman occupation.

1 Prof. C. Lapworth, Proc. Geol. Assocn., vol. xv., 1898, p. 425.
2 *Cf.* S. S. Buckman, Proc. Cott. N.F.C., vol. xii., p. 218.
3 *Cf.* Strahan, Q.J.G.S., vol. lii., pp. 474-89.
Codrington, *Ibid.*, vol. liv., pp. 273-6.
A. Geikie, *Ibid.*, vol. lx., pp. xcvi.-cii.
Prevost and Mellard Reade, Proc. Cott. N.F.C., vol. xiv., pp. 15-23.

II.—The Superficial Deposits

The superficial deposits of that part of the Lower Severn Plain which lies between the North and Mid-Cotteswolds on the east and the Malverns and May Hill on the west consist of :—

(1) *Debris* from the various formations of the two Ranges and from the intervening Triassic and Rhætic rocks.

(2) Drift pebbles and boulders occurring mainly in the gravel terraces bordering the river Severn, and pebbles scattered over the surface of the land to some distance on either side, including most of the low hills. The Drift pebbles consist of white quartz, quartzites of various colours, the larger-sized seldom exceeding 3 x 2 inches, lydian stone, banded rhyolite of Uriconian type, Carboniferous chert and limestone, and Cretaceous flints and fossils. The boulders and pebbles of Scotch and Lake District granites, Arenig felsites, and coarse grits are well rounded.

(3) Fine-grained quartzose sands without Drift pebbles, lying on the eastern side of the Plain, and generally near to the Cotteswold escarpment.

(4) Silts bordering the Severn and its tributaries.

Debris from the eastern and western ranges of hills are rarely seen on opposite sides of the Severn. The only recorded instances of crossing from the eastern side are the single pebble of the "King and Queen" rock of Bredon discovered by Symonds at Holdfast, near Queenhill,[1] and the fragments of Oolitic limestone in gravel on the low ground to the north of Highnam Church recorded by Lucy.[2] On the eastern side of the river I have observed rock fragments from the Malverns only at Kempsey, Ripple, and Denmark Road, Gloucester.

The river Severn or the high ground near to which it flows has thus formed a marked line of separation between gravels derived from the rocks of the Cotteswolds and of the Malverns.

1 Severn Straits, p. 34.
2 Proc. Cott. N.F.C., vol. v. p. 80.

Symonds states that in the construction of the locks at Tewkesbury a depth of nearly one-hundred feet of "Post-Pliocene silts," the upper part of which contained British and Roman pottery and a few Roman coins, was passed through before reaching the basement-bed of Drift pebbles.[1] This depth is not in agreement with other borings and may be an excessive estimate or may indicate a deeper part of the old river channel, probably the former.

Mr. G. W. Keeling has kindly supplied me with particulars of a trial-boring near the same place :—

ft.	in.		
2	0	..	Loam.
16	0	..	Sound red brick clay.
14	0	..	Imperfect blue Lias clay intermixed with black mud, decayed leaves, and other vegetable matter.
4	0	..	Compact blue Lias clay.
—	—	..	A bed of water-bearing gravel; thickness not recorded.

Two miles below the bridge at Upton-on-Severn the depth of the beds overlying the pebbles was found to be 20 feet. The river-silt and brick-earth, also with Drift pebbles at the base, at Alney Island, north of Gloucester, are about 20 feet thick, at Llanthony about 25 feet, and at Westgate Bridge about 33 feet.[2]

I have not seen in the Severn Valley anything of the nature of till or any clay that could have been deposited directly from the great ice-sheets, or beds crumpled or folded thereby.

Flints occur in most of the gravels and are numerous near the confluence of the Avon and Severn, where they are principally of the Avon Valley type. They become smaller and more water-worn and decayed as the Severn is approached from the east, and occur only for a short distance from the river on the western side, where I saw a few in the gravel at Bushley Cross and Sarn Hill. Flints do not appear to have been found in the pebbly gravel under the deep river-silts.

Some of the flints in this area were probably carried by torrents from the Avon Valley to the south of Bredon Hill along the course of the river Isborne and the Carrant

1 Proc. Cott. N.F.C., vol. iii., 1861, p. 37 ; Severn Straits, p. 59.
2 Admiralty Survey, 1849.

Brook, together with the thick gravels at and around Beckford, Bredon, and Shutonger, and the Drift pebbles and flints in the surface-soil between Evesham and Tewkesbury.

A small number of the water-worn flints may have been transported from the north, since they occur at several places near the Severn, as at Wollerton,[1] Shrewsbury,[2] Strethill, and Bridgenorth.[3]

Around Worcester the Drift constituents of the superficial deposits are mainly composed of pebbles and sand derived from the Permian and Triassic breccias and conglomerates of Worcestershire and Staffordshire, together with a considerable number of rocks from more northerly sources, including Welsh lavas, Eskdale and Galloway granites, Arran pitchstone and Ailsa Craig eurite.[4] These occur less frequently in the gravels below Worcester, and are rarely seen south of Upton-on-Severn.

A sub-angular boulder of Criffel granite now in the Worcester Museum was found in gravel at Cornmeadow, about two miles above Worcester, one mile from the Severn and about 54 feet above it. Large erratics are rarely found far from the river in the area under consideration.

[a] EAST OF THE SEVERN.—In approaching the river from the east a diminution of the proportion of Jurassic *débris* in the superficial deposits is observable, and the fine and light-coloured sands become mingled with grains of a brown or deeper red colour.

The more important Drift deposits lie near the rivers Severn and Avon as at Worcester, Kempsey, Beckford, and Gloucester. Beyond the distance of about a mile from the rivers the Drift pebbles are in places thinly scattered over the land, as at Shurdington and Bentham. It is recorded by Lucy that a small seam of gravel with quartz pebbles was found at Hatherley Road, Cheltenham.[5] At Ripple there are beds of gravel containing a great variety of rocks including large rounded boulders of Millstone Grit, some weighing 1½ cwt.,[6] and pebbles of Malvernian granite.

1 Dr. C. Callaway, Geol. Mag., Nov. 1896, p. 483.
2 Mackintosh, Q.J.G.S., vol. xxxv., 1878, p. 446.
3 Maw, Q.J.G.S., vol. xx., 1864, pp. 130-9.
4 George Gray, Brit. Assocn. Reports, 1892, p. 20.
5 Proc. Cott. N.F.C., vol. vii., 1880, p. 56.
6 Symonds, Severn Straits, p. 34.

Gravels containing Drift pebbles and flints occur at Shutonger, 98 O.D., Tewkesbury, 40 O.D., Apperley, 137 O.D., Wainlode, 265 O.D., and Gloucester, 45 O.D. Large and small rounded Bunter pebbles are found in many places at the base of the river silts, as at Tewkesbury, Haw Bridge, Alney Island, and Gloucester.

It is important to note that the northern rocks usually recognized as transported by land-ice from the Arenig Mountains, the Lake District, and the South of Scotland are not found in the gravels capping the low hills near the Severn, except at Apperley, 100 feet above the river, where Symonds and Mackintosh found "Shap and Criffel granites, toadstone from Dudley, Millstone Grit, and Cardington Grit from the Church Stretton country."[1] In the terrace-deposits these rocks occur at elevations of about 50 feet above the stream.

Some of the boulders are still preserved at Apperley by Mr. Algernon Strickland, whom I have to thank for kind assistance on the occasion of my visit.

THE CHELTENHAM SANDS.—The deposits that I have elsewhere so designated,[2] because they reach their greatest development in and around Cheltenham, occur at intervals on the eastern side of the Severn Plain, and generally near the flanks of the Cotteswolds, from Mickleton to the Frome Valley, near Stroud, and probably still further south. Mr. Charles Upton informs me that there is none of this sand in the Stroud Valley above an elevation of about 150 feet O.D.

A somewhat similar sand is also interstratified with gravels on the western side of the Severn at Upton-on-Severn and Highnam.

The Cheltenham Sands rest immediately upon the Lias, and underlie the surface soil. They are much denuded and appear to be remnants of more widely distributed beds, and are cut through by small streams flowing from the hills, as at Moorend, Charlton Kings, where the brook has made a way to the Lower Lias through about 30 feet of the sand. The

1 Severn Straits, pp. 31-2; Mackintosh, Q.J.G.S., vol. xxxv., 1878, p. 443.
2 Proceedings, Cott. N.F.C., vol. xvii., p. 258.

prevailing colour is light brown or red ; the grains are small and often rounded and are much finer than most of the sand forming part of the deposits near the Severn.

The sands contain no Drift pebbles or erratics, and are generally mingled with varying proportions of angular and sub-angular Jurassic gravel, showing in many places a rough horizontal stratification. Lenticular beds of fine clay also occur in a few instances, as at Sandy Lane, Charlton Kings.

At Mickleton, the bed of sand is about 12 feet thick, and lies at an elevation of about 230 feet O.D.[1] Other beds have been observed at Broadway, Little Washbourn, Alderton, Beckford, Bishop's Cleeve, Cheltenham, Shurdington, Fairmile, Hucclecote, Barnwood, Upton St. Leonards, and Wotton, and to the north of Hempstead.

From Charlton Kings the Sands extend to some distance up the Valley of the Chelt. Near the "Duke of York Inn" there is a definite bed at about 270 feet O.D. ; but in a pit near Coxhorne at 300 feet O.D. the sand occurs only in thin seams and small pockets in the Jurassic gravel. Thence the sand gradually thins out ; and it is found sparingly mixed with the gravel at the Dowdeswell Reservoirs, at a height of about 370 feet O.D. I have not observed any of the Cheltenham Sands in the Valley around Winchcomb—a fact difficult to explain, if the current that brought them flowed from the north towards which point the Winchcomb Valley opens. It is possible, however, that floods from melting-ice and snow on the Cleeve Plateau have removed them.

Strickland refers the Cheltenham Sands to a marine origin. Against this hypothesis or the suggestion that they were deposited in a lake, is the lack of any Post-Jurassic shell therein to indicate the long-continued occupation of this part of the Severn Plain by marine or lacustrine waters. The only organisms that occur in the sand, with the exception of water-worn Jurassic fossils, consist of numerous minute fragments of shells, too small for identification, in the sand-bed on the north of the Tewkesbury Road Railway Bridge, Cheltenham.

1 I have to thank Mr. J. M. Dixon, for particulars of this deposit and for kind assistance in my work in the North Cotteswolds.

A lake of moderate depth could have been held up by ice advancing from the Irish Sea along the area of the Bristol Channel, the barrier being reinforced by glaciers from Central and South Wales[1] and by Glacial *débris* carried down by the Severn, Wye, Usk, and Taff.

There are, however, no traces of moraines in the tideway or on the eastern banks of the Channel, over which any effective barrier of ice or moraine matter must have extended; yet it is possible that the evidence may have been removed by slight submergences such as may well have occurred in the region in question with its characteristic rapid tides.

The shoaling of the water on the north of the Flat Holmes has been considered to point to the existence of a moraine; and the great variety of the rocks found there and in other parts of the Channel is cited in support of this contention; but the question of erratics is complicated by the unloading of ballast from vessels hailing from Baltic and British Ports.[2]

On the supposition that the Sands were deposited in an estuary or lake in the Severn Plain, limited to the depth of which there is any evidence, it would be difficult to account for their occurrence at the elevations they attain at Charlton Kings and in the Dowdeswell Valley. They may, however, have been carried thither by winds[3] in dry seasons, the thin layers of sand being covered with Jurassic *débris* on the recommencement of the flow of water down the valley of the Chelt, thus causing a rude stratification that indicates seasonal or other periodical changes with intervals when the flood wash of gravel from the hills was suspended.

The Cheltenham Sands do not appear to have been derived from Jurassic rocks of the Cotteswolds or from the arenaceous soils of the plateaux, since they are of much coarser grain than either. It is possible that they may have been carried by torrents from melting ice in the upper part of the Avon Valley, where sands of similar colour and texture occur, the coarser materials being carried by the main stream down the centre of the Severn Plain, the finer burden settling

1 *Cf.* Geikie, "The Great Ice Age," p. 363.

2 Mr. F. G. Cullis, of Barnwood Court, informs me that some large water-worn granite boulders now in his grounds came from the Baltic as part of the ballast of a timber ship.

3 As in the case of the Blown Sands that extend to the Chalk escarpment of Yorkshire and Lincolnshire.

in more sheltered and quieter waters nearer to the Cotteswolds. In this case the absence of the Sands from the Malvern side of the Plain would indicate the interference of some barrier since removed by denudation—perhaps the central ridge before mentioned—that prevented free access of the sand-bearing currents to that side of the Severn.

The deposition of the Sands seems to have been of comparatively recent date, since they approach to within a short distance of the steep Liassic slope, as at Southfield Farm, Charlton Kings, and for more than a mile up the valley of the Chelt between the hills, as at Dowdeswell. It is thus evident that no great recession of the escarpment has occurred since the Sands were deposited.

THE KINGSHOLM GRAVELS AND SANDS.—There are no sections showing the relation of the Cheltenham Sands to other superficial deposits of the district, but masses of a similar sand that occur in beds lately exposed at Denmark Road, Gloucester, 45 feet O.D., indicate an existence before the upper beds of the Kingsholm gravels were deposited. Several pits, at a distance of about 70 yards to the north-east of the County Council School, were excavated at intervals enabling me for some months thoroughly to examine them and to trace the relation of the various beds, which were exposed down to the lower coarse gravel.

The following are the particulars of one of the sections[1] which may be taken as representative of the others.

No.	ft.	in.	
I.	1	0	Surface soil with a few Drift pebbles that were probably brought to the surface in well-sinking.
II.	2	6	Black earth with Roman pottery and coins and a few Drift pebbles.
III.	5	8	Fine quartzose sand and grey clayey mud in thin seams, enclosing, sometimes in thin envelopes, irregular masses of quartzose sand and Jurassic gravel. Underneath the enclosed masses the seams of sand and clay are bent or waved. There are no Drift pebbles in the sand or mud or in the enclosed masses, which are hard and compact. The surface of this bed appears to have been eroded.
IV.	1	6	Coarse clean quartzose sand of the Severn Valley type.
V.	1	2	Small quartzose gravel with pebbles of Malvernian and Silurian rocks, and a few Liassic fossils. This gravel is similar to that found in the valley west of the Malverns.
VI.	1	0	Coarse quartzose gravel. The largest pebbles are about 2½ inches in diameter.
	Depth not recorded.		

1 *Cf.* L. Richardson, Proc. Cott. N.F.C., vol. xvi., pp. 123-4.

The bed of coarse gravel (No. VI.), in which at a depth of about 12 feet the water-level was reached and further excavation was prevented, is composed mainly of well-rounded pebbles of quartzite and other rocks usually found associated with the Bunter Drift near the Severn in this district. The only Jurassic fragment found in this bed is a much water-worn piece of the shell of a *Gryphæa arcuata*. In a trial-boring made some time previous to my visit, it was ascertained that a thin bed of coarse sand intervened between the gravel and the underlying Lower Lias rock.

Many of the irregular shaped masses in No. III. consist of Oolitic *débris*; others are fine quartzose sand and a few are clay. An angular boulder of the latter found at 9 feet from the surface measured 4 feet in length and 10 inches in thickness.

That the enclosed masses are really isolated and not sections of beds of lenticular shape I ascertained by examining several of them in trenches cut at right angles to one another.

Widely different conditions are indicated by the coarse and fine sediments, but they may have been deposited within a short period from shifting currents flowing into a lake or estuary receiving alternately the characteristic *débris* transported into the area from the Severn, Teme, Avon, and Leadon Valleys towards the close of the Glacial Epoch. The conversion of the area into a lake by a barrier that may never have been sufficiently high to dam the torrents completely would provide favourable conditions for the conveyance of ice-floes detached from the shore of a lake or the banks of a river during seasonal or other changes of climate. On melting, the floes would release their burdens of *detritus*, and some portions still in a frozen state would sink down to the soft sand and clay, pressing the surface into wavy lines or becoming completely embedded. The breaking up of other masses on sinking would account for the production of irregular seams.

It is not improbable that in times more recent than the Glacial Epoch frozen masses of gravel and sand were carried into the area by the flooded Severn and tributaries, but the size of some of the masses in question suggests the existence of ice-floes much larger than are now found on our rivers.

I have found Bunter pebbles together with water-worn fragments of Malvernian and Llandovery rocks on the summit of Dripshill, 200 feet O.D., between the Rhydd and Clevelode, and about half a mile from the Severn on the western side.

There is a capping of Drift gravel at Sarn Hill, 200 O.D., Gadbury Camp, 175 O.D., Maisemore, 100 O.D., and other high ground between Upton-on-Severn and Gloucester. Malvernian pebbles occur at the two first-mentioned places, and a few flints at Sarn Hill.[1]

The gravels on Limbury Hill, 237 O.D., and the Pinetum, Highnam, 184 O.D., are composed of Bunter pebbles, flints, and numerous sub-angular fragments from the Malvern Range and the valleys on the west. A few Jurassic fossils occur in the Limbury gravel.[2]

b WEST OF THE SEVERN.—Drift gravels with seams of coarse and fine siliceous sand occur at several places on the western side of the river, and are well represented at St. John's, Worcester, Rushwick, Upton-on-Severn, and Gloucester.

The gravels and sands near the mouth of the Teme appear to have been derived mainly from the Archæan and other rocks of the district north of the Malverns and from the Permian and Triassic rocks of Worcestershire and Staffordshire.

A typical section of the Severn Valley gravels and sands is exposed at Southend, about one mile west of Upton Railway Station, as follows :—

68 FEET ABOVE O.D., 30 FEET ABOVE THE RIVER

No.	ft.	in.	
I.	2	0	Surface soil with a few pebbles.
II.	5	0	Coarse brown quartzose sand with a few Drift pebbles.
III.	6	0	A similar sand with many seams and pockets of Bunter and other Drift pebbles and numerous small water-worn fragments of Malvernian and Silurian rocks.
IV. Base not reached	3	0	A similar gravel with larger fragments of the last-named rocks and large angular blocks of local Keuper sandstones. One block measured 20 x 18 x 3 inches. Fragments of recent shells are said to have been found at the base of this bed.

1 *Cf.* Symonds, Proc. Cott. N.F.C., vol. iii., p. 31, Guise, *Ibid.*, p. 116.

2 Limbury and the Pinetum are situated near the River Leadon, and the constituents of the gravels resemble those of the valleys west of the Malverns rather than those of the Severn Valley.

At Tunnel Hill, Upton, about 100 feet O.D., Malvernian and Bunter pebbles occur in the sandy soil.

To the north of Upton Railway Station, 48 O.D., about half a mile from the river, Drift gravels, with some Lake District and other northern rocks, have been penetrated to a depth of 18 feet without reaching the base.

At Pool House, Upton, a smooth, round felsitic boulder, eleven inches in diameter, probably Arenig, has lately been found in gravel near the river. A block of dark andesitic rock, sixteen inches in diameter, has long been used as a corner-stone at Cowley's Buildings. This is said to have been found in the gravel, but may have been carried as ballast by a boat plying the river.[1]

At Picken End, Hanley Castle, about two miles from the river, the gravel contains no flints, and is largely composed of sub-angular fragments of Archæan and Silurian rocks. A few quartzose pebbles occur in the surface-soil within a distance of about one mile from the Malvern Hills, where I have found them in a field on the west of Blackmore Park, at a height of about 270 feet O.D.

III.—Marine Shells and Mammalian Remains

Glacial and recent marine shells are recorded as occurring at several places in the Severn Valley, but are very rarely seen in the pits now open. Only a few small fragments have come under my own observation during a search of many years.

Lees says that at Northwick, four miles north of Worcester, "The sand-pit abounds with fragments of broken-up shells in almost as great quantities as I have seen near Weston-super-Mare and on the sands at Tenby."[2]

The following marine shells, mostly fragmentary and water-worn, are recorded from deposits lying within a short distance of the Severn, with the exception of those at Beckford, which is five miles distant :—

1 Mackintosh saw "two very decided Eskdale granite pebbles in front of Hasfield Court (a short distance from the river) in fine gravel which had been taken from a low level in the neighbourhood," but he was led to believe that they were artificially transported. Q.J.G.S., vol. xxxv., 1878, p. 444.

2 Pictures of Nature around Malvern, p. 257.

Place	Name	Height O.D.	Height Above river	
Worcester ..	*Cyprina islandica*	75	50	Allies, Brit. Assoc. Rep. 1840 (1839), p. 70. Murchison, *Sil. Syst.*, p. 532. Lloyd, Q.J.G.S., xxvi., p 221.
do. ..	*Cardium edule*			
do. ..	*Turritella ungulina* (= *communis* ?)			Dr. C. Callaway, Proc. Cott. N.F.C., xiv., p. 184.
Kempsey ..	*Turritella ungulina*	75	30	Murchison, *Sil. Syst.*, pp. 532-4. Allies, Brit. Assoc. Report, 1840 (1839), p. 70. Proc. C.N.F.C., vol. xiv., p. 184.
do. ..	do. *terebra* (= *communis* ?)			
do. ..	*Purpura lapillus*			
do. ..	*Anomia ephippium*			
do. ..	*Cypræa pedicula* (= *europæa*)			
do. ..	*Trochus cinerarius*			
do. ..	*Murex erinaceus*			
do. ..	*Ostrea edulis*			
do. ..	*Bulla ampulla*			
do. ..	*Oliva*			
do. ..	*Turbo littoreus* (= *Littorina littorea* ?)			
Upton-on-Severn	*Turritella*	63	25	Lucy, Proc. Cott. N.F.C., vol. v., p. 83. Symonds, Severn Straits, pp. 32-4.
do. ..	*Cardium edule*			
do. ..	*Anomia*			
do. ..	*Cyprina islandica*			
do. ..	*Purpura lapillus*			
Upton-on-Severn Ravenhill	*Turritella*	100		Symonds, Severn Straits, p. 32.
do. ..	*Cardium*			
Beckford ..	*Rissoa* (= *Hyala vitrea* ?)	140	110	Lloyd, Q.J.G.S., xxvi., p. 211.
do. ..	*Lucina borealis*			,,

It is stated that the Oliva was found in good preservation, under twelve feet of gravel, by Strickland and Allies.

Murchison gives a further list of shells, "associated with the Northern Drift in the Vale of Worcester":—*Buccinum* (*Nassa*) *reticulatum*, *Dentalium entalis*, *Littorina littorea*, *Tellina solidula*, *Cardium tuberculatum*, *Cyprina islandica*, *Turritella ungulina* (? *communis*), *Turritella terebra* (? *communis*), with fragments of species of *Venus*, *Astarte*, *Donax*, and other genera in too imperfect a state to be identified.[1]

Lloyd mentions "marine shells" at Powick, near Worcester, 80 feet above O.D. and 55 above the river.[2]

The same species as those enumerated are found in the gravels bordering the Severn as far north as Shrewsbury.[3]

Most of the shells mentioned may be in or near the places in which they lived during or after the Glacial Epoch, since a submergence of 150 feet would provide the necessary conditions as far as Worcester, which was within the reach of high tides until the construction of weirs in the last century.[4]

The principal records of the discovery of mammalian remains in the Severn Valley are as follows:—[5]

Worcester ..	Elephant, Rhinoceros
Powick ..	Elephant, Rhinoceros
Defford ..	Elephant, Rhinoceros, Hippopotamus, *Cervus elaphus*
Eckington ..	Elephant, Hippopotamus, *Cervus* (*Rangifer*) *tarandus*
Upton-on-Severn	Elephant
Holdfast ..	Elephant
Pull Court ..	Elephant, Rhinoceros, *Urus*, *Equus*
Beckford ..	Elephant, Rhinoceros, *Cervus tarandus*, *Sus ferus*
Tewkesbury ..	Whale, *Canis lupus*
Cheltenham ..	Elephant, *Bos primigenius*
Gloucester ..	Elephant, Rhinoceros, *Urus*, *Equus*, *Ovibos*
Barnwood ..	Elephant, Rhinoceros, *Ovibos*
Hucclecote ..	Elephant
Stroud ..	Rhinoceros, *Cervus tarandus*
Stanley Downton	Reindeer (antler)
Cainscross ..	Mammoth

Mr. Charles Upton states that the reindeer antler found by him at Stanley Downton bore the marks of blows inflicted by a blunt-edged weapon at the hands of man.[6]

1 Silurian System, pp. 532-4.

2 Q.J.G.S., vol. xxvi., p. 220.

3 *Cf.* Dr. C. Callaway, Proc. C.N.F.C., voi. xiv., p. 186; Lister, Q.J.G.S., vol. xlvii., 1862, pp. 159-62; Lloyd, Q.J.G.S., vol. xxvi., 1870, pp. 220-1.

On a supposed marine submergence of the Severn Valley see H. E. Strickland, "Memoirs by Jardine," pp. 92-103.

4 Murchison, Silurian System, pp. 532, etc., and Dr. C. Callaway, Proc. Cott. N.F.C., vol. xiv., pp. 183-94.

5 Hull, Q.J.G.S., vol. xi., 1855, pp. 489-91. Strickland, Memoirs by Jardine, 1858, pp. 90-110, 140-2. Maw, Q.J.G.S., vol. xx., p. 130. Lucy, Proc. Cott. N.F.C., vol. v., 1869, pp. 121-3, viii., p. 94. Lloyd, Q.J.G.S., vol. xxvi., pp. 216-7. Lobley, Proc. Geologists' Assocn., vol. iii., No. 6, 1873, p. 6. Symonds, Severn Straits, 1883, pp. 30-6, 60-1. Lees, Pictures of Nature around Malvern, 1856, p. 53.

6 Proc. Cotts. N.F.C., vol. xii., p. 7, and vol. xvii., 1910, pp. 51-2.

Among the few discoveries of human bones in the superficial deposits is that recorded by Professor Hull, who was informed by Wright that a large human lower jaw was found in Cheltenham in Drift gravel beneath 12½ feet of what is discribed as "undisturbed clay."[1] The depth of clay and gravel indicates great changes since the bone was imbedded, and it may have been derived from a still older deposit.

Human bones found at a depth of 40 feet in the silt at Tewkesbury probably belong to some period of marine or lacustrine submergence in Post-Pliocene times.

Some flints supposed to be of Palæolithic Age[2] have been found near Conderton by Mr. William Bruton.

IV.—Conclusion

The nature and position of the deposits above described suggest a partial derivation from moraines left by ice sheets that approached the district on the north and east. Other parts may be remnants of Tertiary river gravels.

Vast quantities of morainic *débris* must have been carried from the valleys of the Worcestershire Stour, the Teme, Avon, and Leadon into the Severn Valley, which was the principal channel of drainage while the ordinary outlets to the sea on the east and west were closed by ice during the Glacial Epoch.

It is probable that the northern erratics near the mouth of the River Salwarpe, and even as far south as Upton Warren and Feckenham, were carried by land ice to their present positions, beyond which there is no evidence of its further advance in a southerly direction.

It may be doubted whether the waters by which erratics were transported into the Lower Severn Valley reached a sufficient height to permit of the stranding of ice-floes on the summit of Apperley Hill. The contours then existing and the occurrence of floods of great depth from melting snow and ice in the large area drained by the Severn during the Glacial Epoch may, however, have furnished the necessary conditions.

1 Q.J.G.S., vol. xi., 1855, p. 489.
2 Now in the Public Museum at Worcester.

Although there may have been an extension of the Severn Estuary as far north as Worcester there is no evidence of a great Post-Cretaceous submergence of the whole of the Plain. A moderate encroachment of the sea would have provided conditions favourable for the existence of marine organisms in those parts of the Lower Severn Valley in which shells have been found, while a considerable submergence would have caused a more frequent intermingling of rocks from either side than is observable in the few instances recorded.

The following suggestions as to the probable chronological sequence of the various superficial deposits are submitted :—

A	Alluvial silts bordering the streams	Post-Glacial
B	The Denmark Road Gravels and Sands	? Glacial
C	Terrace river-gravels with Drift pebbles and northern erratics	
D	The Cheltenham Sands	
E	Malvernian and Bunter pebbles, Liassic fossils and Cretaceous flints capping the low hills and scattered over the surface above elevations of about 150 feet O.D.	Pre-Glacial

REPORT (No. 4) ON THE PROGRESS MADE IN CONNECTION WITH THE FLORA OF GLOUCESTERSHIRE

By Rev. H. J. Riddelsdell, M.A.

Mr J. W. White of Bristol has just published a new edition of the Flora of Bristol and its neighbourhood. The area covered by this work includes most of our county district 5, which will thus be provided with a complete and well-digested account of its Flora. It is a great gain to our work to have so large and important a part of the county Flora critically studied.

It has taken Mr White and his helpers 25 years to finish this work. This fact will give some guidance to us. Many who are interested in the county Flora want to know when it will be published: some are even disposed to press for publication and to lose heart at delay. It is to be remembered, then, that Gloucestershire has a much larger area than that covered by the Bristol Flora: that for the greater part of it there is no sound basis of past work to build upon: and that much of it has never been touched. If therefore the county Flora is to approach Mr White's work in thoroughness and in critical knowledge—and only so can it be worthy of the Cotteswold Club and others responsible for it—many years must be spent in its preparation. To hurry the work is to leave it undone.

This conclusion is strengthened by a consideration of details. Some facts have been arrived at by an attempt to summarize the results already achieved in a typical order, *viz.*, the *Ranunculaceæ*. These are here given in outline, and deductions are drawn afterwards, in order that we may have a sounder estimate of the time required for publication.

Clematis Vitalba. District 1. Plenty on the hills: no knowledge of the lower ground. 2. Records for the three towns and their immediate neighbourhood: and *only one other* in the whole area. 3. Newent and Northwards: Gloucester neighbourhood, and two other spots only. 4. Eastern border unknown, and one or two other parts. Not certain whether absent from the Woodland of the Forest. Rest of district known. 5. Bristol and immediate neighbourhood: and *two other records.* 6. E. and W. borders, no evidence. *7a. Large parts unknown.* 7*b*. W. border and N.E. part unknown: rest known.

Thalictrum minus. Scattered: Symonds Yat, Dursley, St. Vincent's Rocks, Crickley Hill. Form not always known.

T. flavum. Left bank of Severn down to Elmore: the Avon, Bristol and Avon. Thames and Upper Colne Waters. Upper Windrush. Symonds Yat and Lydbrook, on the Wye. And scattered records away from the rivers (Hempstead, near Lydney, Bream, Stroud Valley).

Anemone Pulsatilla. Numerous spots on summit of the Cotteswolds, from Campden, through Snowshill, Bourton, Dowdeswell, etc., to Colesborne and Barnsley on the East, and Stroud neighbourhood on the West. No records for Districts 2, 3, 4, 5. Most frequent env. Stroud. Records probably complete.

A. nemorosa. 1. General on the hills: lower ground doubtful. 2 and 3. Very few records. 4. Frequent. 5 and 6. Pretty much as records of *Ranunculus acris.* 7. Scattered records: fairly numerous in 7*b*.

Ranunculus acris, repens, bulbosus. Records pretty much alike in these three: *bulbosus* however, more often neglected. 1. Records satisfactory: but *bulbosus* only recorded from hills. 2. As in *Clematis Vitalba*; records from the towns and neighbourhood almost exclusively. 3. As in *Clematis.* 4. Majority of district recorded. 5. Bristol and neighbourhood, and one or two other records. 6. *R. acris* as for *Clematis*: the other species less noted. 7*a.* *R. bulbosus* scattered records: the other species as in *Clematis.* 7*b.* The usual gaps.

R. sceleratus. 1. Not enough records. 2*a.* More complete than usual. 2*b.* Very few. 3. Usual gaps. 4. Lower ground in plenty: by Wye only in lower reaches. 5. Env. Bristol only. 6. Six records: probably not frequent in this district. 7*a.* One record! 7*b.* Very scattered records.

R. Flammula. 1. Unrecorded! 2. Near towns only: but a valuable fact emerges, 'rare near Cheltenham.' 3. Usual omissions. 4. Good records: but gaps. 5. Very few notices. 6. Eight or ten records. 7*a.* Very few. 7*b.* Eight recorded localities, though 'abundant' where it occurs.

R. Lingua. Seven or eight records: only one is sound.

R. auricomus. 1. Hills only. 2*a.* Near Tewkesbury and Cheltenham: Sandhurst. 2*b.* Three records! 3. Longhope, Westbury and Newent. 4. Best set of records I have for this district: though seemingly local. 5. Bristol and neighbourhood, Wotton, Dursley. 6. Records not many. 7. Very scattered: woods need searching.

R. fluitans. Many records; a few only of any use: *e.g.*, probable at Eastington: Symonds Yat: pond in Forest of Dean: Canal at Brimscombe.

R. peltatus. Fairly well recorded in several forms, especially in Stroud Water Canal and in district 4.

R. sardous. All records need confirmation.

R. Ficaria. Absurdly few records, except in 4.

Caltha palustris. Records showing same gaps as in *Clematis.* 4, 6 and 7*b* rather better than usual. Var.: *Guerangerii* noted several times.

Helleborus viridis. No doubt always recorded where seen. Good records in 4 and 6.

H. fœtidus. 2*a.* ?. Tewkesbury. 4. Rocky woods by the Wye, Tutshill, Symonds Yat and Lydbrook: Rocks, Lydney and Aylburton. 5. Woods near Bristol, Ozleworth, Tortworth, N. Wraxall, Stone. 6. Most woods: common. 7. Three records.

Aquilegia. Records scattered, but fairly numerous in 3, 4, 5, 6, 7.

Aconitum. Generally (? always) escape: perhaps native at May Hill, Ozleworth Valley, Edgeworth.

From this Summary follow certain conclusions:—

1st. Not all records are yet in the Editor's hands. This is chiefly true of District 5: but appreciably the case also in 1, 2, 6.

2nd. The Districts are very unequally worked. Nos. 4, 5, 6 are far best known, though plenty remains to be done in all of them; certain areas are unknown. 1 is partly known: 3 has only been systematically worked in the N.W. corner, near Newent. Nos. 2 and 7 show very large portions absolutely untouched. The gaps are being slowly filled by the efforts of several workers: but nothing like completeness can be attained in *e.g.*, 7*a*, the most remote of all the divisions of the county, except after years of labour.

3rd. Critical forms demand endless labour. The *Rubi* of E. Gloucester are almost unknown: *Roses* are everywhere a problem. The Batrachian *Ranunculi*, the FORMS of *R. acris*, *R. Flammula*, etc., are hardly known outside district 5. Attention was called to this point in a former Report.

4th. 'Uninteresting,' obscure-flowered, or early species are neglected: perhaps very common ones are taken for granted. Else why is *R. Ficaria* so inadequately treated? *Anemone Pulsatilla*, Orchids, *Helleborus fœtidus*, and all 'rare' or interesting or pretty or 'taking' species, are recorded *ad nauseam*. Sedges and Grasses are usually left to take care of themselves.

It results, then, that (apart from editorial work proper) we have—

1. A large part of the county untouched.
2. Most of the severely critical work to do.
3. Some *genera* almost neglected.

It is impossible to make even an approximate guess (even for an Editor with large leisure: a description which will not fit the case) at the period that must elapse before the Flora of Gloucestershire can see the light. It is bound to be a very long time.

Workers for the Flora will be glad to know that the Reports issued from time to time have proved useful. The queries put out last year produced some valuable answers, and originated valuable work. Answers about *Draba muralis*, *Drosera anglica*, *Eryngium maritimum*, *Melittis*, *Acorus*, *Eleocharis acicularis*, *Dianthus Armeria*, *Stellaria apetala*, *Cratægus*, *Senecio viscosus*, *Erica* from E. Gloucester, *Monotropa hirsuta*, Mezereon, Saltwater plants in E. Gloucester (several new vice-county records were received from Mr Day as a result of this query), *Cuscuta*, *Digitalis* (certainly, I believe, native in E. Gloucester, but very rare), have come to hand. The experiment is evidently worth trying, and must be repeated from time to time, as more problems arise.

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OF THE

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Part I., 1912. Part II., 1913. Part III., 1914.

GLOUCESTER: 1912—1914.

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CORRECTION

Page 22, line 20, *for* "native plants," *read* "native or escaped plants."

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Hartland, Ernest, M.A.	Hardwick Court, Chepstow
Hedley, G. W., M.A., F.C.S. ..	The College, Cheltenham
Hobbs, J. N.	Concord, Moorend Grove, Cheltenham
Hooker, C. Paget, L.R.C.P., L.R.C.S.	Dollar Ward House, Cirencester
Household, H. W., M.A.	Park Lawn, The Park, Cheltenham
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McAldowie, A. M., M.D., F.R.S.E.	Glengarriff, Leckhampton Road, [Cheltenham
Margetson, W.	Bright Side, Stroud

Marling, Sir William H., Bart., J.P., D.L.	Stanley Park, Stroud
Marling, W. J. Paley	Stanley Park, Stroud
Marling, S. S., J.P.	Stanley Park, Stroud
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Montgomrey, A. S., J.P., ...	19 Royal Parade, Cheltenham
Mylius, F. J...	Winchcombe, Gloucester
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Newton, Surgeon-Major Isaac, I.M.S.	Broadlands, The Park, Cheltenham
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Sewell, E. C.	The Beeches, Cirencester
Sinclair, The Ven. Archdeacon ..	The Greenway, near Cheltenham
Skinner, J. W.	The Edge, Stroud
Slater, A., J.P.	Garron Dene, Gloucester
Smith, A. E.	The Hollies, Nailsworth
Smithin, James A.	Lloyds Bank, Gloucester
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Stanton, Walter John	Stratford Lodge, Stroud
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Waller, F. W.	Horton Road, Gloucester
Washbourn, William	Blackfriars, Gloucester
Watkinson, A.	Mickleton, Campden, Glos.
Watson, Dep. Surgeon-Gen. G. A...	Hendre, Cheltenham
Weaver, Henry J., M.I.C.E.I., M.I.M.E., F.G.S.	Ashcroft, Churchdown, nr. Cheltenham
Wenden, Major J. G., V.D. ..	The Chantry, Dursley
*Wethered, E. B., J.P., F.G.S. ..	The Uplands, Cheltenham
Wilson, E. T., M.B., F.R.C.P. ..	Westal, Cheltenham
*Winnington-Ingram, Rev. A. R. ..	Lassington Rectory, Gloucester
*Winwood, Rev. H. H., M.A., F.G.S.	11 Cavendish Crescent, Bath
*Witchell, E. Northam	Lansdown, Stroud
Witts, Canon F. E. B., B.A. ..	Upper Slaughter Manor, Lower Slaughter, R.S.O., Glos
Wood, Walter B.	Barnwood, Gloucester

*Signifies those who have contributed Papers printed in the "Proceedings" of the Club.

(*Any corrections in this List should be notified to the Hon. Secretary*).

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†The Presidents and Secretaries of these Societies are considered as Ex-officio Members of the Club, and are cordially invited to the Meetings; Programmes of Meetings to be sent to them as invitations.

INCOME AND EXPENDITURE

INCOME

	£ s d	£ s d
To Balance from 1911	14 6 2	
,, 11 Subscriptions for 1911 (including 1 @ 10/-)	8 0 0	
,, 103 do. 1912 @ 15/-	77 5 0	
,, 1 do. 1913 @ 15/-, in advance	15 0	
,, 4 Entrance Fees 1912 and one 1911	5 0 0	
		105 6 2
,, Archæological Society, Share of Rent 25th March, 1912	8 0 0	
,, Sale of Proceedings	13 13 6	
		21 13 6
		£126 19 8

[Assets say—

Balance as on other side ..	£3 18 1
Subscriptions in arrear	4 10 0
Due from Archæological Society Three Quarters' Rent ..	6 0 0
	£14 8 1

and Subscriptions for 1913].

J. H. JONES, *Hon. Treasurer.*

Gloucester, 20th January, 1913.

FOR THE YEAR ENDING DECEMBER 31st, 1912

EXPENDITURE

	£ s d	£ s d
By Hon. Secretary's Expenses	9 16 7	
,, Treasurer's do.	15 9	
,, Bellows—Rent to 25th December, 1912 ..	12 0 0	
,, Library Expenses	11 5	
,, Municipal Schools—Rent to 31st March, 1913	2 2 0	
,, Custodian of Schools, for Winters 1910-11, 1911-12, and 1912-13	2 5 0	
,, Pitcher—Lantern	1 16 0	
,, Bellows—Printing "Proceedings," &c. Balance of last year, £10 8 9 Accounts for 1912 £57 16 4	68 5 1	
,, Coffee House Co.—Refreshments	5 0 0	
,, Ordnance Survey—Printing Map	8 15 0	
,, Norman, Sawyer & Co.—Printing	11 3 9	
,, Griffen & Co., Year Book of Scientific and Learned Societies	6 0	
,, O. Jackson, Photos for reproduction	5 0	
		123 1 7
BALANCE in hands of Hon. Treasurer		3 18 1
		£126 19 8

Audited and found correct,

F. HANNAM-CLARK,

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to obtain the record of all details of geological interest, to promote the preservation of all antiquities, and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member, he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club; one dissentient in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (See Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot); but the President shall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in January, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and other Members forming the Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—All papers communicated to the Club shall be submitted to a Publication Committee, which shall consist of the President, Honorary Treasurer, Honorary Secretary, and two other Members appointed at the Annual Meeting. The decision of the Publication Committee shall be final. Any gentleman who favours the Club with Lectures on any subject shall be invited to furnish an abstract of the lecture for publication in the Proceedings of the Club.

13.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

AT THE

ANNUAL GENERAL MEETING

APRIL 2ND, 1912

WILLIAM CROOKE, B.A., F.A.I.

IN THE CHAIR

The Minutes of the last Annual Meeting were read and confirmed.

The Hon. Treasurer presented his Financial Report, which was approved.

F. J. Mylius, Winchcombe, Glos., was elected a Member.

On the proposition of the Rev. H. H. Winwood, seconded by L. Richardson, Charles Callaway, M.A., D.Sc., was elected an Honorary Member.

> "As an expression of appreciation by the Club of his geological work, especially amongst the Archæan and Cambrian rocks, and of the valuable assistance he has always been most ready to give to Local Field Clubs and Societies, which have done so much to foster the study of geology, and to facilitate intercourse amongst its students."

On the proposition of W. Crooke, seconded by the Rev. Walter Butt, the Rev. Canon Bazeley, M.A., past Secretary of the Bristol and Gloucestershire Archæological Society, was elected an Honorary Member.

> "As an expression of appreciation by the Club of his contributions to archæological knowledge, especially of the County, and for the great services he has rendered the County as Secretary of the Bristol and Gloucestershire Archæological Society, in stimulating an interest in archæology, and in taking a leading part in movements set afoot for the preservation of County antiquities."

The President then delivered his

ANNUAL ADDRESS

On this, the sixty-fourth Annual Meeting of the Club, it is a pleasure to me to be able to state that it continues to maintain its high standard of efficiency, and that the roll of our members has now reached the number of 117, the highest during its existence. The attendance, both at the Field and Winter Meetings, has been gratifying, and, I venture to think, our publications have never attained a higher level of interest and value.

The object of our incorporation is to promote the study of Natural History in all its branches, and of Archæology, particularly in relation to the physical environment of our district. We have steadily endeavoured to organize these studies on a thoroughly scientific basis in the County of Gloucestershire, and at the present time some eight or ten of our members, whose scientific attainments qualify them to undertake such enquiries, are engaged in systematic research, which cannot fail to produce results of permanent value. But while we are anxious to promote intensive research in various directions, we have not forgotten that it is part of our scheme of work to popularize knowledge. This object we have endeavoured to promote by organizing at our Winter Meetings a series of lectures on subjects of scientific and practical importance. As an illustration of practical work likely to prove of permanent advantage to the residents in this district, our Secretary, Mr Richardson, has, after a long series of enquiries, prepared a map showing the distribution of the soils in the town of Cheltenham and its environs. He has demonstrated that the presence of a sand deposit in a hollow of the Lias clay in the Severn Valley determined, principally through the facilities thus offered for obtaining a supply of water, the site of the present town, while our important market-garden industry, as might have been expected, clings to the tracts of loam. We propose to publish this map in a future issue of our Proceedings, and we have little doubt that it will meet with the approval of present and prospective householders in this important educational and residential centre. Mr Richardson has also placed on record a careful survey of the geological conditions which regulate the water supply of the City of Gloucester. During the Winter Session we have been favoured with illustrated lectures delivered by Mr Richardson on the economical situation in Denmark, as examined by him in the course of a recent tour in that country; by Mr W. Bellows on his experiences during a visit to the Faroe Islands, Iceland, and the Island of Jan Mayen; by Mr E. A. Newell-Arber on the Fossil Plants of the Forest of Dean Coalfield; by Mr A. E. W. Paine on a Long Barrow near Bisley, and on certain caves in the valley of the Wye, to which I shall refer more particularly later on in this Address. I beg on your behalf to convey our hearty thanks to the gentlemen who have kindly favoured us with these important contributions.

The most serious work which at present engages our attention is the preparation of the Flora of Gloucestershire, the conception and progress of which are due to the energy and scientific enthusiasm of the Rev Walter Butt. I am indebted to Mr H. J. Riddelsdell for a note on the position of this important undertaking. Up to the present we have reached only the preliminary stage, and we are unable to promise early publication of the results of such a complicated enquiry. Much fresh information is being received almost daily, and new sources of knowledge are being tapped. The many problems resulting from the facts collected by the older generation of workers are being gradually elucidated, and new questions which have arisen in the course of the present survey await further evidence before they can be finally settled. To make the performance worthy of the scientific traditions of the Club, it is necessary, first, to codify the existing records, a serious and laborious undertaking; secondly, to make a definite attempt to cover all that large area of the County which is as yet untouched; thirdly, to attempt to work out the various critical forms, a task the complexity of which is becoming more and more obvious as it extends over a large number of genera. A work like this can, of course, never be absolutely complete, but it constitutes the most important feature of the scheme. The subject is at present in competent hands, and we may hope that as the scientific importance of the project becomes more fully understood, we may be able to command the services of a larger body of skilled workers in the field, as well as those of trained botanists, who will undertake the duty of identifying and collating the vast collection of material which has now been brought together.

As the special part of this Address, I venture to draw your attention to the present situation of some problems connected with prehistoric man in the light of recent important investigations. It is needless to say that the solution of these difficult questions largely depends upon the co-operation of the sciences of geology and palæontology with the work of the anthropologist. This subject is thus of special importance to the working members of a Club which particularly interests itself in geological research throughout a district which furnishes such varied and excellent material in the areas of the Cotteswold hills, the Severn valley, and the tracts which lie on their borders.

The problem, as a whole, is mainly one of stratification. The task which the anthropologist has now undertaken is to bring the scanty remains of primitive man into relation with the evolution of the geological strata, which alone can supply a time test by which the sequence of the successive appearances and progressive development of the human race may be ascertained with any approach to certainty.

The first question is: What is the earliest geological period in which we can trace the appearances of man or of his closely allied forerunners? Putting aside, for the present, some speculations to which I shall refer later on, the geologist and the anthropologist are on common ground in hesitating to conclude that the succession of the fossil remains of the mammalia, and especially of apes and men, suggests that *homo sapiens* belongs to a period earlier than the Pleistocene; but that other human species may possibly have come into existence in the Pliocene, hardly in the Miocene, and still less in the Oligocene epoch.[1] If, of course, we could refer with certainty the so-called Eoliths to the Tertiary period, the existence of human life on this planet must be referred to a far earlier age than the more sober geologist or anthropologist is now prepared to admit. But in the existing state of our information, as I shall point out later on, the difficulties surrounding the Eolithic question are so serious that all attempts to correlate them with the stratification of prehistoric man must be accepted with caution.

The enormous changes in the physiography of Western Europe since the beginning of the palæolithic period are familiar to us all and require no discussion. It is sufficient to say that this period is now by Professor Sollas—though I believe his conclusions are not universally accepted—divided into three groups, each represented by one or more than one human stage, the Upper including Magdalenian, Solutrean, and Aurignacian man; the Middle the Mousterian; the Lower the Acheulian, Chellean, Strepyan and Mesvinian, these terms being derived from the sites in which remains of men and his artefacts have been identified. It is now practically certain that Mousterian man, of whom remains have been discovered at Kent's Hole near Torquay, Wolvercote in Oxfordshire, Reculver in Kent, and Mildenhall in Suffolk, represents the earliest type in these islands of which we possess adequate knowledge.[2] By this time the warm fauna had disappeared, owing to the increase of cold, and this race of man was contemporary with the mammoth, a fact which does not necessarily imply the prevalence of Arctic conditions, because his range is conditioned less by temperature than by the distribution of the plants upon which it fed. The circumstance that in this period man first began to make his home in caves has preserved his remains for our observation.

1. W. J. Sollas, *Ancient Hunters and their Modern Representatives*, 1911, p. 67

2. Discoveries of a date later than that of the preparation of this address cannot now be considered with the attention which they deserve.

We have thus, as a datum, the fact that in Mousterian man we possess the earliest safe evidence of man's existence in these islands. But if we accept the evolutionary hypothesis of the evolution of man from lower forms, we must postulate a period of enormous duration lying behind the Mousterian period, and possibly stretching back even to the Tertiary era. Here we come to consider the Eolithic problem and the discoveries recently made in East Anglia by Dr. W. Allen Sturge.

The Eolithic problem starts with the investigations of Abbé Bourgeois in 1867, in beds of the Upper Oligocene age near Thenay, a village situated south of Orleans. Similar discoveries in other localities have led to a protracted controversy, which is still being vigorously conducted. On the whole, the most sober and qualified observers, including Professor Sollas, who, however, wrote on the eve of further important investigations, are inclined to question the artificial origin of many or most of the implements known as Eolithic. In this country, for instance, Mr S. Hazzledine Warren has conducted experiments by which he has satisfied himself that flints laid upon a road are often broken by the pressure of cart-wheels and the like into forms which closely simulate Eoliths ;[1] and M. Boule at Guerville near Mantes, by investigations conducted at a cement factory, concludes that flints smashed into fragments by the revolving of the mixer by which the clay and chalk are stirred, tend to assume shapes which, in every particular, correspond to the Eolithic type.[2] Abbé Breuil asserts, with, perhaps, less certainty, that similarly shaped objects are the result of pressure exercised by the movements of strata settling under superincumbent pressure.[3] These varied lines of evidence lead Professor Sollas, the last and best authority on the subject, to question the validity of the evidence from Eoliths as proof of the existence of man in geological strata older than those of the Pleistocene age.[4]

The same view is accepted by many competent authorities in regard to the so-called Plateau implements found by Mr B. Harrison at Igtham, in Kent. At the same time, the

1. *Journal Anthropological Institute*, xxxv. (1905 pp. 337 *et seqq.*
2. *L'Anthropologie*, xvi. (1905) pp. 257 *et seqq.*
3. *Ibid:* xxi. (1910) pp 385 *et seqq.*
4. *Op. cit.* p. 69.

evidence that these are the work of primitive man seems to be stronger than that derived from the Eoliths. But if we assume these types to be the work of man, we are forced to assume his existence in these islands at an enormously distant period, because he must have lived on the crown of the great dome of chalk which once covered Kent and Sussex, and has now disappeared under erosion of rivers like the Darenth and Medway.[1]

In another shape this theory of the extreme antiquity of man in Eastern England has been raised by a remarkable paper entitled "The Chronology of the Stone Age," by Dr W. Allen Sturge,[2] which I commend to your serious consideration. To quote his conclusions, in his own words :—" Neolithic man goes back to a period between two and three thousand years ago, and it would seem that we have not even then reached the beginning of the period. Drift man was flourishing from a million years ago to about 700,000 years ago. Neither figure is a limit ; the later figure is probably nearer a limit than the earlier. Between the end of the Drift and the beginning of the Neolithic, we have the great 'cave' periods, which would thus seem to have occupied anything between 200,000 to 400,000 years. Behind Drift man are vast ages of which we are now only beginning to get the first glimpses. But it now seems evident that man was already on the earth in early Pliocene times ; and we must not be surprised if proofs are ultimately brought forward that the *genus homo* goes back even further than that ; it has become almost a shibboleth, that man first appeared in Pleistocene times ; but I affirm that it is no more than a shibboleth. There is absolutely nothing *a priori* for or against the statement ; it is entirely a question of evidence."[3]

It is not the time to criticize such far-reaching conclusions. The question turns on the fact whether this type of implement is really the work of man, or the result of the forces of Nature working upon the raw material. This is a problem for the Petrologist. It is remarkable that, so far as I am aware, the problems connected with the cleavage of flint

1. R. R. Marett, *Anthropology* (1912) pp. 41, *et seqq.*
2. *Proceedings of the Prehistoric Society of East Anglia*, vol. i., part i., (1911) pp. 43, *et seqq.*
3. *Ibid* p. 104, *et seq.*

have not been thoroughly examined. This is a subject which I may commend to our field-workers, who will find a useful contribution to the study in two recent papers by Sir Ray Lankester.[1]

Meanwhile, I would draw attention to a more sober investigation of prehistoric chronology, by Professor Sollas, in the admirable work to which I have already referred. His views will not satisfy those who demand a period of, at least, 100,000 years for the Neolithic period alone, much less do they corroborate the theories of Dr Allen Sturge. He allows no more than 17,000 years for the interval between our time and the close of the glacial episode, and he assigns the Magdalenian period to the time when the ice was retreating, about 12,000 years ago.

Since Professor Sollas formulated these conclusions, a most important piece of new evidence has been obtained, which throws fresh light on the problems of prehistoric man in these islands, and proves, if proof were needed, that in a rapidly advancing science no finality is to be expected, and that a sudden discovery may seriously affect the best considered theories.

In October last, Mr J. Reid Moir discovered beneath an undisturbed layer of chalky clay, rather more than a mile north of Ipswich, a skeleton which, in the opinion of those best qualified to express an opinion, constitutes not only the oldest remains of man hitherto discovered in England, but, with the exception of the Heidelberg jaw, the earliest yet found in Europe. The stratum in which it was found is supposed to antedate the period of the Neanderthal man whose remains are so abundant in France. The parts of the skeleton which were preserved indicate a tall man, about 5 ft. 10 in. in height. The jaws were lost, but the isolated teeth were small, much worn, not differing materially from those of modern man. and very unlike the Neanderthal type. The skull was small, especially for a man of such stature, and it was peculiar in shape—flat and broad in its posterior part, in this respect recalling Neanderthal man ; but the bones of the thigh, forearms and hands were absolutely identical with those of a

1. *The Daily Telegraph*, 16th and 23rd January, 1912. Also in S. Hazzledine Warren's "Problems of Flint Fracture," *Man* xiii. (1913), pp. 37 *et seq.*

modern Englishman. The peculiar features, which at once distinguish this skeleton from every form of man yet discovered, are the shapes of the leg-bones, the tibia and the fibula. Professor A. Keith, in his recent first Hunterian lecture,[1] remarks that in many features the tibia of the Neanderthal man recalled the same bone in the gorilla, but was differentiated from the simian form by possessing a definitely marked anterior border, or shin. In other palæolithic races, and in all other human types, the shin of the tibia was prominent and sharp ; but in the Ipswich man, in place of a sharp shin, there was a flat surface. The significance of this feature is, at present a puzzle to Professor Keith and other anatomists. It does not represent, he believes, a pathological condition ; but it was evidently a peculiarity connected with the gait of the individual.

The question will, naturally, be asked : Is it absolutely certain that we have in this case an undisturbed interment of the early palæolithic period ? Or, is it possible, that in the present instance a man of a much later type was buried in the ancient strata from which his remains have been disinterred ? Professor Keith, at any rate, suggests no doubts on the subject, though the specimen obviously conflicts with facts hitherto generally accepted by comparative anatomists. It was found, he informs us, in a stratum of undisturbed chalky boulder clay, the bones lying at the junction of two formations—chalky boulder clay above, chalky sands below. There can, he assures us, be no question of burial at a much later period, because the various horizontal lines and markings were continued across the strata above the bones, showing that they were in the condition in which they had been originally laid down. The individual to whom the skeleton belonged had clearly lived before the over-lying strata were formed.[2] A friend, who is an expert in the geology of Eastern England, however, suggests to me that the skeleton belongs to a period much later than the strata in which it was discovered. It was

1. *The Times*, 1st February, 1912.
2. *The Daily Telegraph*, 27th February, 1912. A useful account of the discovery, with a picture of the Ipswich man, reconstructed from his remains, will be found in the *Illustrated London News*, 23rd March, 1912. More recently the question has been discussed by Messrs J. Reid Moir and Arthur Keith : "An Account of the Discovery and Characters of a Human Skeleton found beneath a Stratum of Chalky Boulder Clay near Ipswich."—*Journal Royal Anthropological Institute*, xlii. (1912), pp. 345, *et seqq.*

found, he believes, under several feet of boulder clay on the gravelly sand, possibly interglacial, the boulder clay having worked its way down the hill slope from the material capping the plateau ,while the whole river valley, at the head of which the discovery was made, is pierced with rifts from land-slides.

It would be premature to express a definite opinion on the subject until we are in possession of expert examination of the strata in which the body was found. Such enquiries have, doubtless, been made, or are being made, by geologists whose verdict will settle the question. It may, however, be remarked that this is not the only case in which there is reason to suspect that the evolutional seriation has been disturbed by discoveries of remains which appear to be higher in type than might have been expected from the character of the strata in which they were found.

Assuming the geological conditions to be those which Professor Keith accepts, various important considerations suggest themselves. In the first place, this Ipswich specimen is obviously antecedent to the skeleton discovered at Galley Hill, near Northfleet, in Kent, by Mr E. T. Newton, in 1895. This, in spite of some adverse criticism, is now, on the high authority of Dr W. L. H. Duckworth[1] and others, recognized to be of great antiquity, and to belong to the Aurignacian period. The pit in which it was found, according to Mr Hutton, invades "the high-level terrace gravel" of the Thames valley, this 100 feet terrace being part of the ancient bed of the river. But this, in its turn, rests upon the boulder clay, and, therefore, assuming the correctness of the geological evidence regarding the Ipswich skeleton, according to Professor Keith, it belongs to a much earlier date than the Galley Hill man, who is referred to a very advanced civilization of the flint age. If this view be accepted, the Ipswich man, whose physical characteristics do not essentially differ from those of modern Englishmen, establishes what seems to be a break in the chain of human evolution, by orderly stages, from some lower anthropoid, a doctrine which has hitherto met with the acceptance of English palæontologists.

1. *Prehistoric Man* (1912) pp. 20, 32 *et seqq.*, 56 *et seqq.*

In the second place, another suggestion may be made. We know that the movements of the peoples in the earlier stages of humanity were certainly not less constant than in the present times. May we suspect that the Ipswich man represents the intrusion of some foreign race?

Thirdly, the discovery suggests some doubts on the current doctrine that the form of the skull is the final test of race. It is needless to say that between unassociated races, for instance, between the brachycephalic, or short-headed Mongol, and the dolichocephalic, or long-headed Australian native, the contrast of skull form is definite and conclusive, and the same condition of things, according to Dr. John Beddoe, the great local anthropologist, whose recent death we deplore, may be found in this country. Whether the varied types of humanity were produced by separate and local processes of evolution from some anthropoid, or whether the evolution took place at some single centre, and the differences are the result of the influence of environment on the individual, it is unnecessary to enquire. The differences of skull form at these extremes are obvious, and the anthropologist must do his best to explain them. But the case is different with mixed races, and at the present time among a new and increasing school of anthropologists greater stress is now being laid on environment, and the form of the skull, instead of being regarded as the only part of the human frame which survives unchanged from epoch to epoch, is now believed to possess considerable plasticity under the control of the environment, that is to say climate, food supply and the like. Dr John Beddoe has taught us that in this country the citizen develops, by some process of selection, a longer and narrower head than the countryman, a fact observed both in Bristol and in London.[1] In the same way, it has been found that among American immigrants the change of environment does in some way, which we are at present unable to explain, modify the skull form to an important extent.

Various attempts have been made to discriminate the elements of the population of these islands on the basis of differences of hair colour, eye tints, skin pigmentation and the

1. The Huxley Lecture, *Journal Anthropological Institute*, xxxv. (1905) p. 221

like. It is, of course, possible, when we come to later times, that in some parts of a secluded district like the Cotteswolds, or valleys or hill tracts in Wales or Scotland, we may find groups or families of people who retain the type characteristic of Dane, Norseman, or Anglo-Saxon ; and our field workers might take care to observe any cases of the kind which come under their observation. But the rapid movement of our country population into the great towns, and the constant intermingling resultant from marriage, tend to obliterate such distinctions. In short, the anthropologist is at present in search of a definite test which he can safely apply to a mixed people such as that of these islands.

But the moral of the Ipswich discovery is that at any time, in some obscure locality, important evidence may be found which may help to solve the problem of race origin. Those among our members who are in a position to watch excavations in quarries, sand-pits, and the like, should keep in mind the great importance of the remains of prehistoric man, and use anxious precautions that evidence of the kind is not allowed to perish.

An example of the valuable results to be gained by such local enquiries is to be found in the paper recently contributed by Mr A. E. W. Paine on "The Great Doward Cave in the Wye Valley." His investigation of the cave was too limited to produce much valuable information, except that it invites attention to a field which may produce useful material. I may, however, call attention to the skull from a long barrow near Bisley which he presented before us. It had obviously been the subject of the operation known as trepanning or trephining, which remained incomplete, the primitive surgeon having succeeded with his imperfect instruments in producing only a superficial, rudely circular incision into the bone. It is important to remark that the cases of skulls having undergone this operation all seem to belong to the Neolithic period, and this furnishes a test which, so far as it goes, establishes the date of the specimen. One example from a dolmen, at Aiguières, engaged the attention of Dr Paul Broca, in 1868. [1] Here the instrument used was a neolithic flint, or obsidian

1. Miss A. W. Buckland, *Journal Anthropological Institute*, xi. (1882) pp. 7 *et seqq.*

scraper. He came to the conclusion that the operation was intended to release the spirit supposed to be the cause of diseases like epilepsy and convulsions, and he pointed out that trepanning, as a remedy for convulsive disorders, is still in favour with the races of Oceania, with the Kabyles, and the mountaineers of Montenegro. Dr Broca also produced examples of incomplete trepanning, like the specimen from the Wye valley ; and he showed that the piece removed from the trepanned skull was worn as a charm to cure or prevent those diseases for which trepanning was practised as a remedy, and that such amulets were in such request that they became articles of commerce. The question was again raised by the great surgeon, Sir Victor Horsley,[1] who proved this remarkable fact, that in almost all these primitive operations the incision was made over that portion of the brain which is known to be the seat of representation of movement, and that they were therefore obviously intended to relieve epilepsy. Since that time the question has been again considered by Dr R. Munro, who generally supports the conclusions of previous observers, and gives an illustration of a skull from a cist at Mountstuart, Bute, in which the operation was completely, if rudely, performed.[2]

I may also, as an illustration of what discoveries may be made in our district, note the interesting " find " by Mr J. E. Pritchard at Bristol, at a depth of 20 feet, of the skull of a horse, which has been identified by Professor Cossar Ewart as belonging to a small, slender-limbed horse or pony of the Plateau type, which occurred as a wild species during Pliocene times in Italy and France, and in other parts of Europe during the Bronze, Neolithic, and early La Tene Iron periods.[3]

As a suggestion for future work, I may point out that from the paper of Mr Paine on the Great Doward Cave it appears that a number of caves containing remains of early man, situated in the cliffs overhanging the valley of the Wye, have not as yet been surveyed or examined. A scheme to undertake the exploration of these caves in co-operation

1. *Ibid.* xvii. (1888) pp. 100 *et seqq.*
2. *Proceedings Society of Antiquaries, Scotland*, vol. xxvi.: *Prehistoric Scotland* (1899) p. 213.
3. *Transactions of the Bristol and Gloucestershire Archæological Society*, xxxiv. (1911) Part I. pp. 76, *et seq.*

with the Bristol and Gloucestershire Archæological Society, seems to me a work which this Club might with advantage undertake, and I trust that my successor may find it possible to establish a joint Committee to supervise the enquiry. One point is clear, that if this important work is to be undertaken, it must not be left to enthusiastic but unskilled amateurs. If it is impossible to carry it out under expert control, and in conformity with the well-established principles which regulate archæological research in other parts of the world, it would be much safer to leave the material undisturbed until it can be dealt with in an adequate manner by our successors.

In vacating this Chair, after serving as your President for two years, I desire to place on record my cordial appreciation of the unvarying kindness which I have received from the Council and the members of the Club, and to acknowledge the valuable work of our learned Honorary Secretary, Mr Richardson, for the advancement of its interests and the extension of scientific knowledge in our district. Much more might have been done had my place been occupied by a President better qualified than I can pretend to be in the studies to which your attention is mainly directed.

My place will be taken by an old friend of the Club and a man greatly interested in Botany, in whose hands the interests of the Club and the more efficient prosecution of its objects may be safely entrusted.

Mr Crooke then left the Chair.

The Hon. Secretary then called upon the Rev. H. H. Winwood to propose the President for the coming year.

Mr Winwood spoke in eulogistic terms of the address Mr Crooke had delivered and of the able way in which he had discharged his duties as President during the past two Sessions.

Mr Winwood then stated that Sir William Thiselton-Dyer, K.C.M.G., C.I.E., F.R.S., had been invited by the Council to allow himself to be nominated for the Presidentship, but, while expressing his appreciation of the honour that the invitation implied, felt obliged to decline.

The Council had, therefore, approached Mr Butt, and he, under pressure, had agreed to allow the Council to recommend him to the Club as President for the coming Session.

Mr Winwood having proposed Mr Butt, and Mr Charles Upton having seconded, Mr Butt was unanimously elected President.

Mr Butt then took the Chair and thanked the Members for this fresh expression of confidence in him.

The Rev. H. H. Winwood and Messrs C. Bowly, M. W. Colchester-Wemyss, W. R. Carles, Charles Upton and W. Crooke were elected Vice-Presidents.

Mr J. H. Jones was elected Hon. Treasurer; Mr J. G. Phillips, Hon. Librarian; Mr. L. Richardson, Hon. Secretary; and Mr E. T. Paris, Hon. Assistant Secretary. Messrs W. Thompson, G. M. Currie, J. M. Dixon and Major J. G. Wenden, V.D., were elected as representatives of the Members on the Council.

The President, Hon. Treasurer, Hon. Secretary, and Messrs Charles Upton and H. H. Knight were appointed to constitute the Publication Committee.

The places and dates for Field Meetings were fixed as follows:—Droitwich and Stoke Works, May 14th; Cleeve Hill, June 1st; Tidenham Chase (altered later to Thornbury and Aust Cliff), June 11th; Painswick and Kimsbury, June 29th; Bridport District, Dorset, July 16th to 18th; Chippenham and Corsham (altered to Bath and Box), September 17th.

ORDINARY WINTER MEETINGS

Tuesday, November 12th, 1912.

The Rev. WALTER BUTT, M.A., J.P., President, in the Chair.

The Minutes of the last Meeting were read, confirmed and signed by the Chairman.

A Lecture (illustrated with lantern-slides) was given on—

"FORESTRY." By *C. O. Hanson, Principal of the Crown School of Forestry, Forest of Dean, Glos.*[1]

The Hon. Secretary exhibited an MS.-map (6-inch Series, Sheet xxvi., S.E.), showing the geographical distribution of the sand, gravel and clay, in The Park and Leckhampton districts of Cheltenham and Charlton Kings.

The Honorary Secretary stated that Mr Rowland Austin, of the Public Library, Gloucester, had prepared an index to the Club's "Proceedings," Vols. I-XVII.

Mr Richardson was instructed to convey to Mr Austin the sincere thanks of the Members for his valuable piece of work, and the hope was expressed that it would soon be published.

Tuesday, December 10th, 1912.

The Rev. WALTER BUTT, M.A., J.P., President, in the Chair.

The Minutes of the last Meeting were read, confirmed and signed by the Chairman.

Dr E. T. Wilson, President of the Cheltenham Natural Science Society, referred to a circular which he and the late Mr G. B. Witts had issued with a view to securing information from people in Gloucestershire possessing worked flints or other prehistoric implements. Unfortunately, Mr Witts has since died, but Dr Wilson explained that it was his intention to continue the inquiry, and Mr Witts' valuable papers had been placed at his disposal. In 1870, the late Mr Lucy prepared an inventory of these implements for the county, and it was now proposed to go further. There was need for greater supervision of valuable remains over the country generally. He had discovered that a Round Barrow was being opened in the neighbourhood of Cheltenham, and the thing was being kept secret. He was told that he must not mention it to anybody, but when he went to see it he found that a skull had been removed and had been absolutely ruined for all purposes of scientific

1 See page 59.

investigation, by being filled up with putty. Other things had been removed, but nobody knew where they had gone to. He would like to see the county divided up, with gentlemen appointed to prevent anything of the kind occurring again. In Mr Witts' handbook thirty-nine Long Barrows were mentioned, and of these eleven had been examined properly. Evidence as to the ancient men who used these Barrows was fast passing away, and that was why he wished immediate steps to be taken to preserve anything that might be of help to them in their investigations.

The following papers were read:—

1. "On a Well-Sinking at Lansdown, Bath." By *The Rev. H. H. Winwood, M.A., F.G.S.*[1]

2. "The Distribution of Calluna on the Cotteswolds." By *H. H. Knight, M.A.*[2]

It was reported that the Library of the Club had been transferred to the Gloucester Public Library, on terms considered very satisfactory both by the Council of the Club and the Public Library Committee.

1 See page 83. 2 See page 69.

VIEW OF THE RIVER SEVERN AT HOLT FLEET, NEAR DROITWICH.

(Block kindly lent by J. H. Hollyer, Esq.

EXCURSIONS

1912

EXCURSION TO DROITWICH AND STOKE WORKS.

TUESDAY, MAY 14th, 1912.

Director: L. RICHARDSON.

(*Report by* L. RICHARDSON *and* W. THOMPSON).

As usual, there was a good muster of Members for the first Field Meeting of the year, and in accordance with tradition the weather left nothing to be desired. Each year Mr Richardson, the Honorary Secretary, manages to discover new ground for the Club's operations, and the members are fully conscious of the trouble he takes and the discrimination with which he seeks to broaden the field of inquiry and research.

Those present included:—Mr W. R. Carles, C.M.G. (Vice-president), Mr L. Richardson (Hon. Secretary), Ven. Archdeacon Scobell, Rev. Cheeseman, Messrs F. H. Bretherton, C. Brown, O. A. Brown, J. M. Collett, G. M. Currie, Charles Curtis, J. Daniels, J. M. Dixon, T. S. Ellis, O. H. Fowler, B. G. Geidt, F. Hannam-Clark, H. Haigh, G. W. Hedley, H. H. Knight, H. Hume-Rothery, E. Lawrence, A. S. Montgomrey, F. J. Mylius, W. Margetson, F. T. Pearce, A. E. W. Paine, E. C. Sewell, A. E. Smith, W. Thompson, etc.

Droitwich was not unknown to some of the Members of the party, for its famous brine baths have a special attraction for suffering humanity, and stand high in the estimation of the medical faculty. This is supposed to have been the Roman Salinæ (salt city), many Roman remains having been found. It is not a large town, the population being only 4,201, but it is one of the oldest boroughs in the kingdom. In pre-Roman times two great roads or "saltways" led from Droitwich—one to the coast of Lincolnshire and the other to the coast of Hampshire.

Droitwich owes much to the late Mr John Corbett. The salt industry furnished him with much of this world's goods, and in return he spent largely on the town, and by his enterprise contributed not a little to its prosperity. As in Warwickshire, so in Worcestershire, half-timbered black and white houses are a striking feature, and some of the buildings in Droitwich are exceptionally picturesque.

The Members first paid a visit to the Experimental Gardens, maintained by the Worcestershire Education Committee, and were favourably impressed not only by the clean condition of the land, but by the skilful manner in which the fruit trees had been pruned, and the prospect of a heavy crop.

Mr Richardson briefly explained how the teachers of the Public Elementary Schools visit the gardens on Saturday mornings for the purpose of acquiring knowledge in horticulture. This formed a suitable basis for class-work, garden instruction being correlated with other subjects in the school curriculum.

In the absence of the county horticultural instructor, a member of the garden staff acted as guide to the visitors, and drew attention to unpruned trees, and contrasted them with others treated on scientific lines. Interest was also displayed in the numerous braziers or heaters used to protect the trees from frost. These are of two shapes, conical and round, the former being charged with 20lbs. of coal, and the latter with 15 lbs. For effective purposes 60 fires are required to the acre. The method of lighting was explained, and testimony was forthcoming as to the benefit derived during the critical stages of inflorescence and fruiting.

Leaving the gardens, seats were taken in a motor bus, and a pleasant ride was enjoyed to Holt Fleet, on the Severn, a distance of six miles (Plate I.). In this way, as Mr Richardson explained, the Members were able to obtain some idea of rural Worcestershire, and at the same time inspect a particularly picturesque reach of the river which is so prominent a physical feature further south in Gloucestershire. The ride lay through the villages of Hadley and Ombersley, several country seats being passed en route, and not a few of the white and black houses already referred to. Mr Richardson briefly dealt with the geology of the district.

Returning to Droitwich, the party sat down to lunch at the Raven Hotel. Mr W. R. Carles presided, and in sympathetic terms referred to the absence of the Rev. W. Butt, the President of the Club, who had written asking to be excused from attending the meeting in consequence of the death of his daughter. Mr Carles said he knew those present would like to join him in an expression of sympathy to their President, and to assure him that all would wish to lighten his duties in connection with the Club during the coming months. The next field meeting was to have been in the neighbourhood of Chepstow, and Mr Butt had kindly invited the Club to enjoy his hospitality at Oakwood. In consequence of the President's sad bereavement, however, this anticipated pleasure would be postponed.

Mr Richardson had received letters from Canon Bazeley and Dr Callaway, acknowledging in appreciative terms the invitation of the Club that they should allow themselves to be elected Honorary Members, and expressing gratitude for what both gentlemen regarded as a mark of distinction. Reference was also made to the work of investigation recently carried out by Mr A. E. W. Paine in a cave at Symonds Yat, and the decision arrived at by a sub-committee of the Archæological Society and the Cotteswold Club, that Mr Paine's research should be followed up by further excavations. The Bristol and Gloucestershire Society had already contributed two guineas towards this object, and on the proposition of Mr Carles it was agreed to furnish a like sum from the funds of the Club. Many human bones have been found in the cave, and in the opinion of expert archæologists the time is ripe for extending the investigations which from time to time have taken place on the banks of the Wye. [W.T.]

After lunch the St. Andrew's Baths were visited. Thence the Members walked to the Station, catching the 2.36 p.m. train for Stoke Works, the property of the Salt Union, Ltd. Here the party was divided into two sections, and courteously conducted round the Works by two officials.

First, the deep well pumps and engines were inspected, of which there are three sets. The wells are about 220 feet deep and have a bore-hole extending from the bottom for about another 100 feet, making a total depth of about 320 feet, which is the limit of the present borings.

The salt is obtained in the form of brine and occurs in the Upper Keuper Marls. The Upper Keuper Marls are of a prevalent red colour and have a very considerable geographical extent in the English Midlands. It is thought that the conditions which obtained in England at the time that these deposits were formed, were very similar to those which now obtain in the salt-lake district of Utah. Water which has percolated the red rocks and become saturated with salt constitutes the practically inexhaustible supply of brine drawn upon by the Works. The brine has an almost constant specific gravity of 1·2129 at 15°C, and contains about 21,500 grains of salt (Na Cl.) to the gallon, together with small quantities of other salts of lime and magnesia. The brine is delivered to a large reservoir, from which it is drawn off to evaporating pans as required, and is of sufficient purity to allow of the manufacture of salt for all purposes, including domestic and table use, made by the simple process of evaporation, no refining or re-crystallization being required.

The process of manufacture is extremely simple. Shallow rectangular tanks of wrought iron are erected, having a capacity varying from a few tons up to 150 tons of salt per week, the largest being 50 or 60 feet long, and nearly 20 feet wide. These tanks, or evaporating pans, are fixed over coal furnaces, having a system of flues extending under their whole area. Others are heated by steam, while a few circular closed pans are in use, having shallow open pans attached to them for crystallizing and collecting the manufactured salt.

Various grades of salt are produced of different degrees of fineness, the size of crystals being regulated largely by the rapidity of evaporation. Thus, the finest table salt is produced at the highest degree of evaporation.

The ordinary bar salt is made in open pans heated by coal fires. As the salt crystallizes it is lifted from the mother liquid and placed in wooden moulds to drain. These moulds are then carried to drying rooms, and when the salt has become sufficiently firm it is withdrawn from the mould, and when quite dry is ready for the market.

Coarser qualities, that is, grades with larger crystals, are made by evaporating very slowly at a low temperature, some of the pans being left for a month before being "drawn."

For various purposes the salt is ground between iron rollers and packed as a fine powder, while some of the large blocks are cut by means of circular saws for sale as penny and halfpenny bars.

The output of the works is said to be 150,000 tons per annum. The finished product is almost pure chloride of sodium, containing mere traces of the sulphates of lime, soda and magnesia.

ANALYSIS OF SAMPLE OF WORCESTERSHIRE DAIRY SALT.

Sodium Chloride (Salt) ..	98·29
Calcium Sulphate	·87
Magnesium Sulphate	·06
Sodium Sulphate	·74
Moisture	·04
	100·00

The Members left Stoke Prior Station at 4.10 p.m. [L.R.]

HALF-DAY EXCURSION TO CLEEVE HILL, NEAR CHELTENHAM.

SATURDAY, JUNE 1st, 1912.

Director: CHARLES BAILEY, M.Sc., F.L.S.

(*Report by* CHARLES BAILEY).

This excursion was, by kind invitation of Mr Charles Bailey, to Haymesgarth, Cleeve Hill. Those present were:—Mr William Crooke, F.A.I. (Deputy-President), Mr W. R. Carles, C.M.G., F.L.S. (Vice-President), Mr J. H. Jones (Hon. Treasurer), Dep. Surg.-Gen. G. A. Watson, Lieut.-Col. T. H. Sweeny, Messrs J. M. Collett, S. J. Coley, G. M. Currie, Charles Curtis, William Bellows, J. M. Dixon, G. Embrey, F.C.S., O. H. Fowler, J. H. Garrett, F.L.S., B. G. Geidt, E. Hartland, J. N. Hobbs, H. H. Knight, E. Lawrence, A. M. McAldowie, F.R.S.E., A. S. Montgomrey, F. J. Mylius, H. E. Norris, W. J. Stanton, A. J. Stephens, E. T. Wilson, etc. [L.R.]

The object of the excursion was to inspect the Herbarium, which has been removed from Manchester and St. Anne's-on-the-Sea to Cleeve Hill, and which is ultimately to come into the possession of the Victoria University, Manchester. It has been in the course of formation during the last fifty years, and is of considerable range and extent.

The Members were in the first instance taken round the garden, where attention was drawn to the more interesting native plants growing therein, including the following:—*Sisymbrium strictissimum*, Linn., from Heaton Mersey; *Tunica Saxifraga*, Scop., from Tenby; *Saponaria officinalis*, Linn., from Southport; *Silene dubia*, Herbich, from Thirst House Cave, near Buxton; *Geranium sylvaticum*, Linn., from Forres; *Geum intermedium*, Ehrh., from Millersdale; *Peucedanum Ostruthium*, Koch, from Bolton; *Hieracium amplexicaule*, Linn., from Saltburn; *Symphytum tuberosum*, Linn., from Melrose; *Symphytum peregrinum*, Ledeb., from Grange Mill, Derbyshire—a species which is now growing on the south side of Southam de la Bere; *Anchusa sempervirens*, Linn., from Kircudbright; and *Carex pendula*, Huds., from Laverton, some of which plants have established themselves in Great Britain in recent years.

Amongst the plants growing in the garden are many self-sown examples of Lamarck's Evening-primrose (*Œnothera Lamarkiana*, Seringe). The parent plants were originally brought to Cleeve Hill from the estuary of the Ribble, on the Lancashire coast, and although the soil of the neighbourhood is so unsuitable for a sand-loving species, it has continued to maintain itself on the Hill; the species is biennial, and all the plants now in evidence are last year's seedlings. Mr Bailey had been acquainted with the Lancashire plant for more than thirty years, but he did not know its true name until about six years ago; botanists had been accepting it as a large-flowered form of *Œ. biennis*, to which Aiton's name of *grandiflora* was usually applied.

The special interest attaching to *Œ. Lamarkiana* is that the investigations of De Vries have established the fact that from this plant originate descendants, with groups of characters which show considerable diversities from the plants which produced them. The lines of descent do not follow each other in slow or imperceptible variations, but they make decided departures from the parent stock; to these discontinuous variations De Vries has given the name of "mutants." The original plant is presumed to have been grown in the flower-beds of the Paris botanical gardens in 1788, but to this day no one has succeeded in re-finding its native station in North America, whence it was derived. The various American herbaria have also been searched for native examples of the plant and for indications of its source, but fruitlessly, and it is now thought that it once grew in some restricted area in Virginia, where it subsequently became exterminated. In 1858, however, a firm of London nurserymen introduced seeds into England from Texas, without being aware that they were those of *Lamarkiana.* This species has also been found in thousands on an abandoned field in the neighbourhood of Hilversum, near Amsterdam, but the same mystery attaches to the source of the Dutch plant, as it does to that of the Paris plant of 1788, and to the Lancashire plant of the present day.

Special attention was drawn to examples of the Virginian spiderworts (*Tradescantia virginica*, Linn., and other allied species) growing in several parts of the garden, as they furnish good examples of the phenomenon of the streaming of protoplasm. The motion in these plants was first detected by the late Robert Brown (born 1773, died 1858), who reported the fact, in one of his communications to the Linnæan Society ("Transactions," vol. xvi., 1833), as occurring in the cells of the epidermis, and in the coloured hairs which are attached to the filaments of the stamens. The movement of protoplasm has been known since 1774, when Corti first pointed it out, although it was not at that time clearly distinguished from the circulation of sap. As was demonstrated under four microscopes in the library (but with indifferent success, owing to the absence of sunlight) the protoplasmic granules move, with steady regularity, in narrow streams, and often in a "figure of eight" direction; their motion is best seen in each cell of the beaded hairs on the filaments of the anthers, especially round the clearly defined nucleus. Although the word "protoplasm" is now so familiar, it was coined as recently as 1846 by Hugo von Mohl, in one of his papers for that year, published in the *Botanische Zeitung*, page 76.

The generic name of the plant *Tradescantia*, is also noteworthy, as it was named after one of the Tradescants, who were seventeenth century gardeners rather than botanists. There were three generations of John Tradescants flourishing in the days of the Stuarts; they travelled in various parts of the world and introduced many plants into English horticulture, such as the tulip tree (*Liriodendron tulipifera*), or poplar of Virginia, as Evelyn calls it, well exemplified in the famous avenue at Chatsworth.

The grandfather of the Tradescants was a Dutchman, who settled in this country somewhere about the time that James I. became King of England and Scotland. The father was principal gardener to the first Lord Salisbury, and the present Marquis possesses, amongst his archives at Hatfield, a large number of Tradescant's invoices for rare and curious foreign plants; this second John Tradescant passed from Lord Salisbury's service to become gardener to Charles I. The son, the third John Tradescant, had a curious museum and garden at Lambeth, containing many foreign trees and plants. At his death in 1662, he bequeathed his museum to Ashmole, who in his turn passed it on to Oxford, where it now forms part of the Ashmolean Museum. The garden was in existence a hundred years after Tradescant's death, together with many of his plants, but the plot became absorbed by the growth of Lambeth.

The widow of the third Tradescant erected a tombstone in the chancel of Lambeth Church, as a memorial of the Tradescant family; it bears the following quaint inscription:—

> Know, stranger, ere thou pass, beneath this stone
> Lye John Tradescant, grandsire, father, son.
> The last died in his spring;—the other two
> Liv'd till they had travell'd Art and Nature through;
> As by their choice collections may appear
> Of what is rare in land, in sea, in air.
> Whilst they (as Homer's Iliad in a nut)

A world of wonders in one closet shut.
These famous Antiquarians, that had been
Both gardeners to the Rose and Lily Queen,
Transplanted now themselves, sleep here, and when
Angels shall with their trumpets waken men,
And fire shall purge the world, these hence shall rise
And change this garden for a Paradise.

In the regretted absence of the President (Rev. W. Butt, M.A.) on account of a family bereavement, Dr Garrett was voted to the chair, and after tea Mr Bailey gave a short account of his herbarium. A collection of forty sheets of all the British water-buttercups was laid out on the tables for the inspection of the Members.

The Members were interested in an instrument on the terrace for finding Greenwich mean time during sunshine for all the days of the year.

EXCURSION TO THORNBURY AND AUST.

TUESDAY, JUNE 11th, 1912.

Directors: The Rev Canon Cornwall, the Rev. A. D. Lough, F. H. Creswell and L. Richardson.

(*Report by* W. Thompson).

The Members arrived at Thornbury at 11.46 a.m., and were:—The Rev. H. H. Winwood and Mr Charles Upton (Vice-Presidents), Mr L. Richardson (Hon. Secretary), Messrs O. A. Brown, F. H. Bretherton, J. M. Collett, F.C.S., J. M. Dixon, G. Embrey, F.C.S., B. G. Geidt, F. Hannam-Clark, J. N. Hobbs, H. H. Knight, E. Lawrence, A. S. Montgomrey, F. Pearce, J. W. Skinner, A. J. Stephens, W. Thompson, etc.

From the station a stroll through the quiet, but picturesque old town brought the party to

THE PARISH CHURCH

where the Vicar, the Rev. Canon Cornwall, was in readiness to explain the chief historical and architectural features of the building. A fine perpendicular tower, overlooking tall elm trees, is one of the chief landmarks of the neighbourhood, and is of the same period as Gloucester Cathedral and Chipping Campden Church. The Vicar modestly disclaimed any pretensions to be considered an expert archæologist, but it is clear from the interesting paper which he contributed to the Gloucester Diocesan Magazine, that he has acquired considerable knowledge of the fine church in his charge. The Members of the Club listened with pleasure to the reading of this paper. The church is dedicated to St. Mary the Virgin, and is in close proximity to the Castle, a lofty wall of the castle dividing the grounds from the churchyard. There is no record of a church here before the Conquest, but Atkyns states that a Royal Charter given at Winchester in 1106 by Henry I. granted and confirmed to Tewkesbury Abbey certain churches with their lands and tithes, Thornbury being one of them. It is clear, therefore, there was a church on the site of the present one early in the twelfth century. Before the close of the twelfth century the church may have been rebuilt or enlarged, as the existing font and the north and south doorways are of transition work. Some colour is given to the idea by the tradition that the body of the church and the tower were built by Fitzhardinge, the builder of Berkeley Castle. Atkyns states that the south aisle of the fourteenth century church was built

THORNBURY CHURCH AND CASTLE.
(Block kindly lent by A. Prewett)

THORNBURY CASTLE.

Block kindly lent by A. Prewett.)

by Hugh, Lord Stafford, who died in 1386. Externally this aisle seems to have been restored 100 years later, as Leland, who visited Thornbury about 1540, made reference to the fact. There were four chantries in the church. One dedicated 1499 to the Virgin, another was called Barne's Chantry, and the others were Bruis Chantry and Slymbridge Chantry. The church stands in the tything of Kington, as does the Castle. It was at Kington that St. Arilda, a virgin, was martyred. She is the Patron Saint of Oldbury-on-Hill and Oldbury-on-Severn. There is a spring called St. Arild's Well at Kington. Her body was removed to the Abbey at Gloucester. The Tewkesbury monks probably built the church as it now stands towards the close of the fifteenth century, when the Wars of the Roses were over, and men's thoughts were able to turn to the arts of peace. Under Henry VIII., the possession of the monasteries being largely taken away, Thornbury was given to the Duke of Buckingham, who, but for his death on Tower Hill in 1521, would have founded a perpetual college, with dean, sub-dean, eight secular priests, four clerks, and eight choristers, in honour of St. Mary. The tower is undoubtedly the most beautiful feature of the building, and, as Canon Cornwall points out, is "a glorious piece of architecture." The nave of six bays is remarkable for the tall and slender arcade, which carries a lofty clerestory. The church was well restored in 1848, when the walls of the chancel were considerably raised, and the existing chancel arch substituted for a depressed arch. As a result of this the east window is thrown out of place and proportion. There are fragments of beautiful old glass still remaining in the headings of the windows of the south aisle, but it would have been strange if more had survived the days of the great rebellion, situated as Thornbury is between Bristol and Gloucester. There are no monuments of interest to the antiquary or historian.

THORNBURY CASTLE

The Castle is close to the Church, and is surrounded by smooth green turf. The front is reached through an arched gateway, with a postern gate at one side. This opens into a court, originally enclosed on all four sides, but now only on three—the fourth having completely disappeared. It was designed originally by King Edward the Elder, in the early part of the tenth century, as a fortress to check the continual civil warfare of the Mercians.

According to the earliest records, Thornbury belonged to a knight named Aylward, a cousin of the King. Since those days it has been seized and held by the crown three times. It was conferred by William Rufus on Robert Fitz Hamon, and this led to its passing by marriage to the Earls of Hertford and Gloucester. It was in the possession of the De Clares for 200 years, and the Staffords 400 years. In 1637 Mary Stafford, daughter of the fifth Baron, married Sir William Howard, and they were made Viscount and Viscountess Stafford, and their son Earl of Stafford. Henry Howard succeeded to the ownership in 1824, and bequeathed it to his son, the present owner. Henry VIII. having seized Thornbury and converted it into a Royal demesne, sent his daughter Mary there under the guardianship of the Bishop of Exeter. Henry, himself, stayed at the Castle for some days with Anne Boleyn, but subsequently neglected it and allowed it to fall into ruin. The third Duke of Buckingham was closely associated with the place, and his motto "Doresnavant" ("henceforth") is carved over the entrance doorway and repeated within, both in stone and wood. There are finely executed screens of oak in the hall, and two engravings in the same part of the building by Reubens and Vandyck, representing Thomas Howard and his wife Lady Talbot. The drawing-room is described as a delightful room, containing attractive old cabinets and chairs rescued from strange lurking places, charming pictures and china, many books and flowers. In the library there is a fine old carved fire-mantel, and the principal bedrooms and other chambers all have points of interest for the visitor. In the old days it was a large and important seat, and even to-day it is not difficult to conjure up visions of its departed glory and of the power wielded by those who in succession lived there.

From a survey taken in the time of Queen Elizabeth it seems there was then a great hall adjoining the kitchen and buttery at the east end of the north wing. The huge fireplace in the kitchen is no longer used, but the large stack of wood which now stands in close proximity to it is suggestive of the roaring fires which once burnt on the hearth and heated the ample oven, and the buttery hatch close by it is also reminiscent of the good fare which in bygone days was prepared for the inhabitants of the castle. The bay windows must have been particularly beautiful, and exactly the same arrangement is to be seen in a portion of Windsor Castle.

Lunch was served at the Swan Hotel, when a telegram was read from the President, the Rev. Walter Butt, who, although regretting that family bereavement prevented him from attending the meeting, said that from his home at Tidenham Chase he should be thinking of his friends on the opposite side of the Severn.

AUST CHURCH

The party after luncheon drove to the village of Aust, and were met at the Church by the Rev. A. D. Lough, the curate in charge, who, at the request of the Secretary, made a few remarks on the history of the building. He mentioned that the name Aust carries the mind back to Roman times, and was associated with the Emperor Augustus Cæsar. In the year 691 Ethelred gave some lands called Henbury and Aust. In 794 there was trouble about the Aust lands, for the King and noblemen of Mercia seem to have taken the lands, and a bishop named Ethelred got them back, and it was believed they had belonged to the place ever since. Very little was known of the early history of the church, and the name of the patron saint was altogether forgotten. It was sometimes called a chapel of ease, because it was in the tything of Henbury, and he (the speaker) was the assistant curate, although he had charge of this and another church at Northwick. The mother church was nine miles away. The present building dated back to the fifteenth century. Whether there was a church before he could not tell, but it was interesting to know that it was associated with Wyckliffe, who was Prebendary of Aust. He had a stall in the church at Westbury-on-Trym. The people of Aust were proud of the connection, and it would be seen that all the pews had " J.W." carved on them. In the church would be seen a key, which was said to have been used by Wyckliffe for letting himself into the church. This key is kept in a glass case. The registers date back to 1538, and are in a good condition. Attention was drawn to the font of fifteenth century work which was described as unique, there being only one other like it—at Chepstow—and Mr Lough suggested that both might have been made by the same man. The church was restored in 1864, and although the rounded chancel arch has led some people to speculate on its having a Norman origin, Mr Lough was inclined to connect it with the restoration. The tower appears to be older than the main building, and although not comparing with that at Thornbury, possesses some good windows. The handsome chalices exhibited by Mr Lough were admired, and that gentleman was thanked for his courtesy.

TOPOGRAPHY AND GEOLOGY

The route from Thornbury to Aust was first over the high ground, originated by the hard Carboniferous Limestone, whence fine views were obtained of portions of the Severn estuary, backed by the wooded hills around Chepstow, and then over the diversified ground, which owes its undulations to the variety of rocks composing it. The brakes stopped at the top of the hill at

Aust, and the Members alighted to see lying, shining in front of them, the waters of the Bristol Channel. From the end of the old stone pier they looked northward across stream, and saw from north to south the hills at the southern end of the Forest of Dean, Tidenham Chase, Sedbury Cliff (the complement of Aust Cliff), the Beachley Peninsula with the dark Wyndcliff beyond. Out in the stream was the historic rock with St. Tecla's little chapel thereon; and further south, on the opposite bank, one of the pumping stations for the Severn Tunnel. Portishead Hill stood out boldly, and the position of the Avonmouth Docks was indicated. Turning towards the cliff, Mr Richardson said that the section there displayed was one of the most famous in the country. It showed, in ascending order, the Red and Tea-green Marls of the Keuper, the black shales and associated hard bands of the Lower Rhætic, the greenish marls of the Upper Rhætic, with the basement limestones of the Lower Lias on the top. The most notable bed in the section was the Bone-Bed, whence Higgins obtained such a number of

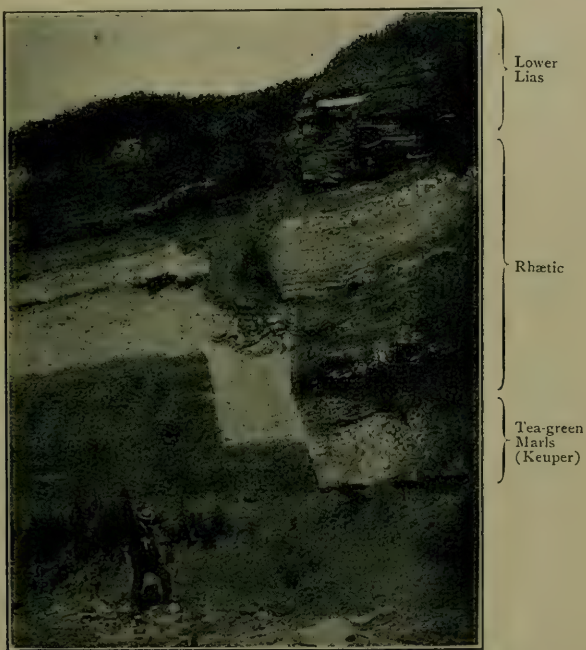


Photo. S. H. Reynolds.

Fig. 1.—Step-fault, Aust Cliff.

Ceratodus teeth. A beautiful "step fault" was pointed out (fig. 1), and the only regret was that the Members had not a longer time to spend in this pleasant spot.

HALF-DAY EXCURSION TO PAINSWICK AND KIMSBURY CASTLE

SATURDAY, JUNE 29th, 1912.

Directors: ST. CLAIR BADDELEY *and* L. RICHARDSON.

(*Report by* W. THOMPSON *and* L. RICHARDSON).

The Club have visited Painswick on several occasions. First, when the late Dr Thomas Wright, Mr W. C. Lucy, Mr Edwin Witchell and other early workers in the field of geology were in the heyday of their strength, and subsequently when Mr St. Clair Baddeley, then a new local worker in archæology and folk-lore, acted as conductor, and laid the Club under a debt of gratitude for his interesting contribution to its transactions. A return visit was made on Saturday—a half-day excursion—and we venture to think the occasion will rank among the pleasantest and most profitable in the Club's history. For this Members had again to thank Mr St. Clair Baddeley, who with mind enriched with additional information concerning the Church, the Court House, and Painswick itself, delivered several addresses of absorbing interest, and also induced his friend, Mr Marsland, the owner and occupier of the Court House, to enter the ranks of speakers, and justify the apprenticeship which he admitted having served under the guidance of Mr Baddeley. Those present included the Rev. Walter Butt (President), Mr L. Richardson (Hon. Secretary), Dr R. C. Affleck, Messrs C. Bowly, C. Upton, F. H. Bretherton, C. G. Clutterbuck, S. J. Coley, T. S. Ellis, G. Embrey, C. Curtis, J. M. Collett, O. H. Fowler, E. P. Little, B. G. Geidt, J. W. Skinner, A. J. Stephens, A. E. Smith, W. Thompson, E. N. Witchell, etc.

The party from Cheltenham and Gloucester were somewhat late in arriving at Painswick, so Mr St. Clair Baddeley having drawn attention to the large number of handsome tombs in the churchyard, exhibiting as they do many examples of slab, altar and octagonal, decorated with garlands, cherubs, shield and scroll, and mentioned that many of them were the work of John Bryan, a local sculptor of great talent, invited the party to accompany him to the stocks. Several Painswickians, including Mr Frith and the Rev B. Oddy, and some ladies were also present, and evidently appreciated the proceedings. Mr Baddeley said the old stocks originally stood at the north gate in company with the whipping-post. The iron stocks which now stand on the south side of the churchyard were removed from the former site. In 1861 they are locally reported to have been used for the punishment of a man who entered the church during service the worse for drink. Acting under orders, the constable took the man in custody, and padlocked him in the stocks. Unfortunately, the key became mislaid, and, after the service, it could not be found. This resulted in unpleasant consequences to the prisoner, who could not be liberated until the iron stocks had been filed through.

THE CHURCH

Speaking inside the church, Mr Baddeley said the story began with the Domesday Book. In the entry Painswick was spoken of as Wyke, and in the first instance the Church meant the Lord of the Manor, it being his possession and built most probably at his expense. Walter de Laci, who was prominent at the Battle of Hastings, was rewarded by the King with 62 manors, that of Wyke being the largest portion of his property, viz., 20,700 acres. Therefore it was most important that there should be a church at Wyke. Possibly there was a Saxon Church before, seeing that at the neighbouring, but less important, Miserden, both the south and north doors of the Church contain Saxon work. In looking through old documents he came across an entry which showed that in 1152, just before Henry II. began to reign, a composition was made concerning two interesting buildings, Llanthony Abbey in Wales and Llanthony in Gloucester. Hugh de Laci, who succeeded his father, was the founder of the great Llanthony, and he gave Wyke to the Monks at Abergavenny. He was, therefore, surprised to find that in the 14th century the Canons at Llanthony at Gloucester were presenting Vicars to Painswick Church. Hugh de Laci had confirmed the Church to Llanthony in Wales, and yet later vicars owed their appointment to the Gloucester Priory. Since then, as he said, he had got hold of a composition which occurred about 1152, by which Painswick Church was handed over to the Gloucester Priory. In addition to that, whilst he and Mr Marsland were overhauling the wall which lay between the Church and Mr Marsland's house, they found a stone which had Norman moulding on it. Moreover, in a heap of stone which came from under the floor of the Church during the alterations in 1883, he had discovered a piece of a Norman arch with the typical sunken star on it. The present building commenced to be built at the end of the 15th century, and another church at Haresfield, which belonged to the same Monastery, had the same double chancel feature. The meaning of this was—or at least it was quite possible—that the two chancels were the size of the original church. Small as it would have been, it must be remembered that the church at Kempley was only 60 feet long, and the first chapelry at Stroud only 33 feet long. The whole of the Norman Church had vanished, but there was sufficient evidence, in addition to documentary, to show that one existed. The chapel at the end of the north aisle was dedicated to St. Peter, and was believed to represent the ancient chapel of the same dedication. The great features, therefore, of the rebuilding in Henry VII's. time were the large nave, the north aisle and the western tower. Reference was then made to the Seaman tomb, the effigies being those of Dr John Seaman and his wife, who lived in the Court House close by. The tomb originally belonged to one of the Talbot's Lords of the Manor. It then became appropriated by Sir Wm. Kingston, the base being much older than the effigies resting upon it. It was clear that this Kingston monument has, since a hundred years, been used as a repository for Dr Seaman's monument. Sir William Kingston died at Painswick in 1540. A hundred years afterwards the soldiers of the Commonwealth and of Charles I. were engaged in fierce conflict in and around Painswick Church, and according to Mr John Theyer, who is said to have been buried in Brockworth churchyard, and who was a descendant of the last Prior of Llanthony, the soldiers tore the brasses off the wall at the back of Sir William Kingston's tomb, broke up the carved work, and no doubt demolished his effigy, but in the wall behind the figures of Dr Seaman and his wife were proofs of the brasses which once stood there. This was an illustration of the want of respect one generation had for another. The speaker alluded to the connection of the Talbots and Lisles with the Manor of Painswick, and the tragedy of the battle of Nibley Green—the most famous of family quarrels between Thomas Talbot and the then Lord Berkeley, his cousin. The Berkeley warriors were victorious, and Lord Lisle, Lord of the Manor of Painswick and Wotton-under-Edge, was shot. The quarrel was over the possession of Berkeley Castle. Mr St. Clair Baddeley suggested that as Lord Lisle could not be buried in Wotton Church, seeing that Lord Berkeley's men were pillaging in the district, and even took the dead Viscount's house "over Lady Lisle's head," the body was brought to Painswick Church and there buried. The altar of George II., with its handsome Ionic pillars, was perhaps the finest thing in the church, and deserved a better position. Reference was made to the famous peal of 12 bells and the Ancient Society of Ringers connected with the town, and, pointing to the wall of the new south aisle, the speaker said that for some curious reason or another, one or two stones of a much older date had been inserted, one bearing a portion of the ten commandments upside down. He had something to say about the Gyde memorial, but the font bearing the date 1661 did not require special notice. The excellent work of Painswick stone-cutters and masons of days gone by was praised, and regret was expressed that so little was done to protect their handiwork as displayed in the churchyard from the mischievous attentions of children.

Allusion was made to the similarity between the effigies of Dr Seaman and his wife and an effigy to be seen in St. Lawrence, Stroud, and the opinion was expressed that they were the work of the same pair of hands.

On leaving the building attention was drawn to the gargoyles, which were said to bear a family likeness to those more famous ones at Winchcombe.

THE COURT HOUSE

Halting outside the churchyard, to the north of the Court House, Mr Baddeley spoke of the struggle which took place on that spot between the King's forces under General Vavasour and those under General Massey, who had occupied the Court House and Church for the Parliament. The lieutenant in command of the Parliamentary forces had mistaken the power likely to be used against him. He fortified the big stone house near the church, by a breastwork which included the church. Sir William Vavasour was expected to arrive on the south side of the town, but appeared on the north with two small canon, which he used on the church, where soldiers had been stationed. Grenadoes and torches were presently thrown through the windows, and some men were slain in defending the place and the rest taken prisoners. Accounts differ as to the numbers.

A move was then made to the Court House, where the party were courteously received by Mr Marsland, who led the way to the terrace, and pointed out certain grooves cut in the stone coping of the old garden-wall, which may have been used as resting-places for the firing pieces of the defending soldiers. Speaking of the house, Mr Marsland said it was an interesting specimen of Cotteswold architecture of the late 16th century, and early 17th. It was spoken of as a mansion house, the greater part, according to Mr Baddeley, having been built about 1595, but the porch was added in 1604. Dr Seaman bought the house after 1608, and proceeded to make an addition on the south. Strong buttresses, however, had soon to be erected, and one of these took the form of an oriel window, now one of the most beautiful features of the building.

Entering the building, Mr Marsland led the way to the billiard room, a fine oak panelled chamber, with a large stone fireplace, which had been hidden behind a wooden screen, which latter the owner took down and reset. Mr Baddeley said it was clear that when King Charles visited Painswick the Court House was occupied by a copyholder, the Lord of the Manor being Sir Ralph Dutton, who lived at the Lodge some distance from the Court House. Sir Ralph had been Sheriff of Gloucester. He was a personal friend of the King, a Lord of the King's Bed-chamber, and he (the speaker) had come to the conclusion that it was with the Lord of the Manor the King stayed when he came to Painswick, at the Lodge. Mr Baddeley passed in review the movements of the King prior to and after the raising of the siege of Gloucester, and referred to the order issued by the King, which is now in possession of Mr W. H. Herbert " from our Court at Payneswicke," commanding that no manner of violence, injury or harm, should be done to the property of his subjects by his soldiers. Mr Baddeley mentioned that a few years ago he came across an entry in which General Massey sent a bill to Parliament for £2240 for scouts, and deduced from this fact that the King was worsted at Gloucester because of the superior intelligence the defending General was able to obtain. He also said that Sir Ralph Dutton, the King's friend and host, settled Standish Manor upon his daughter, and that the Manor still belonged to the Duttons. [W.T.]

From Painswick the party proceeded to

KIMSBURY CAMP

or rather to the Gloucester road, which passes on the west side of the camp. Here a halt was called, and the Hon. Secretary gave a short description of the geology of the district.

Mr St. Clair Baddeley said that close upon forty years ago metatarsal bones of *Rhinoceros tichorinus* were found in the hill-wash exposed in the gravel-pit at Paradise, a hamlet one mile north of Painswick. The bones were identified by Professor James Buckman, and came into the possession of Edwin Witchell. The gravel occurs at about 600 feet above sea-level. "The gravel-pit," continued Mr Baddeley, "is already mentioned as 'sandepytts,' in 1430."

Mr Richardson said that the occurrence of the remains of Rhinoceros at such an altitude was very interesting, and enquired if Mr Baddeley had heard of the discovery of any other fossil bones in the neighbourhood of Painswick, but Mr Baddeley replied that he had not. [L.R.]

The afternoon was now far spent, and as a storm was brewing in the west, it was deemed advisable to proceed with all despatch to Kimsbury House, where Mr J. M. Collett had invited the party to partake of tea. The brakes and motor-cars were scarcely in motion before the rain came down in torrents, and very glad they all were to find shelter in Mr Collett's delightfully situated home. Here, with the assistance of his wife and other members of his family, Mr Collett played the part of genial host, and after tea had been served, opportunity was taken of an improvement in the weather to admire the extensive views on the north and west. Thanks were tendered to all who had ministered to the enjoyment of the Members, and in particular to Mr St. Clair Baddeley.

EXCURSION TO BRIDPORT, DORSET

TUESDAY—THURSDAY, JULY 16th—18th.

Directors: L. RICHARDSON AND THE REV. H. J. RIDDELSDELL

(*Report by the President and Directors.*)

The long Excursion of the Club for 1912, was held in the Bridport district, those participating in the excursion being the Rev. Walter Butt (*President*), Mr L. Richardson (*Honorary Secretary*), Lieut-Col. J. C. Duke, Messrs F. H. Bretherton, J. M. Collett, G. M. Currie, O. H. Fowler, B. G. Geidt, J. N. Hobbs, E. Lawrence, E. P. Little, J. G. Phillips, A. E. Smith, A. J. Stephens, the Rev. H. J. Riddelsdell, and several visitors.

Monday afternoon was devoted by an advance party consisting of the President, Hon. Secretary, the Rev. H. J. Riddelsdell (the well-known botanist) and Mr A. J. Stephens, to botanising. [L.R.]

To people who live and botanise in Gloucestershire, especially in the eastern parts, the soil, scenery, and flora of the heathlands around Bridport and Axminster is something entirely fresh. The advance party motored out from Bridport to Axminster and first of all searched for the well-known Axminster plant, *Lobelia urens*. It was found, in great quantity, over a small area. It is a tall much-branched species easily reaching two feet in height. It tapers off from a bulky base into rather whippy spikes of blue flowers of the typical Lobelia kind.

After tea in Axminster, Champernhayes Marsh, between three and four miles to the east of the town was visited. This bog contains a considerable quantity of *Sphagnum*, which accounts for the occurrence of the little parasitic orchid *Malaxis*; but it was too early for it to be in bloom. To the Gloucestershire eye, the plants which were most unfamiliar were the three Sundews, the Bog Asphodel, the white Beak-rush (*Rhynchospora alba*) and the Butterwort (*Pinguicula lusitanica*). The Bog Asphodel (*Narthecium*) was in extraordinary abundance. The botanical relations of this plant are interesting; its nearest congeners are the liliaceous plants with their varied types of scent. Its foliage is of a peculiar tender green and very soft and pleasant to the touch. When picked, it lasts much longer than most wild flowers. The Sundews were in quantity; but it was necessary to get on to the bog to see them. The white Beak-rush is a local sedge and worth mentioning because of its very neat and tidy appearance.

The other plant mentioned, the Butterwort, is not the same as that which occurs in very great quantity on the Cotteswolds; what was seen was *Pinguicula lusitanica*—a western plant, as its name endicates. Many other plants were noted. *Ranunculus Lenormandi*, a little water or mud buttercup with white flowers; *Viola palustris*, the Marsh Violet; *Lychnis floscuculi*, Ragged Robin; *Hypericum elodes*, the Bog St. John's wort; *Ulex Gallii*, the Western Gorse; numerous very beautiful and luxuriant forms of Bramble: not the Marsh Cinquefoil, however, nor the Grass of Parnassus. Also, the Marsh Pennywort, *Hydrocotyle*; the soft thistle of peaty moors; the beautiful *Anagallis tenella* or Bog pimpernel; two forms of the Eyebright (*Euphrasia*), very distinct in appearance; the Skull cap, *Scutellaria minor*; the little creeping willow, *Salix repens*; the great *Orchis latifolia*, almost entirely in fruit; *Potamogeton polygonifolius*, a favourite pond-weed of the heathlands; and several of the sedge family, especially three species of the Cottongrass, one of which, *Eriophorum vaginatum*, is not recorded for Dorset in the second edition of Mansel Pleydell's Flora. There were very few species of ferns, but a little bed of stunted *Equisetum maximum* was seen at the lower part of the bog.

On Tuesday morning the President and Mr Riddelsdell went to West Bay (Plate IV., fig. 1) and botanised on the little sandy and gravelly tracts around the docks and shelters. The most notable feature was the abundance of little rough clover, *Trifolium scabrum*—a species rare in Gloucestershire. It is partial to seaside places, though not quite indiscriminate in its partiality, for at Seatown not a vestige of this plant could be seen. It was entirely replaced by another and odder species, viz., *Trifolium fragiferum*. The heads of this species swell in fruit into a curious form, which to our forefathers suggested strawberries. Other interesting plants at West Bay were the true Samphire (*Crithmum*), which is turned into a pickle by some people. The plant is said never to grow below high water level. A peculiar species of knotgrass (*Polygonum*) confined to the coast, and not at all common, was growing on the sand; perhaps more interesting is the fact that one of our commonest plants, the Curled Dock, appears in a peculiar seaside development—its branches are shortened and its fruit sepals show their tuberculous swellings (one on each sepal) instead of only on one. There are many plants which are changed by proximity to the sea not only in vegetative characters, but also in important floral points. The common Herb-Robert, for instance, occurs on the Chesil Beach in great quantities; but there it is not a struggling climber amongst other vegetation, but a small, round, very condensed plant, with a long brownish-red diaphanous central taproot. The flower is reduced, and the characteristic smell is modified for the better. But, besides all this, there are differences in the colour of the stamens, character of the fruit, &c., which cannot be so easily explained by environment. Moreover, the same common species varies differently in exactly similar situations on different

Photo. E. C. Hare.

Fig. 1.—WEST BAY, near BRIDPORT (looking eastwards.)

(The cliffs are of Yeovil Sands, capped with Inferior Oolite.)

Photo. E. C. Hare

Fig. 2.—BURTON VILLAS, CLIFF AND GOLDEN CAP.

(The White Limestone occurs *in situ* in the cliff to the right of the tents in the centre of the picture.)

parts of our coasts. Why such varieties occur it is hard to say. Why for example should a glabrous and a hairy form of *Silene cucubalus* exist side by side on the same plot of ground? Environment does not explain such problems. There must be something in the vital powers of the plant which prevent it from being absolutely stable and make for change. This of course is no explanation, though it excludes an explanation which is false. West Bay also produces the beautiful Sea Holly (*Eryngium maritimum*), two seaside species of Agropyron, viz., *A. pungens and A. junceum*, *Medicago maculata*—(is this what is meant by Calvary Clover? It has a purple spot in the middle of each leaflet)—*Carduus tenuiflorus*, *Glaux* (the Sea Milkwort), *Honkeneya*, &c. [H.J.R.]

The main party arrived at Bridport by the 1-55 p.m. train. Headquarters were at the Bull Hotel.

The present population of Bridport is about 6,000. The town is a municipal borough and an important market town.

The records of the town's history are fragmentary in character, but it is interesting to note that as far back as the time of Edward the Confessor it contained a mint, 120 houses, and a priory of monks, and it was a place of considerable importance at the time of the Norman Conquest. In the days of the Plantagenet kings, it was noted for its hempen manufactures and, at one period, all the sails and ropes used in the navy were produced in this town. It is also an interesting fact that nearly the whole of the cordage and canvas for the fleet fitted out to do battle with the Spanish Armada was made at Bridport.

The earliest Charter of which any certain memorial remains was granted by Henry III. in the year 1252. The place was held alternately by the Royalists and the Parliamentarians during the Civil War, and here Charles II, had a narrow escape from Cromwell's troopers. He had ridden over from Charmouth and halted for a short time at the "George Inn," only to find the yard full of Cromwell's soliders, and he made a hasty escape along the Dorchester Road, turned down Lea Lane (a large stone at this spot commemorates the incident), stayed a night at Broadwindsor, returned to Trent, and finally got across the Channel to France in a coasting vessel from Shoreham. The site of the old "George Inn" is now occupied by Messrs Beach & Co., chemists, and part of the old building still remains.

The town was surprised and startled one Sunday morning in June, 1685, when 300 of Monmouth's soldiers made a descent upon it from Lyme Regis, the Duke having landed at the latter place on the ill-fated mission to seize his uncle James II.'s crown.

Shoe-thread, twine, cordage, sail-cloth and fishing nets still employ many busy hands. Comparatively modern industries, such as the making of excellent butter and jam—commodities exported in large quantities—and a large Brewery, also add to the town's commercial prosperity."[1]

CHIDEOCK AND SEATOWN

After lunch the Members set out in brakes for Chideock Quarry Hill. The weather was extremely warm, but on top of the hill there was a pleasant breeze, and a magnificent view.

The Hon. Secretary, Mr L. Richardson, pointed out the features of interest in the landscape, stating that the excursion had been arranged so as

1. Extracted from The "Borough" Guide to Bridport.

to give the Members an opportunity of becoming acquainted with western Dorset, and more particularly with the coast line between Charmouth and Portland. He said there was a great variety of rocks in the district they were to investigate, and in places they were very much faulted. For this and other reasons it was difficult to describe in a few words the precise origin of the varied scenery around them. The main point, however, is that the Upper Greensand transgresses from east to west the basset edges of successively older deposits. Thus at Thorncombe Beacon to the east of Seatown it rests upon the Upper Lias Sands, or as they are called in this neighbourhood, the Bridport Sands; but at the flat-topped Golden Cap on the west, on the Middle Lias.

Chideock Quarry Hill is capped with Inferior Oolite, but here and there are masses of Fullers' Earth, which have been preserved by having been let down by faulting. Quarrying operations have been very extensive in the past, but now only one quarry is in work.

The first section examined was that in which the Fullers' Earth is seen. At its base was observed "The Scroff," a rich brown and purplish clayey marl, 4 to 6 inches thick, resting upon the *Zigzag*-Bed, which is a rubbly bluish, ironstained limestone, full of ammonites (*Œcotraustes* cf. *serrigerus* Waagen, etc), *Collyrites ovalis*, *Terebratula stephani*, etc., on an average 3 inches thick. Below come limestones of *schloenbachi* date—the rock for which the quarry was opened.

Mr S. S. Buckman did not detect "The Scroff," or *Zigzag*-Bed here nor the layer of *truellei* date.[1] As he remarks, the limestone of this date at Burton Bradstock contains abundantly a small variety of *Terebratula sphæroidalis*.[2] In one of the old workings near the only quarry now in work on the hill, however, pieces of limestone full of such small examples of this *Terebratula* were seen, and if—as seems probable—they indicate a deposit of *truellei* date the sequence of the "Top-Beds" here comes into line with that at Burton Bradstock.

The second section examined was that in the only quarry now in work on the hill.

In it, at the top, is rubble of the basement-bed of the "Top-Beds" Below it come the "Red-Beds," The top foot is more of a limestone, is grey and not rich brown and ironshot like the remainder of the deposit. The "Red Beds" are joined on to the rock of *murchisonæ* date, which is one foot thick.

Descending the wheel-track, the Members saw at a level only a few feet below that of the floor of the quarry, an exposure of the Bridport Sands, here rich in specimens of *Rhynchonella pentaptycta*, S. Buckman, *Variamussium læviradiatus* (Waagen) and *Serpula*.

Thus here between the Upper Lias Sands and the limestone that is equivalent to the *Clypeus*-Grit of the Cotteswolds there are only a few feet of rock—a very different matter to the great thickness of strata as seen at Leckhampton Hill. From the hill the Members proceeded to Seatown on the coast.

The heat did not stimulate the party to walk along the shingle to the place below the Down Cliffs, where blocks of the curious "transition-bed" at the junction of the Middle and Upper Lias occur. Instead, they spent the time leisurely, each one according to his own inclinations. The botanists were active, however, but both Chideock Quarry Hill and the coast near Seatown, were singularly unproductive of rare plants, though a bit of the beautiful vetchling, *Lathyrus sylvestris*, was seen at the road side, and some Alexanders near Seatown. There was, however, a real interest in tracing the poverty

1. Quart. Journ. Geol. Soc., vol. lxvi. (1910 p. 57. 2. *Idem.*, p. 73.

of the flora to the occurrence of the Lias clay at Seatown. The cliffs slide badly, sometimes in such masses as to hold up quantities of water. In one such instance, a considerable marsh had formed below the cliff top, and an ordinary marsh flora had collected :—*Equisetum maximum*, the Willowherbs, *Apium nodiflorum*, *Veronica Beccabunga*, Sedges, and others.

ABBOTSBURY

Wednesday was given up to a visit to Abbotsbury. Leaving Bridport about 9-30 a.m. the Members arrived at Abbotsbury about 12 o'clock. The road is an up and down one, but the drive was very pleasant, and fine views were obtained of the sea and coast-line from near Lyme Regis to Portland. At the commencement of the steep descent from near the old earthwork called "Abbotsbury Castle" the village of Abbotsbury came into view—the church and well-known tithe-barn, St. Catherine's ruined chapel on the hill, the waters of the "Fleets" (impounded by the Chesil Beach) and Portland in the distance. Before lunch the church, tithe-barn and remnants of the monastery were visited.[1] [L.R.]

"MONASTIC BUILDINGS.—If we did not know that the phrase referred to something very different, we should say that the proverb 'as sure as God is in Gloucestershire,' pointed to the great number of Religious Houses in our County, compared with others. I do not think the statement is true, speaking of the Religious Houses as a whole, and certainly if one has in mind the early—say the pre-Norman ones—it is false. The pre-eminence is with Dorset in this respect. If we have four or five Houses of Saxon foundations, Dorset had nine founded during the Saxon period. Abbotsbury, Cerne and Milton continued after the Norman Conquest to be Benedictine Abbeys.

The character of the remaining six (for there were nine of the pre-Norman establishments) was altered. One, the Abbey of Cranbourne, survived as a Priory dependent upon our own great Benedictine Abbey at Tewkesbury. Coker, in his Survey of the Countie of Dorset, quoting the Register of the Monastery (unfortunately destroyed with the mansion house of the Strangeways at Abbotsbury—a destruction we shall later on refer to), says that 'here was built in the very infancie of Christianity among the Britains a Church to S. Peter by Bertufus,[2] a holie priest to whom the same Saint had often appeared and among other things gave him a Charter written with his own Hande.' The Apostle professed in the Charter, 'to have consecrated the Church himself and to have given it to Name Abodesbury.'

Afterwards King Knut (Canute) came on the scene—this would be between 1017 and 1035—and gave Abbott to Sir Ore, his housecarle or steward of his palace.

This Sir Ore, or Orc, or Orcus, Orcy Orking, or Urce, with Tola or Thola, his wife, gave, so we read, other lands (granted to them by Cnut) 'to the Church of St. Peter at Abbots, long before built but then decayed and forsaken by reason that the Rovers from the sea often infested it.'

The date of the foundation differs by 18 years according to the authorities I have examined. Reyner in his history of the Benedictines in England, gives the year 1026, and so does Dugdale and Tanner, who adds that Orcus instituted a Society of secular Canons here, which he or his widow changed to a Monastery of the Benedictine Order in the reign of Edward the Confessor.

[1. In his Presidential Address to the Club on January 21st, 1913, Mr Butt gave an outline of the history of the Monastery and details of St Catherine's Chapel. These observations are printed in this account of the excursion, as it is thought desirable to have all the matter relative to the Bridport Excursion together.—L. R., Ed.]

2. Others give his name as Bertulfus.

But Coker states that the Monastery was built in 1044, and 'stored' with Benedictine Monks from Cerne.

It would seem from the rules drawn up by Orcus, for his gild or lay fraternity of St. Peter's at Abbots, that a society existed here previously, which later was converted into a Monastery.

William the Conqueror confirmed what Edward had done and Henry III. confirmed all the Charters granted by William, Henry I., Stephen and Henry II.

In 1315, Edward II.'s time, there was a dispute over a *crassu spiscis* (?whale) and the King confirmed the right of the Monastery to the wreck of the sea.

And so on and so forth down to 1353, when grave complaint was made against the Abbot Walter de Stokes. He was removed by the King, and Bishop of Sarum, and died in 1354. In the 15th century we do not hear much. At a visitation by Bishop Chandler, the Abbot Roger Roddon, was warned that as 'wine and women cause men to err,' he was to buy as little wine as possible and give it out in small vases—vessels. And women were to be kept out.

In the valor of 1535, the income was taken to be £401. Roddon surrendered the Abbey in 1539, and with eight of his brethren received pension of £80. The value was then taken to be £480; but this, for some reason or other seems to have been too low a valuation. The Strangeways family who purchased the buildings and Abbotsbury lands from Henry VIII, for £1096 10s. come into view first in 1505, when a charity was founded in the Chapel of St. Mary within the Abbey by Thomas Strangeways, the Executor of his late wife Alianor. They were the ancestors of the present owner, Lord Ilchester.

Very little of the Monastic buildings now remain. The alterations and rebuilding by the Strangeways, necessary when they made a mansion for themselves on the site, accounts for that.

If the last Monastic edifices were built on anything like the same majestic scale as the great tithe-barn, there must have been a group of buildings of surpassing magnificence. The barn is 276 feet long, with walls 3 feet 3 inches thick, and its width is 31 feet. The eastern part is roofless, but the western end is very perfect. Its date I suppose would be about 1350. The great porches or doorways, the two on the North being much finer than the two on the South, resemble the Transepts of some great Cathedral.

The Church, the conventual one, seems to have been 192 feet in length, by 54 in breadth, within the walls. Eastward of that are traces of a building which may have been the Choir, or the Lady Chapel, of which Coker speaks. Scraps of vaulting-ribs, bosses, bases of piers, and shafting, tell of 13th, 14th and 15th century work.

The lofty gable end, covered with ivy, otherwise the Pinion end, was no doubt part of the Strangeways mansion. This was held for the King by Sir T. Strangeways in the Great Rebellion. Sir Anthony Ashley Cooper in September, 1644, after desperate fighting, took the Church and burnt the house. A letter is extant from the head of the Parliamentary Forces in which he speaks of the 'business being extreme for six hours.' Lighted furzen faggots were pushed into the lower windows, the defenders' magazine blew up, and the end came.

The Church was as gallantly defended as the house, and had to be specially stormed by a party of musketeers. The Members saw evidence of their presence in the bullet-holes in the fine Jacobean pulpit.

With one exception, beside this pulpit and the effigy of an Abbot—not surely a coffin-lid—put up in the porch, there is not much of note in the Church. It is much disfigured by an altar-piece erected in 1751.

Photo. E. C. Hare.

Fig. 1.—CLIFF immediately west of Burton Freshwater, Pier at West Bay, with Golden Cap (the flat-topped hill) beyond.

Photo. E. C. Hare

Fig. 2.—CLIFF AT WEST BAY.

(The cliff is mainly composed of Yeovil Sands, and only capped with Inferior Oolite.)

The exception is this, and most worthy of the attention of anyone visiting Abbotsbury. It has I think, been called the most noteworthy object, now to be seen. Over the West window is a sculptured stone, representing the Blessed Trinity. It cannot be much later than 1200, and it might well be earlier. It is much weathered, and is difficult to describe. The Holy Father appears to be seated on a central canopied throne. He is bearded, nimbed, and his right hand raised in the act of giving a benediction. A curious kind of lippet, fastened by a brooch, or "morse," as we should call it if the garment were a Cope, is across His chest. The Holy Son is extended on a small Latin Cross resting as it would seem against the knees of the Eternal Father. His feet rest on a globe. The Holy Ghost, in guise of a Dove, seems to be whispering into the right ear of the Principal figure. Altogether it is one of the strangest sculptures in existence. Some have seen in it more than I saw, to wit, on the arch moulding of the stone a branch of the Tree of Life on the dexter side, and on the sinister, a grotesque animal." [W.B.]

After lunch most of the Members visited the celebrated gardens belonging to Lord Ilchester, the swannery and decoys, and St. Catherine's Chapel; while the President and Mr Riddelsdell botanised on Chesil Beach. *Lathyrus maritimus*, the beautiful sea-pea, was there in enormous quantities and good fruit. The pea is very sweet to the taste; though small, it would do as well for the table as any of our cultivated forms. It was used largely on the Suffolk coast at one time, during famine. Flocks of pigeons were feeding on it on the Chesil Beach, and rose from their dinner as the botanists came along. A mile further on was the rare *Suæda fruticosa*, a relation of the Goosefoots, *Atriplex*, Spinach, &c. At that point, from the water of the Fleet, were procured quantities of *Zostera*, *Ruppia spiralis* and other plants. The *Ruppia* has its fruit growing on a beautiful spiral peduncle, the spire often having six or eight turns in it. [L.R.]

"St. Catherine's Chapel.—The conspicuous land mark of St. Catherine's Hill is crowned by one of the most beautiful perpendicular buildings in existence.

Buildings dedicated to St. Catherine—her of Alexandria and not of Bologna, Genoa and elsewhere—the St. Catherine of our Kalendar on November 25th—are often placed on hills, and the reason, however fanciful, is stated to be this. She was martyred about the year 307 by being fastened to a wheel set with knives and her body was then said to have been carried by angels to Mount Sinai and there interred. But Mr Hills, Secretary of the British Archæological Association, which visited Abbotsbury in 1871, suggested that as the name (Catharine) comes from the Greek καθαρός, *pure*, Chapels dedicated to that Saint were erected in high and isolated positions, where the air was purer than elsewhere; and even more grotesque reasons have been suggested.

Let us return to the building. It was built probably before 1450, though there may be traces of earlier work to be seen in it—the Piscina for example. It is 45 feet in length, and 15 feet in width (inside measurements), no wood whatever is used in its construction. It is wholly of stone, roof and all, and in this respect is resembled by very few, perhaps only four or five buildings in this country. One of these, singularly enough, is in this same county of Dorset. I am alluding to the Chapel situate on that grand promontory between Swanage and Weymouth with its sheer drop of 450 feet to the sea. This is almost always wrongly styled on maps and charts 'St. Alban's Head.' Of course, it should be 'St. Aldhelm'—the great and first Bishop of Sherborne (Founder of Malmesbury Abbey, circa 680), to whom the tiny little Chapel upon it is dedicated. It is used now regularly by the Coast-Guards as their place of Worship, and in the summer by visiting tourists. Tiny, I have called it, and so it is, only about a score can find accommodation in it. A quaint place with its squat central pillar and one little narrow slit of a window at the east. But to return to St. Catherine's Chapel. It is to be regretted that more care is not being taken of a building that ecclesiologists and architects have long catalogued as one of the architectural gems of the country. Landmark, beacon tower, and sailors' chauntry, it excites our admiration and interest. No doubt the three wishing holes in the doorway were noticed. The village girls still place a knee and both hands in these, and pray thus :

'A husband, St. Catherine
A good one, St. Catherine
A rich one, St. Catherine
And soon, St. Catherine.'

Let us hope that they are not disappointed !" [W.B.]

After dinner in the evening some of the rarer plants were shown to the Members and discussed.

BURTON BRADSTOCK

Thursday, from 10 a.m. to 3 p.m. was spent in the neighbourhood of Burton Bradstock. First the quarry in the allotment ground was visited. It shows the basal portion of the Fullers' Earth, "The Scroff" (as a thin bed is called), the *Zigzag*-Bed, and the strata of *schlœnbachi* and *truellei* date, rich in fossils. Next the road-cutting between the village and the sea was entered (Plate VI.) and the beds exposed in it made out. At the top of the section are beds similar to those seen in the lower portion of the quarry, and at the bottom, the Bridport Sands—a very fine section.

Arrived near the beach Mr Richardson pointed out the pieces of white limestone, concerning the date of which there had been some doubt.[1] Similar rock was seen *in situ* in the Bridport Sands round the corner to the right (Plate IV., fig. 2.).

After lunch at the Anchor Inn, the Members went to Burton Freshwater to see the cliffs there, and do some botanising. Here there are quantities of sea pink or thrift, and some small amount of the narrow-leaved Flax, and the little Centaury (*Erythrœa pulchella*). Finally a large amount of the Yellow Horned Poppy was seen, and a very small allowance of the Sea Kale —a plant which has become rare on our coasts, largely owing to its being dug up for gardens. One plant was a disappointment : the Seaside Convolvulus occurred in plenty, but none of it showed any sign of flower.

Returning to Bridport the majority of the Members left by the 4-30 p.m. train, after an excursion that was generally admitted to have been one of the best, if not the best, that the Club has held.

EXCURSION TO BATH AND BOX.

TUESDAY, SEPTEMBER 17th, 1912.

Director : THE REV. H. H. WINWOOD, M.A., F.G.S.

(*Report by* W. THOMPSON).

Twice before in comparatively recent times the Cotteswold Club has visited Bath, including an inspection of the Midford Sands, but on September 17th, in addition to renewing acquaintance with Aquæ Solis—that important Roman settlement, which from time to time has yielded up such interesting material for the antiquary—the following Members also travelled to Box and inspected some of the renowned building-stone workings which have

1. S. S. Buckman, Quart. Journ. Geol. Soc., vol. lxvi. (1910) pp. 69-71.

SECTION IN ROAD-CUTTING AT CLIFF HILL, BURTON BRADSTOCK.

(The Inferior Oolite is seen in the upper half of the section, the Bridport Sands in the lower.)

obtained for the district a world-wide reputation: Rev. H. H. Winwood, F.G.S. (Vice-President), L. Richardson (Hon. Sec.), E. T. Paris (Hon. Assistant Sec.), Lieut.-Colonel J. C. Duke, Messrs F. H. Bretherton, H. W. Bruton, Charles Curtis, A. J. Cullis, T. S. Ellis, R. G. Foster, O. H. Fowler, J. W. Gray, F.G.S., F. Hannam-Clark, H. Haigh, H. H. Knight, H. Knowles, E. L. Lawrence, H. McLaughlin, E. C. Sewell, J. W. Skinner, W. J. Stanton, W. Thompson, H. J. Weaver, etc.

The Members arrived at Bath at 12.10 p.m. Here they were met by the Rev. H. H. Winwood, who conducted them to the Pump Room and Roman Baths.

First of all, he reminded them that Bath was celebrated for its Roman remains. Indeed, probably there was no place in Britain where they were so fine as here, and very few continental places surpassed them in this respect. Directing attention to the pediment of a temple found in 1790, Mr Winwood dealt with the three theories advanced by way of explaining its original meaning. First they had the Sulinus-Minerva theory, the large head carved on the stone being supposed to have the characteristics of the Sun God and those of Minerva. Of the latter it was possible to point to Minerva's emblem of the owl and her helmet. Another authority said that it was the Gorgon's head or Medusa, and yet another held that it was Esculapius. Personally he lent to the Sulinus-Minerva theory. Another carved figure was undoubtedly Luna, the crescent near the head of the fair goddess being very conspicuous. Turning from these remains of an ancient temple, Mr Winwood conducted the party to the main bath, which is open to the sky, and for over thirty years has attracted a steady stream of visitors. He explained that whilst it was opened up in 1878, they must go back to 1755 for the first discovery. They were now standing beneath the open sky, but many years ago he walked through a drain situated above these remains, and it might interest them to know that there were eleven feet of lacustrine mud superimposed upon these old baths. They knew it must be lacustrine mud because of the shells taken from it. How long did it take for that mud to accumulate? The Romans left the district between 410 and 425, and the Saxons came in 577. The place was destroyed, but how, remains, and must remain, a mystery. It was absurd to suggest, as had been suggested, that an earthquake did it. As proving that it must have been a lonely, swampy place, it might be mentioned that a teal's egg was found there and forwarded to the British Museum. The level of the baths was 14 feet below that of the present streets.

The Members then proceeded to make a perambulation of the baths, inspecting one of the hot springs, and noting the solid masonry still remaining *in situ*, and testifying to the substantial nature of the structure. The daily out-put of hot water from the three springs is 507,000 gallons, and the temperature, 120 degrees as it rises from the earth, never varies.

After visiting the Pump Room and Corporation Baths, a move was made for Messrs Fortt and Sons' for lunch. In the regretted absence of the President, Mr Winwood presided.

At 2 p.m. the Members left Bath and motored to the Box Ground Stone Quarry of the Bath Stone Firms, Ltd. Here they were courteously received by officials of the Company.

"The tradition of the discovery of the famous stone at Box, known as 'Box Ground,' is not generally known. According to the legend, St. Aldhelm, a man of distinguished piety and virtue, being about to found the Abbey at Malmesbury, indicated, by throwing down his glove, the spot where stone might be found, or, to use the words of Aubrey, the learned Wiltshire antiquary:—'Hastlebury Quarre (*i.e.* Box) is not to be forgot; it is the eminentest freestone quarry in the West of England, Malmsbury, and all round the country of it. The old men's story that St. Aldhelm riding over there, threw downe his glove and bade them digge and they should find great treasure, meaning the quarry.' . . . . . St. Aldhelm also built the little church of St. Lawrence, at Bradford-on-Avon, probably the most perfect specimen of Saxon architecture in this country, of which the learned professor, Freeman, says :—' This, the one surviving old English Church in the land,' and probably the oldest English church in the land. The stone for this building was quarried from Haselbury. It seems only natural that such a keen observer as Leland should note the existence of these quarries, for in the account of his itinerary, he says ' I left the left hand on the toppe of a little hille a hermitage; withyn a little I turned down to Hasilbyre.' The quarries near Box have supplied stone for the erection of many other noteworthy and historic buildings. Among them are Lacock Abbey, and such magnificent mansions as Shockerwick, Bowood and Corsham Court. The Augustine Abbey of Lacock is situated in an old Wiltshire town about three miles south of Chippenham, on the high road between Bath and London. . . . . . . This structure is one of the best examples of a building of Bath stone, though much of the present building, and surrounding out-buildings, are 16th century work. Mr Breakspear states that the Abbey buildings were constructed with rubble walls of hard stone, and dressings of freestone, and was supplied from the Haselbury Quarre in the Manor of Box."[1] The Members entered the workings and went about a mile underground.

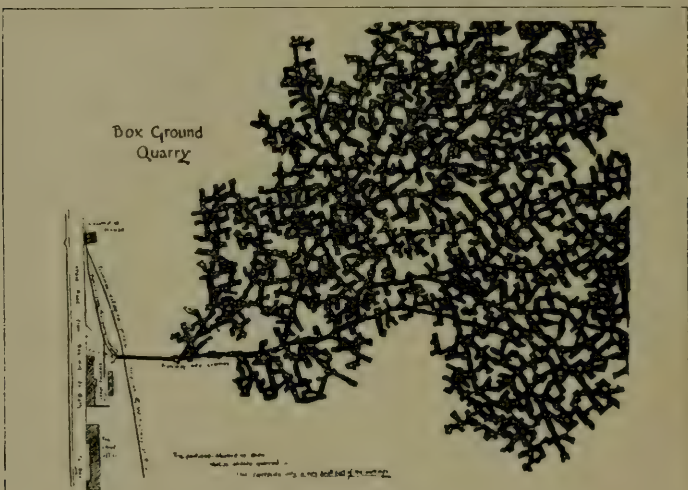


Fig. 1.—Plan of a portion of the underground quarries at Box. [2]
[The distance from end to end of the quarry is approximately two miles.]

The following account of the method of working the stone is taken from a booklet issued by the Firm :—[3]

1.—Extracted from a reprint of a paper by T. S. Cotterell, read at the Sixty-first Congress of the Brit. Archæol. Assoc., held at Bath in 1904.

2.—The blocks for figs. 1 and 2 were kindly lent by the Bath Stone Firms, Ltd.

3.—Other quarries of The Bath Stone Firms are situated at Combe Down, Hartham Park, Westwood, Bradford, Limpley Stoke and Kingsdown.

"One system of getting the stone prevails throughout the quarries, and this system is an inversion of the mode of working coal. The coal-miner in many mines undercuts his coal that the mass may fall and break, but building-stones so worked would make a valueless rubbish-heap. The freestone miner or quarryman has to commence his operations at the roof of the stone. This picking operation is effected by means of adze-shaped picks, on the heads of which longer handles are inserted as the work proceeds, and the men thus make their driving a distance of six to seven feet back into the rock. The width or span of these stalls must of course depend on the soundness of the rock. In the Monks Park and Corsham workings they can without danger be driven a width of 25 to 30 feet. In the Box Ground quarries, where the rock is not so sound, and the capping or ceiling bed not so regular, the drivings are limited to from 12 to 20 feet. This is, of course, regulated by the space that may be safely opened without danger to the working beneath. . . . . . Another process, by a fresh agency, is now called into exercise, for the cutting of the rock into blocks of required dimensions; for this, a one-handled saw is used. These saws are worked in lengths of four, five, six and seven feet, and are made broad deep at the head or

Fig. 2.—Sawing out blocks in the underground quarry.

extreme point, so as to ensure the saw sinking to its work at that point. The saw is worked in first horizontally, dropping a little as the cut goes on, and after the rock is thus opened down to the next natural parting, and the block thus separated laterally from the parent rock, levers are introduced into the bed or parting at the bottom of the block, and these levers are weighted and shaken till the block is forcibly detached at the back. It is then drawn down by crane power, and the broken end and the bed dressed with the axe, so as to make the block shapely; it is then placed on a trolley and allowed to run to the loading platform. After the first block is removed it is evident that the workmen have then access by that opening to the back of the bank of stone, and they avail themselves of this to work the saw transversely, which, separating the block from its back or hinder attachment, renders any further breaking off unnecessary, so the first block of each face is the only stone broken from the rock. To each face or heading of work, a 10-ton crane is erected in such position as to command the whole face. These cranes are now constructed telescopically, so as to accommodate them to slight variations in the headings, arising from differences in the depths of the valuable beds, and the expense otherwise attendant on frequent alteration of the crane is thus avoided, and the periodical shifts from old worked-out to new localities are effected with less trouble and loss of time. After a block of freestone has been loosened *in situ*, a lewis bolt is let into the face of the block, the chain of the crane attached to it, and the block is then drawn out horizontally. By the removal of the first stratum a sufficient

Fig. 3.—Crane removing a block of stone from the face of the underground quarry.

space is obtained to allow the workmen an entrance under the roof; and vertical cuts are again carried through the next bed to the parting below, and transverse cuts readily made; meanwhile the cutting is continued in the picking bed, the upper layer removed as before, and everything below this point quarried away, with all the sides of the block sawn, except the bed on which it has rested, and those abutting on the natural joints. Hence each block comes out ready to pass into the hands of the mason and builder."

From the quarry the Members motored back to Bath and caught the 4.35 p.m. train (M.R.)

NOTGROVE LONG BARROW[1]

BY

G. B. WITTS, C.E., J.P.

This interesting Barrow, hitherto unnoticed in any archæological work, is situated in the "Poor's Lots," one mile north-west of the village of Notgrove, adjoining the road that leads from Hawling to Bourton-on-the-Water, and four-and-a-half miles from the latter place.

The length of the Barrow was apparently 140 feet, and its greatest width 78 feet, the direction is north-west and south-east, the height of this part being only five feet, but originally it must have been quite ten or twelve feet.

The entire crown of the Barrow has at some time been removed, probably for the sake of the stone of which it was composed, and several large upright stones are exposed to view, forming a series of chambers very similar to those at Uley and Nympsfield.

The interior of the Barrow is composed of stones from the Oolite Freestone and Stonesfield Slate—a very large quantity of the latter being found, though it must have been brought from a distance, as there is none of this rock nearer than a mile from the Barrow.

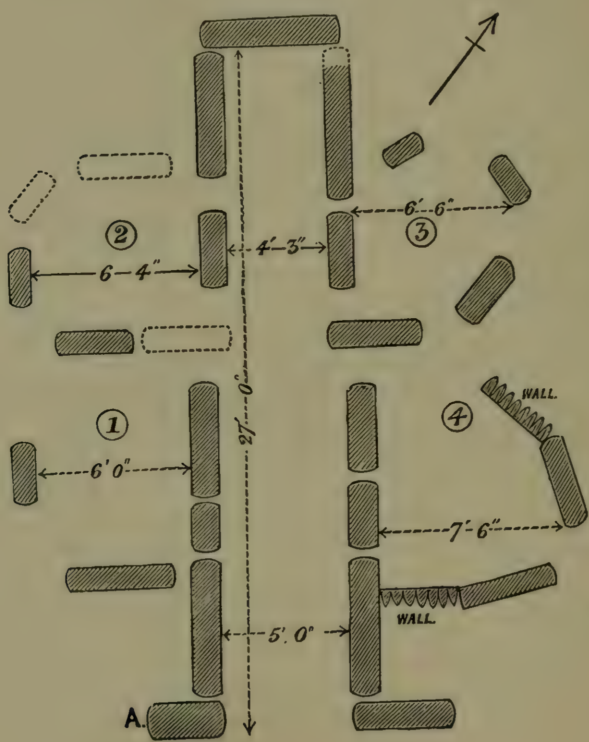
The Barrow is enclosed by a well-built wall composed of Stonesfield Slate. Towards the south-east end, at its widest portion, the width of the Barrow from wall to wall is 56 feet 6 inches, and here probably the walls assumed the horned shape, though they have not yet been thoroughly traced.

1. This paper is reprinted from *The Cheltenham Ladies' College Magazine*, for February, 1882, pp. 14-16.—*Ed.*

In examining the chambers of this Barrow in April, 1881, it was found that there were twenty stones still standing in their original position, and five others were prostrate and obviously out of place.

On reference to the ground plan given below, it is seen that there is a central passage with two chambers on each

PLAN OF CHAMBERS.



22 STONES IN POSITION.

side. The passage is five feet wide towards the south-east end, and four feet three inches wide towards the north-west; the extreme length of the passage being twenty-seven feet.

The first chamber on the west (No. 1 in the Plan) measures eight feet four inches by six feet between the stones. Chamber No. 2 measures six feet four inches by probably six feet. Chamber No. 3 somewhat different in shape, measured six feet across in each direction; and Chamber No. 4 measured nine feet six inches by seven feet.

The stone marked A, on plan, is five feet above the original surface of the ground, being three feet long and sixteen inches wide; some of the other stones are larger, and of the same thickness, but they do not stand so high. Only those stones standing in their original position, twenty-two in number, are shaded on the plan; the remaining four are shown by dotted lines, arranged probably near their original positions. During the excavation it was found that Chamber No. 4 had never been disturbed though the other three had been cleared of their contents; a careful examination was therefore made of it. Under a large flat stone, lying about twelve inches above the original surface of the ground, were found portions of two human skeletons in a contracted position; the skulls, which appeared to be lying towards the west, were broken into very small pieces, and being incomplete cannot be reconstructed; only one portion of a jaw contained any teeth, but they were in good preservation. The bones of these skeletons were much more decomposed and fragmentary than the bones found in the "West Tump," though of the same type and configuration. With these human remains were found also two teeth and the pelvis of some kind of ox, probably the *Bos longifrons*, one dog's tooth, a very perfect leaf-shaped arrow-head made of flint, a black oval bead one-and-a-half inch long (now in the Cheltenham Museum) composed of Kimmeridge Shale or of similar substance, having a hole through the centre of it made with a flint borer. This bead, though larger, resembles the one found in the Eyford Long Barrow, described in "British Barrows," page 519. Lastly, thirty pieces of rough British pottery, half baked and belonging to the same vessel, one piece only showing the form of the rim.

The spaces between the upright stones in Chamber No. 4 are filled up with well-built, very dry walls of Stonesfield Slate, explaining the construction of the other three chambers where the walls have been destroyed.

It thus appears that none of the large stones of this interesting series of chambers are missing, although five of them are prostrate and out of position.

The bottom of Chamber No. 4 was roughly paved with small flat stones of Stonesfield Slate well fitted together, and forming a level surface.

SOME INFERIOR-OOLITE BRACHIOPODA

[Plate VII.]

BY

L. RICHARDSON, F.R.S.E., F.G.S.

AND

CHARLES UPTON

(*Read November 6th*, 1909.)

There still remains a considerable number of brachiopods from the Inferior-Oolite rocks of England, which have not been described and figured.

The object of the present paper is to describe and figure a few of these.

We are deeply indebted to Mr J. W. Tutcher, of Bristol, for the photographs of the specimens reproduced in Plate VII.

EUDESIA DOULTINGENSIS sp. nov. Pl. VII., fig. 2.

T.l.[1] Doulting, Somerset.

Hor. "Top-Beds of the Inferior Oolite." ή. *schlœnbachi.*

Colln. L. Richardson.

Description.—Shell flabellate; pedicle valve slightly more convex than the brachial valve, with a conspicuous truncated beak, perforated by a rather large foramen, valves coarsely-ribbed and concentrically marked with neat halt-lines; ribs eleven or twelve in number on each valve.

Remarks.—Specimens of this brachiopod are not uncommon in the Rubbly Beds of *schlœnbachi* hemera at Doulting.

1. *T.l.* stands for "type-locality"; *Hor.* for "horizon"; *Colln.* for "collection"; and ή for "hemera."

In outline this form corresponds with the middle-age of a specimen figured by Szajnocha from Balin, under the name of "*Terebratula* [*Eudesia*] *neidzwiedzkii*" (Brach. fauna der oolithe von Balin bei Krakau, pl. V., fig. 12).

Since, however, Szajnocha's species assumes an elongate form after middle-age and all the specimens obtained as yet from Doulting are of the "middle-age" outline, we have deemed it desirable to give the Doulting form a distinctive name.

The outline of the present form separates it from the specimen of "*Terebratula* [*Eudesia*] *cardium*, Lamarck" as figured by Davidson (Monograph, pl. XII., figs. 13 and 13a).

ORNITHELLA CLEEVENSIS,[1] sp. nov. Pl. VII., figs. 4*a* and *b*.

T.l. "Sand-hole," near "Roadstone Hole," Cleeve Hill.

Hor. Lower *Trigonia*-Grit. ῃ. *Disciteæ*.

Colln. L. Richardson.

Description.—Shell elliptical in outline with a suggestion of subpentangularity and a tendency to become distinctly subpentangular in old age owing to the straightening of the anterior margin. Valves regularly convex. Beak prominent, but somewhat close to the umbo; foramen small; deltidial plates scarcely visible.

Remarks.—There is no other species of *Ornithella* in the Lower *Trigonia*-Grit of the Cotteswold Hills at all like the present species. The shell which it most closely resembles is *Ornithella hughesi* (Walker) from the Upper *Trigonia*-Grit. From it, however, the present species is distinguished by its usually more robust appearance, due to the greater convexity of the valves (particularly the brachial), and its tendency to assume a subpentangular outline.

Up to the present *Ornithella cleevensis* has been recorded only from the "Sand-hole" near the "Roadstone Hole" on Cleeve Hill, where it is abundant in the bottom portion of the Lower *Trigonia*-Grit along with specimens of corals (*Chorisastræa*, etc.).

1. From Cleeve Hill, near Cheltenham.

RHYNCHONELLA AURICULIFERA, sp. nov. Pl. VII., figs. 13*a*, *b*, 14*a* and *b*.

T.l. Crickley Hill, near Gloucester.

Hor. Pea-Grit. *ή. Murchisonæ.*

Colln. L. Richardson.

Description.—Shell small, the brachial valve being noticeably flattened in the umbonal region. The mesial fold has usually three ribs on the upper side, while the lateral areas have each of them three conspicuous and three inconspicuous ribs. The beak is well projecting, and acute and more incurved immature than in immature specimens. Deltidial plates prominent, almost surrounding the foramen, with lateral calcareous growths resembling two ear-like projections.

Remarks.—The type-specimen came from the Pea-Grit of Crickley Hill, where numerous examples are to be obtained along a certain horizon. The holotype, however, is a particularly large specimen. Frequently more aged-looking examples are to be found which are considerably smaller and appear to be mature forms dwarfed. Specimens have been obtained from the Pea-Grit at Birdlip and Selsley Hill, near Stroud. It is common also in the Coral-Bed on top of the Pea-Grit at Juniper Hill, near Stroud.

The fossil figured in Plate VII., figs. 14a and b is from the *Scissum*-Beds of Haresfield Beacon, near Gloucester. It has only two ribs on the mesial fold, is narrower and more coarsely ribbed than the form from the Pea-Grit.

In the Oolite Marl of Westington Hill, near Chipping Campden, specimens of a rhynchonellid, which are considered to belong to the present species, are very abundant. The majority of the specimens collected are immature, are flatter, and have a more horizontally-projecting beak. The few mature forms that have been obtained, have more incurved beaks, one specimen is biplicate and similar to that from the *Scissum*-Beds of Haresfield, so that for the present, the specimens from the three horizons are associated under the same specific name.

RHYNCHONELLA CHELTENSIS, nom. nov.

T.f. 1878, Davidson, Monogr. Brit. Oolitic and Liassic Brachiopoda., Suppl. pl. XXIX., figs. 13, 13*a* and *b*.

T.l. "Cheltenham District."

Hor. "Inferior Oolite." [*Scissum*-Beds. ῆ. *Scissi.*]

Colln. British Museum [J. F. Walker Colln. Reg. No., B. 27327.]

Remarks.—This form, to which it is proposed to restrict the name *Rhynchonella cheltensis* is readily distinguished from the true *Rhyn. subdecorata* Davidson. It is that figured by Davidson, with a query, as "*Rhynchonella subdecorata*, var. ? ", in the supplement to that portion of his monograph which deals with the Oolitic and Liassic Brachiopoda. Davidson's fossil is a little more circular in outline than the majority of our specimens, which exhibit a distinct tendency to expand transversely.

Specimens have been obtained from the *Scissum*-Beds of Stanley, Nottingham and Cleeve Hills, near Cheltenham; Cassey Compton, near Chedworth; Withington; Puckham, near Cheltenham; and an opening in the bank on the north side of the road near Cornwell, near Chipping Norton.[1]

RHYNCHONELLA CLEEVENSIS, sp. nov. Pl. VII., figs. 6*a* and *b*.

T.l. "Sand-hole" near the "Roadstone Hole," Cleeve Hill.

Hor. Lower *Trigonia*-Grit. ῆ. *Disciteæ*.

Colln. L. Richardson.

Description.—Shell subcircular, being broader than long. Beak, moderately produced, foramen circular. The surface is ornamented by about seventeen large plicæ. The front margin is elevated to form a mesial fold of moderate height.

Remarks.—This rhynchonellid is not a common form, but has been obtained from the Lower *Trigonia*-Grit of Cleeve Hill, Stanway Hill (in the North Cotteswolds), Tuffley's

1. Proc. Cotteswold Nat. F.C., vol. xvii., pt. 2 (1911), page 230, where it is entered as "*Rhyn. subdecorata*, Dav."

Quarry (near Birdlip) and Rodborough Hill, Stroud. A poorly-preserved pedicle valve, probably of a shell belonging to this species, has been obtained from the Harford Sands (*concavi*) of Cleeve Hill, near Cheltenham.

RHYNCHONELLA GRAYI, sp. nov.[1] Pl. VII., figs., 5*a*, *b* and *c*.

T.l. Tuffley's Quarry, between Cheltenham and Birdlip.

Hor. Lower *Trigonia*-Grit. ἡ. *Discitæ*.

Colln. L. Richardson.

Description.—Shell globular, coarsely-ribbed with a low mesial fold with three prominent ribs. There are four prominent ribs on each lateral area of the brachial valve. The beak is acute, prominent and incurved, but well separated from the umbo.

Remarks.—In aged specimens of this species the shell is thickened by increment along the anterior edges of the valves in such a manner that the front is almost upright. The deltidial plates are well displayed and practically surround the foramen.

A number of specimens have been obtained from the type-locality and from beds of the same age at the Frith Quarry, near Painswick.

RHYNCHONELLA SELSLEYENSIS, sp. nov. Pl. VII., figs., 7*a*, *b* and *c*.

T.l. Selsley Hill, near Stroud.

Hor. *Clypeus*-Grit (base). ἡ. *Truellei*.

Colln. L. Richardson.

Description.—Shell sub-globular and well-ribbed. A front view (pl. VII., fig. 7*c*) shows a marked fold, but the contour of the shell is unaffected or only slightly affected by it. The beak is acute and incurved.

Remarks.—*Rhynchonella selsleyensis* is very abundant in a bed lying immediately on the Upper *Trigonia*-Grit at Selsley Hill.[2] The form has also been noted at several other localities in the Cotteswold Hills.

1. After J. W. Gray Esq., F.G.S.
2. Proc. Cotteswold Nat. F.C., vol. xvii., pt. 1 (1910), p. 124.

It is a very neat form and almost suggests the use of the term " globular " wherewith to describe it. This feature distinguishes it at once from *Rhyn. hampenensis*, S. Buckman, which is more transverse.

RHYNCHONELLA SUBDECORATA, Davidson

T.f. 1851-2. Davidson, Monogr. Brit. Oolitic and Liassic Brachiopoda. Pl. XVIII., fig. 10, and Appendix, Pl., A., figs. 23 and 25.

T.l. " Birdlip Hill, Gloucestershire."

Hor. " Inferior Oolite." [*Scissum*-Beds. *η. Scissi.*]

Colln. Pl. A, figs, 23 and 25 ; British Museum [Davidson Colln., Reg. No., B. 5558].[1]

Remarks.—Several forms have hitherto been grouped under the name " *Rhynchonella subdecorata*, Davidson," one of which is now named "*Rhynchonella cheltensis*" (see page 50.)

The first specimen that came into his hands, Davidson figured as " a most remarkable variation of *Rhyn. tetrahedra*, approaching to *Rhyn. decorata* and said to be from the Inferior-Oolite of Cheltenham " (explanation to pl. XVIII., fig. 10, of his Monograph). In Plate A of the Appendix to this vol. I. of his Monograph, Davidson names the form " *Rhynchonella subdecorata* " and figures specimens from the Inferior Oolite, Birdlip Hill, Gloucestershire ; " a series of ages and varieties, figs. 23 to 26." Of these figures 23 and 25 accurately picture a fossil that is not at all infrequent in the *Scissum*-Beds of the Cotteswold Hills, and it is highly probable that Davidson's specimens from Birdlip came from the same horizon.[2]

Specimens of the true *Rhyn. subdecorata*, Dav., have been obtained from the *Scissum*-Beds of Oxenton, Birdlip, Cooper's and Nottingham Hills—all near Cheltenham.

1. The specimen figured in pl. xviii., fig. 10, is said by Davidson to be in the Walton Collection, but Mr R. B. Newton informs us that it is not in the British Museum (Nat. Hist.).

2. Figs. 24 and 26 represent a smaller form which is found at the top of the Lower Limestone near its junction with the Pea-Grit, especially at Cud Hill, near Painswick, and is not the young stage of *Rhynchonella subdecorata* as here depicted.

RHYNCHONELLA WITCHELLI,[1] sp. nov. Pl. VII., figs. 1*a* and *b*.

T.l. Selsley Hill, near Stroud.

Hor. Oolite Marl. *ἡ. Bradfordensis.*

Colln. C. Upton.

Description.—Shell broader than long, coarsely plicated with three or four plaits in the mesial fold and usually four on each side. Beak prominent, acute and slightly incurved.

Remarks.—*Rhynchonella witchelli* is a very distinctive form and has long been known to collectors who have worked on Selsley Hill, where it is common in the hard beds which participate in the formation of the deposit which is equivalent to the Oolite Marl—the "Upper Freestone" of Witchell. Specimens have also been collected from the Oolite Marl of Peter's Barn (near the Broadway Monument in the North Cotteswolds); from a marly layer exposed in a freestone quarry close to the road at Longford's Mill, near Nailsworth, Gloucestershire;[2] Stroud Hill; and the Frith Quarry, near Painswick.

One of us (C.U.) has collected several specimens of a rhynchonellid, somewhat larger, but otherwise scarcely separable from *Rhyn. witchelli*, from the Coral-Bed on top of the Pea-Grit at the Frith Quarry.

TEREBRATULA MICROSTOMA,[3] sp. nov. Pl. VII., figs, 15*a* and *b*.

T.l. Cowley-Wood Quarry, near Cheltenham.

Hor. *Clypeus*- Grit (top). *ἡ. Schlœnbachi.*

Colln. L. Richardson.

Description.—Shell pentangular in outline; valves equi-convex. Front margin biplicate. Beak well formed, with short beak-ridges and a remarkably small foramen.

Remarks.—The exceptionally small foramen is the principal characteristic of this species. Two specimens have been obtained, both from the top of the *Clypeus*-Grit of the

1. After the well-known Stroud geologist, Edwin Witchell, F.G.S.
2. *Vide* Proc. Cotteswold Nat. F. C., vol. xvii., pt. I. (1910), p. 129, where it is recorded as "*Rhyn. Witchelli*, Rich."
3. Greek: *mikros*, small; *stoma*, an opening.

Cowley-Wood Quarry, near Cheltenham. In the smallness of the foramen and the structure of the beak, *Ter. microstoma* much resembles *Ter. shirbuirniensis*, S. Buckman, from the *Bradfordensis*-Beds of the Sherborne district and Dundry Hill. Hitherto this shell would have been labelled "*Ter. globata*, auctt."

TEREBRATULA PISOLITICA, S. Buckman, var. RANDWICKENSIS, var. nov.

T.l. Randwick Ash, near Stroud.

Hor. Pea-Grit. η. *Murchisonæ.*

Colln. L. Richardson.

Description.—Same as for *Terebratula pisolitica*, S. Buckman (Proc. Cotteswold Nat. F. C., vol. IX., pl. I, 1886, p. 41, and pl. III. figs. 1*a b*, and *c*), only the lateral furrows are very angular and there is often a corresponding accentuation of the anterior folds.

Remarks.—This well-marked variety of *Ter. pisolitica*, S. Buckman, has long been known to local workers, and while most abundant at Randwick, has also been recorded from the Frith Quarry, near Painswick, and Crickley Hill, near Gloucester.

TEREBRATULA PAINSWICKENSIS,[1] sp. nov., Pl. VII., figs. 9*a*, *b*, and *c*, and 16*a*, *b*, and *c*.

T.l. Dunley's Quarry, near Cranham, near Painswick, Glos.

Hor. *Buckmani*-Grit. η. *Post-discitæ.*

Colln. L. Richardson.

Description.—Shell biplicate, the folds usually being somewhat pinched together so that the lateral furrows of the brachial valve are broad and conspicuous. Beak truncated, with a large foramen.

Remarks.—Specimens of this species have been obtained from the *Buckmani*-Grit of Dunley's Quarry (type-locality), Buckholt Wood, near Birdlip, and Charlton Common, near Cheltenham; and the Lower *Trigonia*-Grit of Swift's Hill, near Stroud, and the Frith Quarry, near Painswick.

1. Proc. Cotteswold Nat. F. C., vol. xv., pt. II. (1905), pp. 86-87, and pl. III., figs. 11-13.

Terebratula degenerata, Upton, which occurs in the Lower *Trigonia*-Grit, differs from the present species—which is most abundant in the *Buckmani*-Grit—in being monoplicate instead of biplicate.

Some specimens of the *Ter. painswickensis*-group instead of lengthening and becoming inflated with growth, remain thin and expand transversely, ultimately assuming features which we consider sufficiently distinct from those of *Ter. painswickensis* as to warrant separate designation. Such a form is figured in Plate VII., figs. 17*a*, *b* and *c*, under the name of *Ter. cranhamensis* sp. nov.

An exceptionally large specimen of *Ter. painswickensis* is figured in Pl. VII., figs. 9*a*, *b* and *c*.

TEREBRATULA RODBURGENSIS, sp. nov., Pl. VII. figs. 10*a* and *b*.

T.l. Rodborough Hill, near Stroud.

Hor. *Clypeus*-Grit (top). ἡ. *Schlœnbachi*.

Colln. L. Richardson.

Description.—Shell, in outline, subpentangular; valves convex, the pedicle or perforate valve more so than the brachial. Front margin incipiently-biplicate. Beak stout and incurved over the umbo. Foramen circular and moderate sized.

Remarks.—This shell differs from its contemporaries in most details and therefore should be easily identified if found. One specimen has been procured up to the present time.

TEREBRATULA TUBULIROSTRATA,[1] sp. nov., Pl. VII, figs. 8*a* and *b*.

T.l. Leckhampton Hill, near Cheltenham.

Hor. Lower *Trigonia*-Grit. ἡ. *Discitæ*.

Colln. C. Upton.

Description.—Shell inflated, typically elongately-globular. Brachial valve convex, somewhat carinated, umbo prominent. Pedicle valve also very convex, with a conspicuous tubular beak perforated with a comparatively small foramen. Beak ridges inconspicuous or absent. Anterior margin broadly uniplicate to incipiently biplicate.

1. Latin: *tubulus*, a little tube; and *rostratus*, beaked.

Remarks.—*Terebratula tubulirostrata* is a very distinct brachiopod, of which the peculiar beak is perhaps the most characteristic feature. The holotype came from the Lower *Trigonia*-Grit of Leckhampton Hill.

TEREBRATULA WITCHELLI,[1] sp. nov. Pl. VII., figs. 12 *a* and *b*.

T.l. Tuffley's Quarry near the Air Balloon Inn, near Birdlip, Glos.

Hor. Upper *Trigonia*-Grit. $\acute{\eta}$. *Garantianæ.*

Colln. L. Richardson.

Description.—Shell somewhat globular, subcircular in outline (being slightly longer than broad); valves equi-convex; front margin elevated to form a single fold which has a suggestion of depression in the middle. Beak short, stout, with a large circular foramen.

Remarks.—Several specimens have been obtained from Tuffley's Quarry.

ZEILLERIA TENUIS,[2] sp. nov., Pl. VII., figs. 3*a* and *b*.

T.l. Cold Comfort, near Cheltenham.

Hor. *Witchellia*-Grit. $\acute{\eta}$. *Witchelliæ.*

Colln. L. Richardson.

Description.—Shell quadrate, *thin* and lenticular. Brachial valve somewhat inflated and drawn out in the umbonal region to form an acute umbo; but depressed in the anterior portion with a tendency to form a slight sulcus. Pedicle valve regularly convex in longitudinal section, but somewhat lenticular or even carinated in transverse section—its margin with that of the brachial valve forming a very sharp edge. Beak protruding, so that the deltidial plates are apparent; beak-ridges not very acute; foramen small.

Remarks.—The characteristic features of this slender little brachiopod are its quadrate outline, sharp margins, lenticularity and protruding beak. There is no other shell in the *Witchellia*-Grit with which it may be confused. Three specimens have been obtained; two from Cold Comfort and one from the Rolling-Bank Quarry, Cleeve Hill, near Cheltenham.

1. After E. Witchell F.G.S.
2. Latin: *tenuis*, thin or slender.

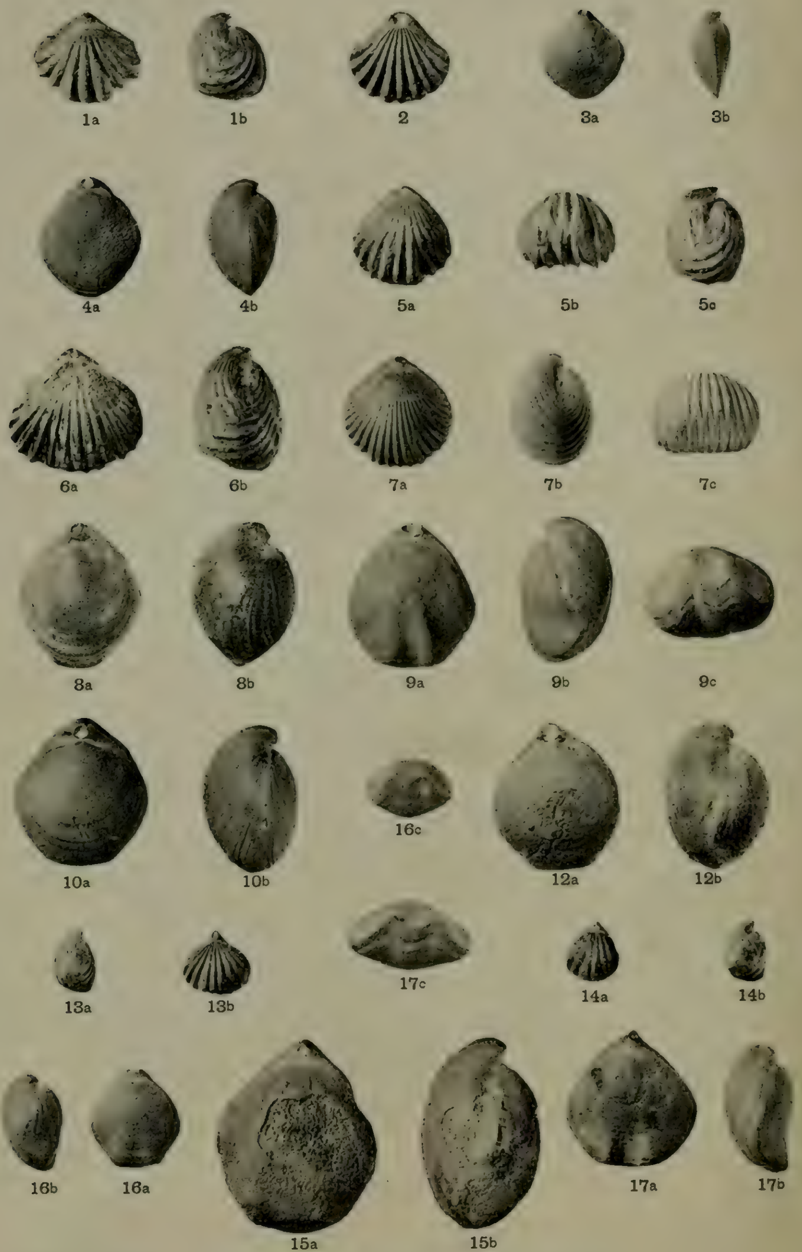


Photo J. W. Tutcher.

INFERIOR-OOLITE BRACHIOPODA

EXPLANATION OF PLATE VII.

FIGS. 1*a* and *b*.—RHYNCHONELLA WITCHELLI, sp. nov. (See p. 53.)
1*a*—dorsal view; 1*b*—lateral view
Horizon: "Oolite Marl." η. *Bradfordensis*. Locality: Selsley Hill, near Stroud.

FIG. 2.—EUDESIA DOULTINGENSIS, sp. nov. (See p. 47.)
Horizon: "Top-Beds." η. *Schlœnbachi*. Locality: Doulting, Somerset.

FIGS. 3*a* and *b*.—ZEILLERIA TENUIS, sp. nov. (See p. 56.)
3*a*—dorsal view; 3*b*—lateral view.
Horizon: *Witchellia*-Grit. η. *Witchelliæ*. Locality: Cold Comfort, near Cheltenham.

FIGS. 4*a* and *b*.—ORNITHELLA CLEEVENSIS, sp. nov. (See p. 48.)
4*a*—dorsal view. 4*b*—lateral view.
Horizon: Lower *Trigonia*-Grit. η. *Discitæ*. Locality: Cleeve Hill, near Cheltenham.

FIGS. 5*a*, *b* and *c*.—RHYNCHONELLA GRAYI, sp. nov. (See p. 51.)
5*a*—dorsal view; 5*b*—anterior view; 5*c*—lateral view.
Horizon: Lower *Trigonia*-Grit. η. *Discitæ*. Tuffley's Quarry, near Cheltenham.

FIGS. 6*a* and *b*.—RHYNCHONELLA CLEEVENSIS, sp. nov. (See p. 50.)
6*a*—dorsal view; 6*b*—lateral view.
Horizon: Lower *Trigonia*-Grit. η. *Discitæ*. Locality: Cleeve Hill.

FIGS 7*a*, *b* and *c*.—RHYNCHONELLA SELSLEYENSIS, sp. nov. (See p. 51.)
7*a*—dorsal view; 7*b*—anterior view; 7*c*—lateral view.
Horizon: *Clypeus*-Grit (base). η. *Truellei*. Locality: Selsley Hill.

FIGS. 8*a* & *b*.—TEREBRATULA TUBULIROSTRATA, sp. nov. (See p. 55.)
8*a*—dorsal view; 8*b*—lateral view,
Horizon: Lower *Trigonia*-Grit. η. *Discitæ*. Locality: Leckhampton Hill, near Cheltenham.

FIGS. 9*a*, *b* and *c*.—Large specimen of TEREBRATULA PAINSWICKENSIS, sp. nov. (See p. 54.)
9*a*—dorsal view; 9*b*—lateral view; 9*c*—anterior view.
Horizon: *Buckmani*-Grit. η. *Post-discitæ*. Locality: Dunley's Quarry, near Cranham, Glos.

FIGS. 10*a* and *b*.—TEREBRATULA RODBURGENSIS, sp. nov. (See p. 55.)
10*a*—dorsal view; 10*b*—lateral view.
Horizon: *Clypeus*-Grit (top). η. *Schlœnbachi*. Locality: Rodborough Hill, near Stroud.

FIGS. 12*a* and *b*.—TEREBRATULA WITCHELLI, sp. nov. (See p. 56.)
12*a*—dorsal view; 12*b*—lateral view.
Horizon: Upper *Trigonia*-Grit. η. *Garantianæ*. Locality: Tuffley's Quarry, near Cheltenham.

FIGS. 13*a* and *b*, 14*a* and *b*.—RHYNCHONELLA AURICULIFERA, sp. nov. (See p. 49.)
13*a*—lateral view, and 13*b*—dorsal view of specimen from the Pea-Grit; and 14*a*—dorsal view, and 14*b*—lateral view of specimen from the *Scissum*-Beds.
Horizon of 13: Pea-Grit. η. *Murchisonæ*. Locality: Crickley Hill; and horizon of 14: *Scissum*-Beds. η *Scissi*. Locality: Haresfield, near Gloucester.

FIGS. 15*a* and *b*.—TEREBRATULA MICROSTOMA, sp. nov. (See p. 53.)
15*a*—dorsal view; 15*b*—lateral view.
Horizon: *Clypeus*-Grit (top). η. *Schlœnbachi*. Locality: Cowley-wood Quarry, near Cheltenham.

FIGS. 16*a*, *b* & *c*.—TEREBRATULA PAINSWICKENSIS, sp. nov. (See p. 54.)

16*a*—dorsal view; 16*b*—lateral view; 16*c*—anterior view.

Same horizon, hemera and locality as specimens pictured in fig. 9.

FIGS. 17*a*, *b* & *c*.—TEREBRATULA CRANHAMENSIS, sp. nov. (See p. 55.)

17*a*—dorsal view; 17*b*—lateral view; 17*c*—anterior view.

Same horizon, hemera and locality as specimens pictured in figs. 9 and 16.

[All the specimens figured, with the exception of those pictured in figs. 1*a* and *b*, and 8*a* and *b*, which are in Mr Upton's Collection, are in Mr Richardson's Collection.]

All the figures are natural size.

FORESTRY

BY

C. O. HANSON

Principal of the Crown School of Forestry, Forest of Dean.

(REPORT BY LECTURER.)

For the correct management of woods, landowners must be able to obtain expert advice, and also the services of trained working foresters. The Government has recently arranged, in connection with the Development Fund, for the appointment of five "Forestry Advisers," one at each of the five teaching centres—Oxford, Cambridge, Bangor, Armstrong College, and the Royal Agricultural College, Cirencester. These experts will give advice to any landowners who may require it. Gloucestershire comes into the district served by Cirencester, and it is understood that no charge is made for advice, only for expenses.

A limited number of trained working foresters is supplied annually from the School of Forestry, Forest of Dean. This school, which was opened in 1904, is for working men only, 12 being admitted annually. They must be between 20 and 25 years old, and work as labourers in Dean Forest during the two years' course. They attend the school on two afternoons each week. They receive 15s per week for their work, and the education is free. Board and lodging is provided for 11s, so a careful man can keep himself while at the school. The education given is a thoroughly practical one, and on leaving, the men are fit for a forester's situation. The prospects for the students are good. The 56 men who have obtained certificates are now employed as follows:—Foresters in the Colonies, pay £120-£200, 5; foresters in England, pay £75-£150, 10; assistant foresters or head woodmen, pay 21s to 28s a week, 20; employed by the Crown in various positions, 16; continuing study in Germany, 1; left forestry for other businesses, 4.

Forestry, or sylviculture, is the growing of trees in masses for profit, and is not the same as arboriculture, which is the growing of trees singly, chiefly for beauty. A forester must often force his trees to take on an unnatural shape in order to get tall, straight timber free from branches, as this is what is required by timber-merchants. He must also get the largest possible quantity per acre. This is done by regulating the density of the woods, owing to the effect of light and shade. Water is taken in by the roots, and ascends to the leaves. The leaves take in carbon dioxide from the air. The chlorophyll or green colouring matter in the leaves manufactures out of the water and carbon dioxide, sugar, which is the food of the tree. This, however, can only be done in sunlight, so if a tree is shaded too much it dies; also if a branch is kept in the dark it dies. The different species vary in their light requirements, oak, ash and larch requiring much light, beech and silver fir bearing some shade. A plantation should be made with the plants as closely crowded as possible, consistently with keeping down the expense, in order to get a cover over the ground as soon as possible, and to get the crop into a thicket early. Where there are no rabbits, and not too much weed growth, a dense crop can sometimes be got cheaply by natural regeneration; when this is impossible, planting at four feet apart is usually dense enough. Closer planting is too expensive. In the thicket stage, between the 12th and 20th years, a struggle for existence is set up, the weaker trees die for want of light, and the better trees are forced upwards, growing tall and straight owing to their struggle upwards for light. Their branches die off as they are shaded by surrounding trees. If the struggle goes on too long, all the trees will grow too thin and lanky, and, therefore, a thinning is made to reduce, without stopping, the struggle. The worst trees are cut, leaving the best, and the cover must be kept complete. The struggle is then continued and another thinning is necessary in about ten years' time. This continues as long as the wood is growing vigorously. In the second half of the life of the wood the thinnings are made more heavily, the crowns then increase, and the trees grow in girth instead of in height. With oak, at about the 30th to 40th year, it is found impossible to keep the wood sufficiently dense, as the oak must not have much light. Beech is, therefore, planted below the oak, and as it grows it maintains the density of the wood, and its fallen rotting leaves form a leaf mould or humus, which improves the soil and acts as a manure to the oak. The beech will, eventually, catch up the oak, and both are felled together when the oak is aged about 120 years and the beech about 80 to 90 years. Only flourishing young woods are worth underplanting. Most English woods have been over-thinned, and the struggle for existence having thus been stopped, the trees are only half as tall as they should be. Also, they are too branchy, and there is far too small a volume per acre. The soil has usually deteriorated owing to the absence of humus. The climate and soil in England is excellent for the growth of trees, and, with proper management, the results can be just as good as on the Continent.

THE DEAN FOREST SCHOOL OF FORESTRY

BY

W. THOMPSON

A week, to the day, after hearing Mr Hanson deliver his interesting lecture in Gloucester, I, with two other Members of the Club, visited the School at Parkend, with a view to obtaining further information about the practical work, and at the same time inspecting at first hand some of the fruits.

The day we chose for our trip to the Forest was infinitely superior to many summer days. All the rich colouring so prevalent a month previous had vanished. The oaks and beeches had divested themselves of their leafy mantle. That had gone to increase the stock of humus—that top-dressing so beneficial to vegetation, and so helpful to acorns, beech mast and chestnuts when self-sown. To study the outline of a tree, it must be seen in a state of nudity. Then it is possible to gauge its true proportions, and admire its symmetry of form. Ever and anon the sunshine piercing through the clouds shot down streamers and lighted up the magnificent woods and open clearings, such time as we climbed the hill from Parkend to take our bearings for Soudley. But, before doing that, Mr Hanson took us to his Forest Nursery, and showed us what the students have accomplished in the way of raising from seed young larches, Douglas firs, Corsican pines, beeches, chestnuts, oaks, spruces, &c. Beech mast has been very abundant this year (1912), and we were shewn a large stock of the brown keeled nuts which, in due course, will be planted. A square yard of seedling larches will yield a thousand plants, of which, at least eight hundred will be good enough for transplanting. The seed is sown in trenches about a foot wide, the covering of soil being thin. There are some fine oaks on the gently sloping ground situated between Mr Hanson's office and the Nursery. These are to be felled soon, and it is proposed to make an arboretum by way of adjunct to the Nursery.

Next we went to the School, a really business-like establishment. Mr Hanson was about to give a lesson to the students, who, as he explained in his lecture to the Club, devote two years to theoretical and practical forestry. They live on the school premises, sleeping in cubicles, and having meals in common. There are excellent class-rooms, billiards and other forms of recreation are provided on the ground floor, and a Museum containing specimens of wood, cases illustrating the life history of insect pests and the ravages they commit, and many other things of an educational nature. One curiosity was a piece of timber bearing a Government mark of ancient date. It was made years ago when Forest trees were cut down for naval ship-building purposes. The stamped tree did not fall to the woodman's axe, but went on growing. The official sign thus became encased in the hard wood, and when, eventually, the tree was cut down, it was found interned far enough away from the bark. What we saw of the students favourably impressed us. Their faces were intelligent, and their bodies well-knit and strong. The latter is what one would expect, seeing that to study is added fence-making, tree-felling, lopping, &c.

All this was very interesting, but our chief enjoyment was derived during that walk to Soudley. Mr Hanson had put himself in telephonic communication with a Crown keeper, who lives in a Forest lodge on a breezy height a few miles from Parkend and in our line of march for Soudley. This official—looking every inch a Forester, although not clad in Lincoln green—was in waiting in a hollow near that wonderful piece of old Roman road about which so much has been written. The portion exposed is comparatively small, but how eloquent it is of the thorough way in which the Romans did their work. The stone kerbing on either side the seven feet track is as perfect as when laid seventeen or eighteen centuries ago. The part laid bare leads down to a merry rippling stream, and a little off-shoot pointing towards a modern bridge which spans the stream a few roads from the main track, seems to suggest that the present bridge occupies the place of one much older. Once across the stream, we reach a section of the road which has been opened up quite recently.

This is even more striking than the part already referred to. The Ermine Way, Fossway, Icknield Street, and other familiar trackways long macadamised and utilised—first for stage coach and other horse traffic, and now rendered even more perfect for motors—serve to remind us of the Roman legions and the forced labour which made the original roads possible. They are always interesting, but not to the same extent as this bit of primitive Forest track—abandoned long ages ago, as the iron workings of our southern conquerors were abandoned when the call from Rome drew them off for service at home.

From the valley we proceeded upwards in the direction of Viney Hill. This was to enable us to see the work in forestry which is being accomplished by regeneration. The old oaks and beeches have, for the most part, been cut down, and now self-sown acorns and beech-nuts have produced fine plantations of trees. Here we saw evidence of that struggle for existence which Mr Hanson spoke about at Gloucester, and obtained information from our guide about the general principles underlying forestry. From the Keeper's lodge the walk to Soudley took us through some romantic country. Past a fine belt of spruce, which is soon to be felled, down a long and winding descent commanding a view of the Severn on the right, with here and there a majestic oak or beech, with undergrowth of bracken, now sere and suitable for litter, masses of fibrous wood of *Clematis vitalba* depending from branches, and patches of the white cottony seed still bidding defiance to autumn winds. Before reaching the valley in which Soudley village and its small railway halt are situated, we saw a plantation of strong, sturdy oak, forty years old, claimed by Mr Hanson to be the finest of its kind in England. The impression we gained was that forestry in Dean Forest is being carried on with all the skill and scientific knowledge which such an important industry requires. By natural planting or regeneration provision is being made for future needs, and although our Navy no longer makes demands on the Forest of Dean for ship-building purposes, it is evident that the rearing of trees is a profitable as well as interesting industry.

A "SWALLOW-HOLE" IN THE INFERIOR OOLITE, NEAR CHELTENHAM.

BY

L. RICHARDSON.

About half-a-mile to the east of the Seven Springs are two outliers of Fullers'-Earth clay capped with Great Oolite. The Fullers' Earth rests upon the Inferior Oolite, and this, in turn, upon the Upper Lias, of which the uppermost 10 to 20 feet is probably sand, the rest clay.

At a place in a corner of a field, best described as situated above the letter "N" in "Needlehole" on the 1-inch Ordnance-Survey map, Sheet 235 (3rd Ed.) or on the map in my "Handbook to the Geology of Cheltenham" (1904), is a depression, in plan triangle-shaped, each of the sides about 40 feet long, 12 to 15 feet deep, and narrowing downwards so that the lowest portion is circular with a six-foot diameter. Into this hollow trickles water from three separate sources, and yet the hollow does not fill. The hollow is situated at the edge of the more northern of the two outliers of Fullers' Earth. Water running off the Fullers' Earth has found a way straight down through the porous Oolite to the relatively impervious Upper-Lias clay. In a field to the west may be traced a slight hollow, running westwards. Following this hollow, the observer will find that it continues into the wood, where it rapidly develops into a deep valley, but subsequently into a shallow depression, which is continuous to the artificial lake below the Seven Springs. It would seem probable that when the water is lost sight of in the "swallow-hole" it pursues an underground course indicated at the surface by the dry valley described above.

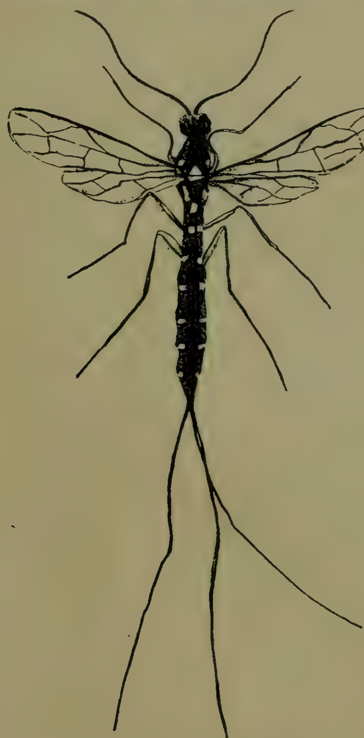
This is the only case I know of in the Cotteswold Hills where water disappears into a depression of relatively small size, which merits the term "swallow-hole." There may be others, there probably are, and it would be interesting to hear of them.

LONG-TAILED ICHNEUMON FLY (*Rhyssa persuasoria*, Linn.) IN GLOUCESTERSHIRE

BY

C. GRANVILLE CLUTTERBUCK, F.E.S.

The accompanying illustration (fig. 1) is a life-size drawing of a female specimen of the Long-Tailed Ichneumon Fly,



Mrs Clutterbuck del.

Fig. 1.—The Long-tailed Ichneumon Fly.

found by Mr John Gill in Green Lane, Hucclecote, near Gloucester, on the 15th June, 1912, and very kindly given to me by its captor a week after. I submitted the drawing to Mr Claude Morley, F.E.S., F.Z.S., who identified the specimen for me. He says (*in litt.*) :—

> "It is of general distribution, but cannot be said to be by any means common. I have never personally met with it in twenty years' collecting. . . . It is parasitic upon the larger Sirices, Gigas and Noctilis (cf. my Ichn. Brit. vol. iii.)"

It belongs to the sub-family PIMPLINÆ of the family ICHNEUMONIDÆ of the Tribe ENTOMOPHAGA of the order HYMENOPTERA, which order includes the bees, wasps, ants, ichneumon flies, saw-flies, gall-flies and their allies. This insect is met with in fir plantations, and uses its extraordinary ovipositor to drill holes in trees infested by the larvæ of the Larch Borers, or Tailed Wasps (*Sirex gigas*, &c.) on which its own is parasitic. The insect frequently drives its ovipositor so firmly into the wood of the tree that it is unable to withdraw it and perishes in this position.

THE DISTRIBUTION OF CALLUNA ON THE COTTESWOLDS

BY

H. H. KNIGHT, M.A.

(*Read December 10th*, 1912)

A noticeable feature of the vegetation of the Cotteswold country, in Gloucestershire, is the absence or rarity of plants belonging to the Heath or Moorland associations. The familiar Heather, or Ling (*Calluna vulgaris* Hull) is found in a few places, and sometimes in abundance, as on Cleeve Hill and Broadway Hill. In both these places it occurs on a sandy deposit which Geologists call the "Harford Sands." Mr Richardson, in his Handbook to the Geology of Cheltenham, says this "deposit consists of white and pale-brown sand, often cemented together by carbonate of lime. The rain water gradually dissolves this calcareous cement, and leaves an incoherent accumulation of sand, composed of very fine quartz grains." This non-calcareous sand, in which the Cotteswolds are usually deficient, is favourable for the growth of Ling, with which are associated other plants of the Heath formation as *Galium saxatile* L. and *Viola canina* L. The Heather on Broadway Hill is found mostly in Worcestershire, but some of it extends over the boundary into Gloucestershire.

There is a piece of land near Taddington and Snowshill, known as the Ling Ground. Here the Heather grew in abundance till a few years ago, when plantations destroyed it. It still occurs in the isolated piece of Worcestershire close at hand—that part in which Cutsdean is situated.

I have not been able to find any Heather at Harford, near Bourton-on-the-Water, the district whence these sands take their name. Mr Riddelsdell has a record of its occurrence in "Preserves between Notgrove and Bourton," where it may possibly have been planted. Mr Richardson says that the

Harford Sands are not found south of the Cheltenham and Bourton district, and Heather seems to be still more scarce on the Cotteswolds to the south of this. It is found on Painswick Hill, but here, according to Messrs Skinner and Coley, it was planted some years ago. Also, it has been found sparingly in Cranham Woods (Mr Coley).

The Rev. G. W. Sandys, about 1840-50, found it at Cranham and Stroud; and the Painswick locality was mentioned in the Painswick Parish Magazine list published many years ago. There were two small clumps of heather near Puckham Wood, and James Buckman, in 1841, found it at Leckhampton.

In the Cirencester district Heather grows in the fields on the West side of Oakley Park, and also near Bagendon (Mr Greenwood). This is on the Great Oolite series, and its occurrence here may be due to the presence of certain beds of the Forest Marble, which, according to Mr Richardson, weather into a sandy soil. A portion of the Heather in Oakley Park is railed off to protect it from grazing animals, and this enables it to grow to a greater size than we usually see it on the Cotteswolds.

The only locality for Heather to the south of the Stroud Valley, that I know, is on the top of Cam Long Down, near Dursley. Here it grows on the Cotteswold Sands, and is associated with the Autumn Gorse (*Ulex Gallii* Planch.), a plant we do not find on the North Cotteswolds. Miss Roper, of Bristol, says she does not remember ever having seen any Heather on the southern portion of the Cotteswolds. The Rev. H. P. Reader, however, has found it in a wood near Uley.

The Lower Lias of the Severn Valley is still more unfavourable to the growth of Heather and its associated plants, and though there are deposits of sand near Cheltenham, and elsewhere in the Valley, I have never seen any trace of an ericetal vegetation. The case is different near Moreton-in-the-Marsh. This lies on the Lower Lias, which, in parts, is covered by a sandy deposit known as the "Northern Drift." There is a bit of uncultivated ground near the Four Shire Stone, where a typical Heath vegetation flourishes. The county boundaries here are very intricate, but the ground I refer to is in the County of Gloucester, though it is on the border of Wolford Wood, which is mainly in Warwickshire. Here *Calluna vulgaris* is plentiful, and with it are the following plants of the Heath association :—*Erica Tetralix* L., *Ulex Gallii* Planch., *Viola canina* L., *Montia fontana* L., *Hydrocotyle vulgaris* L., *Galium saxatile* L., *Salix repens* L., *Salix aurita* L., *Potamogeton polygonifolius* Pourr., *Juncus squarrosus* L., *Carex binervis* Sm., *Mollinia cœrulea* Moench., *Nardus stricta* L., and the Mosses *Polytrichum commune* L., *Aulacomnium palustre* Schwaeg., *Hypnum exannulatum* Gümb., and *Campylopus pyriformis* Brid.

The Northern Drift extends from Moreton down the Evenlode Valley to Milton, in Oxfordshire, and on the Ordnance Map its course is marked by numerous Heaths. The land now is mostly under cultivation, and so much of the former Heath vegetation is destroyed. It is probable that in former days many of the plants mentioned above were found along the course of the Northern Drift. Mr Druce, in the Flora of Oxfordshire, records *Calluna vulgaris* from Bruern Wood, and Lord Moreton mentions that a small patch of Heather grew in a wood called Churchill Heath, near Kingham Station, till within two or three years ago. Lord Moreton also drew my attention to the name Bruern. The Abbey here was also known as Bruere and Brueria (Dugdale's Monasticon), perhaps from the Heather, French, "Bruyère." In "Place-Names of Oxfordshire," by H. Alexander, another derivation is suggested from the Old English breaw-ern, meaning brew-house.

The Cotteswold Hills, as defined by Mr Buckman in the Proc. Cotteswold Nat. F.C., vol. xiv., include Wychwood Forest in Oxfordshire, but not this country of the Northern Drift. Mr Druce remarks in his Flora that the Oxford Clay at Ramsden Heath in the Wychwood district is capped with a gravel deposit, and on this are found several ericetal plants including *Calluna*. Also in the springs where the gravel meets the clay, *Sphagnum* is still found (1886). This is the only record of *Sphagnum* on the Cotteswolds.

ON THE ABUNDANT OCCURRENCE OF INVOLUTINA LIASSICA (JONES) IN THE LOWER LIAS AT GLOUCESTER

BY

CHARLES UPTON

The object of this note is to record the abundant occurrence of the foraminifer *Involutina liassica* (Jones) in the Lower Lias at Gloucester.

The specimens upon which the type-description were founded by Rupert Jones,[1] were obtained by the Rev. P. B. Brodie[2] from the cliff at Fretherne—from the *Angulatus*- or *Bucklandi*-Zones.[3] J. F. Blake records specimens from the same zones at Redcar, Yorkshire.[4]

Recently, an excavation has been made by the canal-side, near the Gas-works, at Gloucester, in clay of *oxynoti* hemera. I have washed some of this clay, and was surprised to find a multitude of specimens of *Involutina liassica*. Contrary to the usual experience, ostracods were exceptionally rare. There were numerous foraminifera belonging to the *Dentalina*- and *Cristellaria*-Groups. Holothuroids of the genus *Hemisphæranthus* occurred. The larger fossils included *Cymbites globosus* (Oppel) *Oxynoticeras* spp., *Schlotheimia glevensis* S. Buckman, *Belemnites acutus* Miller, *Dentalium parvulum* Rich. ex J. Buckman MS., *D. trigonale* Moore, *Rhynchonella*, *Astarte* cf. *amalthei* Qu., *Cardita consimilis* Tate and *Grammatodon* (minute immature specimens).

1. Proc. Cotteswold Nat. F.C., Vol. I. (portion for 1853), p. 241.

2. *Idem.* pp. 242-243. I did not find any specimens in the three samples of clay from Fretherne that I examined.

3. *Vide* Richardson, *id.*, Vol. XVI., pt. 2 (1908), p. 137.

4. "The Yorkshire Lias" (1876). p. 453, pl. XVIII., fig. 6.

ON THE STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION OF THE INFERIOR-OOLITE ECHINOIDS OF THE WEST OF ENGLAND SUPPLEMENT [1]

BY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

AND

E. TALBOT PARIS, F.C.S.

[Plate VIII.—Echinoids.]

Since our main paper was published in 1908 we have completed a detailed investigation of the Inferior Oolite of the whole of the tract between the Mendips and the coast at Burton Bradstock. Additional information has been acquired, which it is the object of the present Supplement to record.

Wright, in his admirable monograph,[2] records very few echinoids from the Inferior-Oolite of this district. The reason is, because while a number of specimens of a species may be obtained locally, the total number of species found in the district is small. He records *Cidaris bouchardi* Wright, *Clypeus agassizi* Wr., *C. altus* M'Coy, *Collyrites ovalis* (Leske), *C. ringens* (Agassiz) and *Hemicidaris pustulosa* Ag.

In our main paper the following additional records were made :

> Rubbly-Beds, Doulting.—*Acrosalenia spinosa* Ag. (p. 165) ; *Collyrites ovalis* (Leske) var. *depressus* Paris[3] (pp. 165 and 181) ; *Echinobrissus clunicularis* auctt. (p. 169) ; *Holectypus depressus* (Leske), (p. 172) ; *H. depressus* var. *conicus* Paris (pp. 172 and 183);

1. The main paper is in Proc. Cotteswold Nat. F.C., vol. xvi., pt. II. (1908), pp. 151-193.
2. "A Monograph on the British Fossil Echinodermata from the Oolitic formations." Pal. Soc. (1858-80).
3. Called *Collyrites* aff. *ovalis* (Leske) in the List of Inferior Oolite Fossils in the John Phyllis Collection from Doulting, Somerset, Geol. Mag., 1908, p. 512.

H. hemisphericus Ag. var. *conicus* Wr. (p. 173); *Hyboclypeus gibberulus* Ag. (p. 174); *Trochotiara depressa* Ag. (p. 176); *Stomechinus ? bigranularis* (Lam.), (p. 177); and *Pygaster macrostoma* Wr. (p. 176).

Murchisonæ-Beds, Holway Hill.—*Galeropygus agariciformis* (Wr.) var. *conicus* Paris (p. 182).

Omitted from the records in the main paper was

Clypeus hugi Ag., Rubbly Beds, Doulting.[1]

TABLE I.—List of Echinoids from the Inferior-Oolite of the District South of the Mendips (Excluding Doulting.)

Name of Species or Variety.	HEMERÆ								
	Aalensis to Opaliniformis	*Scissi*	*Murchisonæ*	*Bradfordensis*	*Concavi to Niortensis*	*Garantianæ*	*Truellei*	*Schlœnbachi*	*Zigzag*
Acrosalenia sp. indet.	......	......	......	......	......	......	......	——	......
Cidaris bouchardi Wright ...	......	......	*	......	......	?	——	——	......
,, *confluens* Wr. ex Forbes MS.	......	......	......	......	......	......	—or	——	......
,, *yeovilensis* Wr.	......	......	......	......	......	......	......	......	......
Clypeus agassizi Wr. ...	......	......	......	......	......	——	——	——	......
,, *altus* M'Coy	......	......	......	......	......	-o-	-o-	-o-	......
Collyrites ovalis (Leske) ...	......	......	......	......	......	......	——	-o-	——
,, ,, var. *depressus* Paris	......	......	......	......	......	......	...—	——	......
,, ,, *ringens* (Agassiz)...	......	......	......	......	......	——	——	-o-	——
Diplopodia pentagona M'Coy ...	......	......	......	......	......	*	——	——	......
Diplocidaris desori Wr. ...	......	......	......	......	......	......	......	......	......
Galeropygus agariciformis Wr.	......	——	-o-	......	*	......	......	......	......
,, ,, var. *conicus* Paris	......	......	——	......	......	......	......	......	......
Holectypus hemisphæricus Ag. and var. *conicus* Wr.	......	......	......	......	......	——	——	-o-	——
Hyboclypeus gibberulus Ag. ...	......	......	......	......	......	......	......	——	......
,, *cf. ovalis* Wr. ...	......	......	......	......	......	-o-	......	......	......
,, *subgibberulus* sp. nov.	......	......	......	......	......	-o-	......	......	......
,, *woolstonensis* sp. nov.	......	......	......	......	......	-o-	......	......	......
Rhabdocidaris? (radioles only) ...	......	......	......	......	......	......	......	——	...—
,, (radioles only) ...	......	......	......	......	......	......	......	——	......
Stomechinus bigranularis (Lam.)	......	......	......	......	......	......	——	-o-	......
Trochotiara depressa (Ag.) ...	......	......	*	*	......	——	......	——	......

A circle denotes the principal horizon or horizons at which the species occurs.

* An asterisk denotes that the species occurs at the horizon indicated in the Cotteswold Hills, but has not yet been recorded from the equivalent deposit south of the Mendips.

1. Geol. Mag., 1908, p. 512.

REMARKS ON THE SPECIES

ACROSALENIA

A single specimen, too imperfect for specific determination.

Top-Beds (*schlœnbachi*), Broadwinsor, near Beaminster.

CIDARIS BOUCHARDI Wright.

In our main paper specimens of this echinoid were recorded (p. 165) from the Doulting Stone of Vallis Vale, near Frome, and—on the authority of Wright—from the " *Parkinsoni* Zone " of Bridport.

It is now possible to add that this echinoid is by no means infrequent in the Top-Beds (*truellei-schlœnbachi*) of the Crewkerne-Burton-Bradstock district and more particularly in the rock of the later hemera.

Top-Beds (portion of *schlœnbachi* date).—Allotment and Larkfield Quarries, Burton Bradstock; Peas-Hill Quarry, near the New Inn, Shipton Gorge; " Garden Section," Shipton Gorge; Loder's Cross; Vinney Cross: (portion of *truellei* date) North Perrott, near Crewkerne: ?*Garantiana*-Beds, quarry near the Keeper's House, Hinton Park, Dinnington, near Crewkerne.

CIDARIS CONFLUENS Wright ex Forbes MS.[1]

The worn portion of a *Cidaris*, upon which this species is founded, is in the Museum of the Geological Survey at Jermyn Street [Reg. No. VII $\frac{5}{13}$]. It is labelled as having been obtained from the " Inferior-Oolite, Sunny Hill House, Frome." It must have come from the Top-Beds, as they are the only Inferior-Oolite strata present in the neighbourhood of Frome and probably from the portion of either *truellei* or *schlœnbachi* date.

It is impossible to say more concerning the specimen than that it may be a worn portion of *Cidaris bouchardi* Wright.

CIDARIS YEOVILENSIS Wright.[2]

The " type " is in the British Museum, South Kensington [Reg. No. E. 1660], and is labelled " Inferior-Oolite, Yeovil," The specimen consists of a single radiole, and it is probable that it came from one of the hard beds in the Yeovil Sands (of about *moorei* hemera) [E.T.P.].

1. " A Monograph of the British Fossil Echinodermata from the Oolitic Formations. Pal. Soc., pp 42 and 60.
2. *Ibid.*, pl. XVI., fig. 5.

CIDARIS cf. YEOVILENSIS Wright.

In the same bed as the plates of *Cidaris bouchardi* Wr. at the old quarry with the lime-kiln in it to the east of Loder's Cross, near Bridport, are numerous examples of club-shaped radioles. They do not appear to belong to *Cidaris bouchardi*, for in the British Museum pieces of the radioles of that species are seen to be long and narrow: they are nearest to that figured by Wright as *Cidaris yeovilensis*,[1] but more spherical.

CLYPEUS AGASSIZI Wright.

This species has been found to occur along with *Clypeus altus* M'Coy in the *Garantiana*-Beds of the Castle-Cary district and Woolston, and in the Top-Beds of places further south.

Top-Beds.—Burton Bradstock; Broadwinsor; Furzy Knaps, Seavington St. Mary, near Crewkerne (Bath Museum); *Garantiana*-Beds, Mill Pitch, between Hadspen and Cole, near Castle Cary.

CLYPEUS ALTUS M'Coy.

In our main paper, on page 163, it was stated that

> "*Clypeus agassizi* is found associated with *Clypeus altus* around Castle Cary, Bruton and Crewkerne. Towards the south it appears to give place entirely to *Clypeus altus*."

and on page 166, *Clypeus altus*

> "Occurs chiefly in beds of post-*garantianæ* date in Dorset."

These remarks were mainly based upon the information published by the Geological Survey.

We are now able to add that at Mill Pitch, between Hadspen and Cole, *Clypeus agassizi* occurs not uncommonly in the basal portion of the deposit of *garantianæ* hemera along with *Clypeus altus*; that *Clypeus altus* is fairly abundant in the *Garantiana*-Beds of Hadspen and Woolston, and occurs —along with *Clypeus agassizi*—in the Top-Beds of further south.

Top-Beds.—Dinnington: (portion of *schlœnbachi* date) Hensacre; Vinney Cross; Barrowfield Quarry; Horn Park; Broadwinsor: (portion of *truellei* date) road-cutting, Burton Bradstock; "Garden Section," Shipton Gorge; *Garantiana*-Beds, Mill Pitch; Hadspen and Woolston.

1. Monograph, pl. XVI., fig. 5.

COLLYRITES OVALIS (Leske)

This fossil is extremely abundant in the Top-Beds of the Burton-Bradstock district—especially in the portion which is of *schlœnbachi* hemera.

> *Zigzag*-Bed (*zigzag*)—Chideock Quarry Hill, near Bridport; Powerstock Station; Allotment Quarry, road-cutting and cliffs, Burton Bradstock; King's Pit, Bradford Abbas: Top-Beds, (portion of *schlœnbachi* date), Allotment Quarry; Walditch; Hensacre; Whaddon Hill; Horn Park; Broadwinsor; and North Perrott.

COLLYRITES RINGENS (Agassiz)

This echinoid is commonest in the neighbourhood of Burton Bradstock.

> *Zigzag*-Bed (*zigzag*)—Allotment Quarry, Burton Bradstock. Top-Beds (portion of *schlœnbachi* date); Allotment Quarry; Walditch, Vinney Cross; Bell Quarry, Lower Loders; Jack's Hill Quarry, Mapperton; Barrowfield Quarry; Whaddon Hill (Stoke Knap); Broadwinsor; Dinnington: (*truellei*) Half-Way House: *Garantiana*-Beds (*garantianæ*), Dinnington; Limekiln Quarry, Hadspen.

DIPLOPODIA PENTAGONA M'Coy

Specimens of this echinoid occur not uncommonly in the Upper Coral-Bed (*truellei*) of Dundry Hill and occasionally in the Upper *Trigonia*- and *Clypeus*-Grits of the Cotteswolds.

> *Truellei*-Deposit.—Stoford Quarry, near Yeovil Junction.

DIPLOCIDARIS DESORI Wright

The specimen upon which this species was founded[1] is in the British Museum, South Kensington [Reg. No. E. 1535] and consists of one large plate, coarsely granulated, with one tubercle. It is not well preserved and is labelled "Inf. Oolite, Yeovil." Wright thought it probably came from the "Upper Lias."

GALEROPYGUS AGARICIFORMIS Wright

In the Cotteswold Hills, this echinoid is very characteristic of the Pea-Grit—a deposit of *murchisonæ* hemera and occurs also in the *Scissum*-Beds. South of the Mendips it also characterises rock of *murchisonæ* and *scissi* hemeræ.

A closely allied form, however, occurs in Beds of *postdiscitæ* and *shirbuirniæ* dates in the Cotteswold. Whereas the

1. Monograph, pp. 56-58.

specimens from the *Murchisonæ* and *Scissum*-Beds have the base flat, or nearly so, those from the higher beds have it noticeably concave. This feature is exhibited by a specimen, which has been examined since our main paper was published, from the Gryphite-Grit (*shirbuirniæ*) of Charlton Common, near Cheltenham, as well as by that from the *Buckmani*-Grit (*post-discitæ*) of Withington, near Cheltenham, which was figured in our main paper, plate XVI, figs. 4*a* and *b*., under the name "*Galeropygus agariciformis* Wr."

Except for this difference in the matter of the base the specimens from all the horizons mentioned appear similar, but it is probable that this feature may ultimately prove to be sufficient for specific differentiation.

Bradfordensis-Beds.—Limekiln Quarry, Corton Downs. *Murchisonæ*-Beds (*s.l.*), Horn Park; Quarry near South Perrott; Lime-Works, Misterton; Strutter's Hill, Pitcombe, near Bruton.

GALEROPYGUS AGARICIFORMIS (Wr.) var. CONICUS Paris.

Another example of this variety has been obtained from Holway Hill, near Sherborne, from the beds of *murchisonæ* date.

HOLECTYPUS HEMISPHERICUS (Agassiz)

This echinoid is extremely abundant in the Top-Beds of Dorset and many individuals are of the conical forms—*H. hemisphericus* var. *conicus* Wr.

Zigzag-Bed (*zigzag*)—Allotment Quarry. Top-Beds.—Allotment Quarry; road-cutting and cliffs, Burton Bradstock; "Garden Section," Shipton Gorge; Walditch; Bell Quarry, near Lower Loders; Jack's Hill Quarry, Mapperton; Whaddon Hill; Barrowfield Quarry; Horn Park; Broadwinsor; railway-cutting and quarries Crewkerne: Upper *Trigonia*-Grit (*garantianæ*), Dinnington; Woolston; Shotwell; Hadspen; Lamyatt Hill, near Bruton (conical variety).

HYBOCLYPEUS GIBBERULUS Agassiz

This sea-urchin is rare.

Top-Beds (*schlœnbachi*)—Allotment Quarry, Burton Bradstock: (*truellei*) Loder's Cross; Dinnington.

HYBOCLYPEUS cf. OVALIS Wright. Pl. VIII, figs. 1*a* and *b*.

In the *Garantiana*-Beds of Hadspen a form of *Hyboclypeus*, nearest to *H. ovalis* Wright, is not uncommon and is associated with *H. subgibberulus* sp. nov. (see page 78).

Most of the specimens are indifferently preserved, so that the exact outline of the test is somewhat difficult to determine. Compared with the figure given by Wright (Monograph, pl. XXII., fig. 1) this form seems to be similar except in one respect, namely, in the relative length of the test. In the forms from Hadspen the outline appears to be subcircular, the breadth being very slightly greater than the length; while according to Wright's figure, the length is slightly greater than the breadth.

> Wright records his species "only from the marly fossiliferous vein which traverses the upper ragstones of the Inferior-Oolite, in the zone of *Ammonites Parkinsoni*, Sow., near Hampen, Gloucestershire, where it is associated with *Holectypus depressus*, Leske, *H. hemisphæricus*, Desor, *Pedina rotata*, Wright, *Clypeus Hugi*, Agass., *Clypeus Plottii*, Klein, *Trigonia costata*, Sow., *Pecten symmetricus*, Morris, *Ammonites Parkinsoni*, Sow."

This association suggests that the date of the deposit is *truellei*.

> Wright also adds that he has found "one specimen in the *Trigonia*-Bed at Cold Comfort [near Cheltenham], where it was associated with the large *Perna isognomoides*, Stahl."

The horizon from which this specimen came is doubtful, as there is now no *Trigonia*-Grit exposed at Cold Comfort, although the Upper *Trigonia*-Grit may once have been seen resting on the *Witchellia*-Grit, in which the *Perna*-Bed, from which many large *Pernas* have been obtained, occurred. In our main paper (p. 174), the specimen was queried as having come from the Lower *Trigonia*-Grit (*discitæ*), but in the light of the new record of a closely allied form (perhaps only a local variant) from the *Garantiana*-Beds of Somerset, it seems more probable that it came from the Upper *Trigonia*-Grit.

In the main paper a small specimen from the *Buckmani*-Grit (*post-discitæ*) of Tuffley's Quarry, Crickley, near Cheltenham, was referred to *H. ovalis* Wright, being regarded as probably the young of that species. The specimen, however shows no sign of the anterior elevation of the test, and the apical system, though not well shown, suggests that the specimen should be referred to *Galeropygus* and not to *H. ovalis* Wr.

Garantiana-Beds, Hadspen, Somerset.

HYBOCLYPEUS[1] WOOLSTONENSIS sp. nov. Pl. VIII. figs. 3*a*, *b* and *c*.

T.l. Woolston, Somerset.
Hor. *Garantiana*-Beds. ἠ. *Garantianæ*.
Colln. L. Richardson.

Description.—A very depressed form of *Hyboclypeus*, subcircular in outline, with a concave base. The two posterior ambulacra do not bend in towards the anal canal, but run straight across from the ambitus towards the posterior end of the apical system.

The apical system is not well shown in any of the specimens that have been examined, but from what can be seen of it, it appears to be similar to that exhibited by *Hyboclypeus ovalis* Wright.

Remarks.—In general appearance this species very closely resembles *Galeropygus agariciformis* (Wright). Apart from the form of the apical system, it differs from that species in the straightness of the two posterior ambulacra, and in being slightly more depressed. In *G. agariciformis* the two posterior ambulacra curve in towards the anal canal. These differences might be of use in identifying a specimen in which the apical region was not preserved.

The depressed circular form of the test and the absence of any anterior elevation distinguishes this species from *Hyboclypeus subgibberulus* sp. nov. (*infra*) and *Hyboclypeus* cf. *ovalis* Wright, which occur at the same horizon.

Garantiana-Beds (*garantianæ*)—Woolston.

HYBOCLYPEUS SUBGIBBERULUS sp. nov. Pl. VIII, figs. 2*a*, *b* and *c*.

T.l. Woolston, Somerset.
Hor. *Garantiana*-Beds. ἠ. *Garantianæ*.
Colln. L. Richardson.

Description.—An ovate, depressed form, the test elevated anteriorly after the manner of *Hyboclypeus gibberulus*, but much less conspicuously. The outline of the specimen figured approaches very nearly to that of Wright's figure of *H. ovalis*; it is, however, a more depressed form.

1. Detailed descriptions of the new species of *Hyboclypeus* have not been attempted, but attention is directed to those features which distinguish the species from allied forms. The detailed structure of the test (tuberculation, etc.) has not been studied.

Remarks.—At Hadspen, this species is found associated with what we have called *Hyboclypeus* cf. *ovalis* Wr. Both are undoubtedly near relations to *H. gibberulus*, which occurs at a slightly higher horizon, but *H. subgibberulus* would appear to be the more nearly related. It has not however the marked "crest" of *H. gibberulus*, it is more elongate, and lacks the posterior drooping "lip" at the end of the anal canal. From *H.* cf. *ovalis*, it is distinguished by being more elongate, more depressed, and in having the apex relatively nearer the anterior end of the test.

Garantiana-Beds (*Garantianæ*), Woolston and Hadspen, Somerset.

RHABDOCIDARIS ?

In the list on page 74, 2 "*Rhabdocidaris* ? (radioles only)" is recorded twice.

The one record refers to a portion of a very large radiole from the rock dated by Mr S. S. Buckman at Whaddon Hill, near Beaminster, as *schlœnbachi*, and the other to the record of a radiole from the deposit of the same date at the Lime-kiln Quarry, Loder's Cross, near Bridport.

STOMECHINUS BIGRANULARIS (Lamarck)

As remarked in our main paper, this species "seems to be common in this country only in Dorset" (page 177), and numbers of specimens were collected when the quarries in the neighbourhood of Burton Bradstock were in work. We remarked that "a single immature example, probably referable to this species, has been obtained from the Rubbly Beds of Doulting."

In the Bath Museum are several specimens from the Inferior-Oolite of Vallis Vale, near Frome, and one from the "I [nferior] O [olite ? *Anabacia*-Limestones] Tunley [near Radstock]."

We have now to add a mutilated specimen from the deposit which is probably of *truellei* date at Hadspen ; and another from the Top-Beds of Whaddon Hill.

TROCHOTIARA DEPRESSA (Agassiz)

The following records are additional for this sea-urchin, whose generic name was formerly "*Pseudodiadema*."

Top-Beds (*schlœnbachi*)—Peas-Hill Quarry, near the New Inn, Shipton Gorge: (*garantianæ*), Limekiln Quarry, Hadspen, near Castle Cary.

ERRATUM IN MAIN PAPER.

Page 155, Table I.—Insert "Lower *Trigonia*-Grit" between *Buckmani*-Grit and Upper Snowshill Clay.

EXPLANATION OF PLATE VIII.

FIGS. 1*a* and *b*.—HYBOCLYPEUS cf. OVALIS Wright.

1*a*—actinal view; 1*b*—lateral view.

Horizon: Hadspen Stone (*garantianæ*). Locality: Hadspen, near Castle Cary, Somerset. Collection: L. Richardson.

FIGS. 2*a*, *b* and *c*.—HYBOCLYPEUS SUBGIBBERULUS, sp. nov.

2*a*—actinal view; 2*b*—abactinal view; 2*c*—lateral view.

Horizon: *Garantiana*-Beds. Locality: Woolston, Somerset. Collection: L. Richardson.

FIGS. 3*a*,*b* and *c*.—HYBOCLYPEUS WOOLSTONENSIS, sp. nov.

3*a*—actinal view; 3*b*—abactinal view; 3*c*—lateral view.

Horizon: *Garantiana*-Beds. Locality: Woolston, Somerset. Collection: L. Richardson.

The figures are natural size.

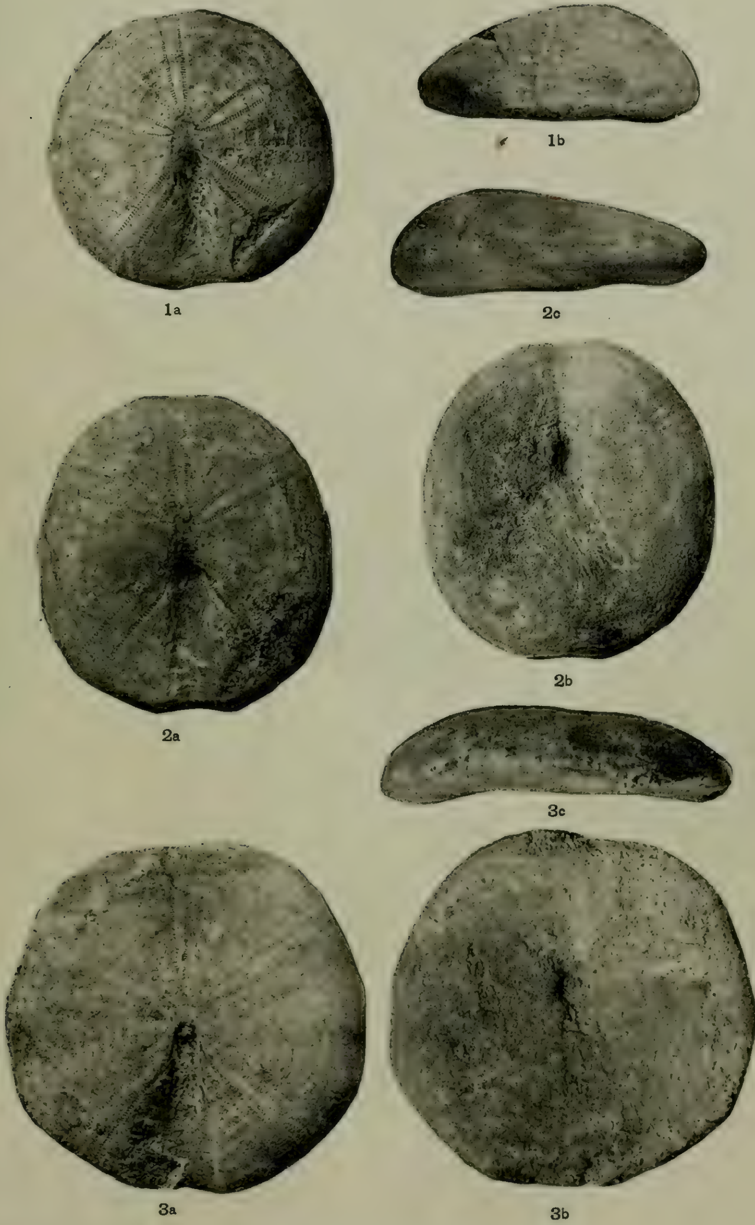


Photo E. T. Paris.

INFERIOR-OOLITE ECHINOIDS

Fissile Beds.

Massive-bedded coarsely-oolitic strata

Bottom Bed exposed.

GREAT-OOLITE STRATA IN QUARRY NEAR CHARLCOMBE FARM, LANSDOWN, BATH.

WELL-SINKINGS ON LANSDOWN, BATH

BY THE

REV. H. H. WINWOOD, M.A., F.G.S.

[Plate IX.]

(Read December 10th, 1912)

Three wells have been recently sunk on Lansdown, Bath. The first was sunk in 1908, and a record of the strata passed through was published in the Geological Magazine for 1909 (p. 119).

During 1912 two other wells have been sunk, but the sinking of one of them is not yet complete.

It is very desirable that records of the strata passed through in sections open only for a short time should be published, and attention called to any particular features.

Lansdown, I may remind you, is an elevated plateau capped with Great Oolite, and 780 feet above Ordnance-datum at its highest point. To the south-east, on the opposite side of the Avon Valley, "Brown's Folly," the highest point, is only 600 feet above Ordnance-datum. This hill, also, is capped with Great Oolite.

Notwithstanding the comparatively short distance between these two elevations, some three miles as the crow flies, the upper beds composing the two hills are entirely different.

Before discussing this matter, however, the details of the strata in the three wells must be given.

WELL-SINKING, No. 1.—The section noticed in the well on the Golf Course (No. 1 on map, fig. 1) has been described elsewhere (Geol. Mag., 1909, p. 119); it will suffice, therefore, to say that the thickness of the Great Oolite beds displayed above the Fullers' Earth was 31 feet 8 inches.

Fig. 1.—Map of Lansdown Hill, Bath.

WELL-SINKING, No. 3.—This well is situated in the Kingswood School playing-field, and I am indebted to Mr Workman, the head-master, for allowing me to watch the progress of the sinking. When the well-sinking reached the Fullers' Earth, the first spring burst out, but the sinking was continued to 23 feet 6 inches into the Fullers' Earth.

3.—WELL-SINKING ON LANSDOWN, BATH

		ft.	ins.
Great Oolite	Turf and thin fissile beds	6	0
	Thicker bedded strata of Oolite	19	0
	Shelly beds	8	6
Fuller's Earth	"The Cement Bed." Hard bed of blue shale; *Terebratula decipiens*, Dav.	1	6
	Blue clay: seen	22	0

The highest beds exposed in the well must be very near the top of the Great Oolite, because at a very slightly higher horizon, at the end of the same field, is a quarry in the Forest Marble.

The bottom-bed of the great Oolite is 2 feet thick, and rests upon a curious band of blue shale, called by the workmen "the Cement Bed." On examination with a lens, this bed was seen to contain several dark round polished-looking oolite-granules, and a large *Terebratula*, identified by Mr S. S. Buckman as "*Terebratula decipiens*, Dav., from the *Zigzag*-Zone." Mr L. Richardson concurs in this identification, but would hesitate to rely upon this evidence alone for suggesting a date.

WELL-SINKING, No. 2.—At the same time as well No. 3 was being made, another was being sunk at the south-eastern edge of the Lansdown plateau, overlooking Charlcombe Grove Farm, at a place 715 feet above Ordnance-datum.

2.—WELL-SINKING NEAR CHARLCOMBE GROVE

		ft.	ins.
Great Oolite	Fissile Beds	3	4
	Beds of Oolite, more or less thick-bedded ..	6	3
	Coarse-grained Oolite	1	6
Fuller's Earth	Clay: seen	84	0

Only two fossils were found here—a small *Gervillia* and a *Cardium*. The so-called "Cement-Bed" appeared to be absent, although nodules of blue close-grained limestone occurred here and there on its horizon.

About 200 yards to the north-east of this last well, and at the same altitude, 715 feet, is a quarry (Plate IX.) in which the beds are comparable with those proved in the well.

QUARRY NEAR CHARLCOMBE GROVE

		ft.	ins.
Great Oolite	Soil and fissile beds	6	0
	Massive-bedded coarsely-Oolitic stone	5	10
	Bottom-bed: seen	1	7

The dip is very slight on Lansdown. Therefore, since the top of the well on the Golf Course is 750 feet above Ordnance-datum, and the bottom of the quarry near Charlcombe Grove about 702 feet, it would seem that the thickness of the Great Oolite on the hill is about 48 feet.

At Box, however, the sequence and thicknesses of the beds are as follows :—

GENERALIZED SECTION OF THE GREAT OOLITE AT BOX[1]

"Upper Rags," etc.	Rubble .. .. Fine pale fissile Oolite with softer marly beds, shelly in places, and much false-bedded, with harder beds of fine-grained Oolite at or near the base	20 ft. to 35 0
	Coarse shelly Oolite, one bed being known as the "Scallet Rag" or "White Rag"	5 ft. to 10 0
	"Corn-Grit"	15 ft. to 20 0
	"Roof-Bed"	3 ft. to 5 0
Bath Freestone	Fine Freestone or "Ground-Bed" ..	12 ft. to 14 0
"Lower Rags," etc.	Stone-beds (proved in well)	30 ft. to 40 0
	[Fullers' Earth]	
	Maximum ..	124 ft. 0 in.

The difference in thickness between the Great-Oolite beds on the north and south sides of the Avon Valley is thus very noticeable. Only the "Lower Rags" are represented on the north side of the valley, the Bath Freestone and "Upper Rags," etc., are absent.

The late Charles Moore noticed this difference, and held that it was due to faulting in Great-Oolite times, whereby, while the ground to the south of the fault sank and continued to receive deposit, that to the north remained stationary, and the Freestone and "Upper Rags," etc., were not deposited.[2]

I hardly think Moore's "fault theory" will explain the absence of these beds on the north side, or account for the difference in level of the beds on the opposite sides of the valley. With regard to this, it has been suggested that the dip might account for the difference, but as the beds show little, if any, dip, and the distance between the two sides of the valley is so short, comparatively speaking, that, in my opinion, can hardly account for the variation.

1. Taken from "The Jurassic Rocks of Britain—The Lower Oolitic Rocks of England (Yorkshire excepted)" vol. iv. (1894), p. 267. Mem. Geol. Surv.
2. Proc. Bath Nat. Hist. and Antiqu. F.C., vol. ii (1869) p. 40

In conclusion, then, my object has been to draw attention to the following facts :—

1. The thinness of the beds representing the strata from the top of the Fullers' Earth to the incoming of the Forest Marble on Lansdown.

2. The rigid line of division between the Fullers' Earth and the lowest bed of the great Oolite.

3. The absence of Fullers' Earth Rock so far as at the depth of 84 feet.[1]

4. And the difficulty in accounting for the difference of level between the corresponding beds on the north and south sides of the Avon Valley.

1. According to a record of a well section at Beckford's Tower, on Lansdown, noted by Bristow, the Fullers' Earth was only 70 feet thick.

THE EFFECT OF GRASS OVER THE ROOTS OF YOUNG FRUIT TREES

BY

G. H. HOLLINGWORTH, F.R.H.S.

The fruit industry of Gloucestershire is an important one. In view of this, it is unfortunate that many orchards are not treated seriously enough : too little attention, in many cases, is paid to details of cultivation. Careful planting, judicious pruning, staking, and providing adequate protection, are essential ; but, in addition, it has been found very desirable not to allow the grass to grow over the roots of the young tree for a few years after planting. It was for the purpose of emphasizing the importance of this treatment that an experiment was started in an orchard planted under my direction on the estate of G. E. Lloyd Baker, Esq., at Hardwicke, near Gloucester, four years ago, and devoted entirely to apples for cider making. When the trees were planted, the general process was to cut up the turf taken from the surface when digging the holes, and put it in the latter before fixing the stake and planting the tree. The exceptions to this rule were a number of cases in which the turf was simply laid back over the roots and up to the stems after planting the trees. For four years, then, a circle about four feet in diameter round most of the trees has been kept free from grass by periodical hoeing, while in other cases the turf has grown up to the stems from the commencement. The following figures show the measurements of the stems 4ft. from the ground, which were taken in March, 1913 :—

Variety of apple.	Tree with grass over roots.	Tree with circle round stem 4ft. in diam. free from turf.
Royal Wilding ..	$3\frac{1}{2}$ inches. ..	$5\frac{1}{2}$ inches.
Medaille d'Or ..	$3\frac{1}{2}$,, ..	$5\frac{1}{4}$,,
Strawberry Norman ..	$3\frac{3}{4}$,, ..	5 ,,
Kingston Black ..	$3\frac{1}{4}$,, ..	$5\frac{1}{4}$,,
Sweet Alford ..	$4\frac{1}{4}$,, ..	$6\frac{1}{2}$,,

Not only are there the above differences in the girth of the stems, but the branches of the "grassed" trees are thinned by comparison ; the heads are not more than half as big as the rest, and they are conspicuously noticeable in the rows. The experiment proves that the little expense of labour entailed in occasionally hoeing round the trees is amply repaid by the growth they make.

OBITUARY

GEORGE BACKHOUSE WITTS, C.E., J.P.

By the death, on 6th September, 1912, of Mr George Backhouse Witts, the Club has lost a Member to whom it is greatly indebted for contributions to our knowledge of the Archæology of the County. The Rev. W. S. Symonds, Rector of Pendock, by his investigations on the banks of the Wye, proved the occupation of the western part of Dean Forest by Palæolithic man. The opening of the long tumuli at Uley (near Dursley), and at Belas Knapp (near Winchcombe), revealed numerous relics of early Neolithic men, but it was for Mr Witts, by his discovery and investigations of the West Tump long barrow (near Birdlip), to demonstrate with accurate detail their mode of life and the method of their sepulture, a work in which he had the invaluable help of Professor Rolleston, of Oxford. Subsequently he made a close study of the Prehistoric and Roman antiquities of the shire of Gloucester, and published the result in an *Archæological Handbook of the County of Gloucester*, in which he enumerated 40 long barrows, 126 round barrows, 113 ancient camps, 26 Roman Villas, and a large number of British and Roman roads. Later investigations have added to these lists, but Mr Witts's book still remains the most authoritative work on the subject. At the time of his death he was engaged in collaboration with our colleague Dr E. T. Wilson, of Cheltenham, in the compilation of a list of the flint implements, arrow-heads, found in Gloucestershire. The work is being continued by Dr E. T. Wilson, and, when completed, will throw a flood of light upon a somewhat dark period in the early occupation of the county by primitive man. J. SAWYER

E. A. WILSON, M.D.

Although Dr E. A. Wilson, one of the heroes of the ill-fated Scott Expedition to the South Pole, was not a Member of the Cotteswold Club, he was the son of an esteemed colleague, and a brief note of his work may fitly find a place in our obituary page. Like his father, he was a Naturalist by heredity, and training, and to him more than to any man, is the scientific world indebted for an addition to our knowledge of the fauna of the Antarctic regions. An artist as well as a naturalist, he has bequeathed to us a series of pictures of Antarctic life, such as had never before been seen, while the value of his contributions to physical science is cordially acknowledged by the leading Societies in Europe and America. It is gratifying to know that his name will be perpetuated by a memorial in Cheltenham, the home of his birth and early education. J. SAWYER

APPENDIX

REPORT (No. 5) ON THE PROGRESS MADE IN CONNECTION WITH THE FLORA OF GLOUCESTERSHIRE

By the Rev. H. J. Riddelsdell, M.A.

The work of preparing the County Flora has reached a stage which it is desirable to mark in a special way.

A good amount of work was done in 1912 by Mr Day, who worked at a definite area in the neighbourhood of Tetbury, and made systematic records; by Messrs Haines and Knight, and other workers. The President of the Club, and the Editor of the Flora, spent some weeks at Cranham, and made careful investigation of many places in the neighbourhood, with the assistance of Messrs Coley, Jolly, and other botanists. A number of new records, especially in critical plants, (*e.g. Rubus fuscus*, and its beautiful var. *macrostachys*, *R. scaber*, and the rare *R. botryeros*) were noted, and the distribution of some of the scarcer species more accurately gauged.

It is now proposed to follow the lead given by Mr F. H. Davey, who edited the Flora of Cornwall a few years ago. In preparation for the complete work, he issued a preliminary list of records a number of years previously. In this he collected all records, good and bad, available up to the date of issue; supplied blank interleaved pages, and issued it for the use of those who could help him in the further work of investigation. Workers thus had the whole of the facts available put before them. The danger of spending time over unnecessary work was escaped; a simple and easily available means of noting new records was provided. Botanists saw where it was necessary to follow up and re-establish an old record, where gaps needed filling, where there existed an ignorance of critical forms, etc.

It is proposed to follow this plan for the purpose of the Gloucestershire County Flora. The Preliminary List will be compiled as soon as possible, in a simple and straightforward way, with a few hints as to what is desired in the way of further work. It will take some time to compile, but when it is ready, and in use, it should certainly make the advance towards the complete Flora much more rapid.

For the purpose of this Preliminary List, workers are requested to send in all outstanding records as soon as possible.

The objects of the Club are to promote the systematic investigation of the Natural History and Antiquities of the County; to make excursions in the County and to other parts; to facilitate intercourse on scientific matters, and to aid in obtaining more general attention for the objects of Science.

Members are elected on a Certificate of Recommendation, signed by two Members, one of whom must have personal knowledge of the Candidate. The Admission Fee is £1; and the Annual Subscription is 15/-.

Winter Meetings are held at Gloucester, and there are frequent Field Meetings. Proceedings are published annually.

Forms of proposal for Membership and any further information may be obtained on application to the Hon. Secretary.

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*** The Publication Committee's decision as to the publication of any paper is final, and the Committee will not be able to consider any paper unless it is placed in the Secretary's hands within a month of its being read.

[*The Editor of the Proceedings of the Cotteswold Naturalists' Field Club is directed to make it known to the Public that the Authors alone are responsible for the facts and opinions contained in their respective Papers*].

VOL. XVIII. PART II.

PROCEEDINGS

OF THE

Cotteswold Naturalists' FIELD CLUB

FOR

1913

EDITED BY THE HONORARY SECRETARY

[With Plates illustrating Reports of Field Meetings and Papers by L. RICHARDSON and the late G. B. WITTS.]

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Books, Pamphlets, etc., presented to the Club should be addressed to the Librarian, the Cotteswold Club, Public Library, Gloucester.

Correspondence should be addressed to the Honorary Secretary, L. Richardson, 10 Oxford Parade, Cheltenham.

Subscriptions (15/-, due 1st January, each year) should be sent to the Honorary Treasurer, J. H. Jones, Eldon Chambers, Gloucester.

The undermentioned publications of the Club can be supplied at the following prices :—

			To Members			To the Public		
			£	*s*	*d*	£	*s*	*d*
Vol. I.	(not in parts) . .	1847–1853	0	10	6	0	15	9
,, II.	,, . .	1854–1860	0	10	6	0	15	9
,, III.	(with 4to plates) .	1861–1865	1	1	0	1	11	6
,, IV.	(3 parts) . .	1866–1868	0	10	6	0	15	9
,, V.	(3 ,,) . .	1869–1871	0	10	6	0	15	9
,, VI.	(4 ,,) . .	1872–1877	0	14	0	1	1	0
,, VII.	(2 ,,) . .	1878–1880	0	7	0	0	10	6
,, VIII.	(3 ,,) . .	1881–1885	0	10	6	0	15	9
,, IX.	(5 ,, with Supplem't*)	1886-1889	0	17	6	1	6	3
,, X.	(3 ,,) . .	1890–1892	0	10	6	0	15	9
,, XI.	(3 ,,) . .	1893–1894	0	10	6	0	15	9
,, XII.	(3 ,,) . .	1895–1898	0	10	6	0	15	9
,, XIII.	(4 ,,) . .	1899–1901	0	14	0	1	1	0
,, XIV.	(4 ,, with Supplem't†)	1901–1903	0	13	0	0	19	3
,, XV.	(3 ,,) . .	1904–1906	0	10	6	0	15	9
,, XVI.	(3 ,,) . .	1907–1909	0	10	6	0	15	9
,, XVII.	(3 ,, with Supplem't‡)	1910–1912	0	13	0	0	18	3
,, XVIII.	(2 parts published) .	1912–1913	0	7	0	0	10	6
	Cost of Set to date . .		£10	11	6	£15	15	9

* The Supplement to Vol. IX., is 'The Origin of the Cotteswold Field Club, and an Epitome of the Proceedings from its formation to May, 1887,' by W. C. Lucy, F.G.S.

† The Supplement to Vol. XIV., is the 'Contents of Proceedings,' Vols. I.–XIV. 1847–1903. To Members, 2/6; to the Public, 3/6.

‡ The Supplement to Vol. XVII., is the 'Index to the Proceedings,' Vols. I.–XVII. 1847–1912, by Roland Austin.

Vols. IV. and onwards are sold in separate parts, if required, at the price for each part—to Members, 3/6; to the Public, 5/3.

Vol. II. lacks the plate of Cirencester High Cross.

Copies of Vol. III., imperfect as regards plates of Crosses, will be sold at one-third reduction.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

PRESIDENT

REV. WALTER BUTT, M.A., J.P.

HONORARY SECRETARY

L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

Vol. XVIII. Part II.

1913

A

PRINTED BY JOHN BELLOWS
GLOUCESTER

OFFICERS OF THE CLUB

Elected January 21st, 1913

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10 Oxford Parade, Cheltenham

Hon. Assistant Secretary:

E. TALBOT PARIS, B.Sc., F.C.S.
15 Montpellier Villas, Cheltenham

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CHARLES UPTON

PRESIDENTS OF THE COTTESWOLD CLUB

[The names of those deceased are printed in *italics*.]

1846—1859	*T. B. Lloyd Baker*
1860—1888	*Sir W. V. Guise, Bart., F.G.S.*
1888—1894	*W. C. Lucy, F.G.S., F.A.S.L.*
1894—1900	M. W. Colchester-Wemyss, J.P., D.L.
1900—1902	E. B. Wethered, F.G.S., F.R.M.S.
1902—1904	C. Callaway, M.A., D.Sc., F.G.S.
1904—1906	Rev. Walter Butt, M.A., J.P.
1906—1908	W. R. Carles, C.M.G., F.L.S., F.R.G.S.
1908—1910	Rev. Walter Butt, M.A., J.P.
1910—1912	William Crooke, B.A., F.R.A.I.
1912—1914	Rev. Walter Butt, M.A., J.P.

HON. SECRETARIES OF THE COTTESWOLD CLUB

[The names of those deceased are printed in *italics*.]

1846—1854	*Sir Thomas Tancred, Bart.*
1854—1860	*Prof. James Buckman, F.S.A., F.L.S., F.G.S.*
1860—1862	*John Jones*
1862—1865	*W. C. Lucy, F.G.S.*
1865—1887	*W. H. Paine, M.D., F.G.S.*
1887—1894	E. B. Wethered, J.P., F.G.S., F.C.S., F.R.M.S.
1894 [died 19th Dec.]	*Prof. A. Harker, F.L.S.*
1895—1897	*The Rev. Canon E. Cornford, M.A.*
1897—1898	*A. S. Helps*
1898—1904	S. S. Buckman, F.G.S.
1904—	L. Richardson, F.R.S.E., F.L.S., F.G.S., A. Inst.W.E.

LIST OF MEMBERS

Honorary Members:

Year Elected	
1880	G. Embrey, F.I.C., F.C.S., Hill-close, 47 Park Road, Gloucester
✠1902	C. Lloyd-Morgan, LL.D., F.R.S., F.G.S., The University, Bristol
1902	H. B. Woodward, F.R.S., F.G.S., 85 Coombe Road, Croydon
✠1912	C. Callaway, M.A., D.Sc., 16 Montpellier Villas, Cheltenham
✠1912	Rev. Canon W. Bazeley, M.A., Matson Rectory, Gloucester
✠1913	Rev. H. J. Riddelsdell, M.A., The Old Registry, Llandaff

Members:

1911	Affleck, R. C., M.B., Ch. B. ..	Glendale House, Cheltenham
1909	Ainsworth-Davis, Prof. J. R., M.A. .	Royal Agricultural College, Cirencester
✠1913	Austin, Roland	5 Midland Road, Gloucester
1913	Baddeley, W. St. Clair, J.P. ..	Castle Hale, Painswick, Stroud
1910	Bailey, Charles, M.Sc., F.L.S. ..	Haymesgarth, Cleeve Hill, Glos.
1893	Baker, G .E. Ll., J.P.	Hardwicke Court, near Gloucester

1887	Ball, A. J. Morton	The Green, Stroud
1911	Bathurst, Right Hon. Earl, C.M.G. .	Cirencester House, Cirencester
1913	Bathurst, Charles, M.P., M.A. ..	Lydney Park, Lydney
1900	Baxter, Wynne E., J.P., D.L., F.G.S.	Granville Cottage, Stroud
✠1902	Bellows, William	Walden, Denmark Road, Gloucester
1900	Birchall, J. D., J.P.	Bowden Hall, Gloucester
1878	Bowly, Christopher, F.R.A.I., J.P.	Siddington House, Cirencester
1908	Bretherton, F. H.	Belgrave House, Gloucester
1911	Brown, C., C.I.E.	Southend Lodge, Leckhampton, Cheltenham
1912	Brown, O. A.	Shiel, Sandy Lane Road, nr. Cheltenham
1908	Brown, Walter	Radipole House, Bitterne Park,
1910	Bruton, Henry Tew	Newlyn, Gloucester [Southampton
1896	Bruton, H. W.	Bewick House, Gloucester
1893	Bubb, Henry, J.P.	Ullen Wood, near Cheltenham
✠1898	Butt, Rev. Walter, M.A., J.P. ..	Oakwood, Chepstow
1913	Butt, Walter	The Hyde, Newnham-on-Severn,
✠1904	Carles, W. R., C.M.G., F.L.S. ..	Silwood, The Park, Cheltenham [Glos.
✠1888	Chance, H. G., M.A.	Barnwood Court, Gloucester
✠1912	Clutterbuck, C. G., F.E.S.	16 Clarence Street, Gloucester
✠1893	Colchester-Wemyss, M.W., J.P., D.L.	The Bell House, Newnham
1906	Cole, R. M., M.R.C.S.	Northgate House, Gloucester
1905	Coley, S. J.	King Street, Stroud
1904	Collett, J. M., F.C.S.	Wynstone Place, Brookthorpe
1913	Crewdson, J. D., J.P.	Syde House, Syde, near Cheltenham
✠1904	Crooke, W., B.A., F.R.A.I. ..	Langton House, Charlton Kings, Cheltenham
1911	Croom-Johnson, A., J.P., F.G.S. ..	Fox Elms, Robinswood Hill, Glouces-
✠1909	Cullis, A. J., A.M.I.C.E.	21 Park Road, Gloucester [ter
✠1903	Cullis, F. J., F.G.S.	18 Alexandra Road, Gloucester
1893	Currie, G. M.	26 Lansdown Place, Cheltenham
1909	Daniels, J. S.	Lightpill, Stroud
1906	Dixon, J. M., B.A., LL.B.	Mickleton, Campden
1876	Ducie, The Earl of, F.R.S., F.G.S. .	Tortworth Court, Falfield, R.S.O.
✠1899	Duke, Lieut.-Col. J. C.	Gwynfa, Cheltenham
✠1883	Ellis, T. S., M.R.C.S.	10 Alexandra Road, Gloucester
1906	Finlay, D. E., M.B., B.S., F.Z.S. ..	Wells Dene, Park Road, Gloucester
1882	Foster, R. G., J.P.	Lennox House, Gloucester
1895	Fowler, O. H., M.R.C.S., J.P. ..	Ashcroft House, Cirencester
1912	Gardiner, C.I., M.A., F.G.S. ..	The College, Cheltenham
✠1891	Garrett, J. H., M.D., F.L.S., D.P.H.	Municipal Offices, Cheltenham
✠1903	Gray, J. W., F.G.S.	6 Richmond Pk. Cres., Bournemouth
1895	Grosvenor, W. W., B.A., M.D. ..	Granville House, The Spa, Gloucester
1883	Guise, Sir W. F. G., Bart., J.P., D.L.	Elmore Court, near Gloucester
1910	Haigh, Herbert	Coed Ithel, Llandogo, Mon.
1894	Hannam-Clark, F.	12 Queen Street, Gloucester

1913	Hanson C. O.	3 Malvern Place, Cheltenham
1878	Hartland, Ernest, M.A., F.S.A.	Hardwick Court, Chepstow
1903	Hedley, G. W., M.A., F.C.S.	The College, Cheltenham
1905	Hobbs, J. N.	Concord, Moorend Grove, Cheltenham
1907	Hooker, C. Paget, L.R.C.P., L.R.C.S.	Dollar Ward House, Cirencester
1910	Household, H. W., M.A.	4 Park Place, Cheltenham
1910	Hume-Rothery, J. H., M.A., B.Sc.	The Pines, Tivoli Road, Cheltenham
1913	Hurry, A. E.	Hempsted Court, Gloucester
1877	Jones, John H.	Barrow Hill, Churchdown, Cheltenham
✠1909	Knight, H. H., M.A.	The Lodge, All Saints' Villas, Cheltenham
1896	Knowles, H.	Egerton House, Spa Road, Gloucester
1912	Lawrence, E.	Southlands, Queen's Road, Cheltenham
1913	Leach, R. E., M.A.	Fairview, Painswick
1909	Little, E. P.	Amberley Court, near Stroud
1907	McAldowie, A. M., M.D., F.R.S.E.	Glengarriff, Leckhampton Road, Cheltenham
1891	Margetson, W.	Bright Side, Stroud
1913	Martin, J. Middleton, B.A., M.D., B.C., D.P.H.	The Chestnuts, Stroud
1867	Marling, Sir William H., Bart., J.P. D.L.	Stanley Park, Stroud
1888	Marling, W. J. Paley, J.P.	Stanley Park, Stroud
1887	Marling, S. S., J.P.	Stanley Park, Stroud
1901	Mitchinson, Right Rev. J., D.C.L., D.D.	College Gardens, Gloucester
1911	Montgomrey, A. S., J.P.	19 Royal Parade, Cheltenham
1912	Mylius, F. J.	Winchcombe, Gloucester
1878	Moreton, Lord	Sarsden, Chipping Norton, Oxon.
1902	Newton, Surgeon-Major Isaac, I.M.S.	Broadlands, The Park, Cheltenham
1899	Norris, H. E.	Cirencester
✠1891	Paine, Alfred E. W.	The Poplars, Welford-on-Avon
1913	Palin, P. Nevine, J.P.	Aylesmere Court, St. Briavels, Glos.
✠1906	Paris, E. Talbot, B.Sc., F.C.S.	15 Montpellier Villas, Cheltenham
1909	Pearce, F. T.	Lorraine House, Gloucester
1898	Phillips, J. G.	Barnwood Avenue, near Gloucester
✠1905	Prevost, E. W., M.A., Ph.D., F.R.S.E.	Weston, Ross
1908	Price, M. P., J.P.	Tibberton Court, Gloucester
1909	Price, W. R., B. A., F.L.S.	Pen Moel, Chepstow
✠1900	Richardson, L., F.R.S.E., F.L.S. F.G.S.	10 Oxford Parade, Cheltenham
1908	Rixon, W. A., J.P., C.C.	Turkdean Manor, Northleach, Glos.
✠1891	Sawyer, John, J.P., C.C.	Battledown, Cheltenham
✠1883	Scobell, Ven. E. C., M.A.	7 College Green, Gloucester
1878	Sewell, E. C.	The Beeches, Cirencester
1910	Sinclair, The Ven. Archdeacon	The Greenway, near Cheltenham

1913	Skillicorne, W. N., J.P.	9 Queen's Parade, Cheltenham
1903	Skinner, J. W.	The Edge, Stroud
1905	Slater, A., J.P.	Garron Dene, Gloucester
1882	Smith, A. E.	The Hollies, Nailsworth
1913	Smith, G. H. Pavey	High Beeches, Nailsworth
1909	Smithin, James A.	Lloyds Bank, Gloucester
1908	Stanton, A. W.	69 Oxford Terrace, London, W.
1862	Stanton, C. H., M.A., F.R.G.S. ..	Field Place, Stroud
1906	Stephens, A. J.	Clovelly, Denmark Road, Gloucester
1887	Taynton, H. J.	8 Clarence Street, Gloucester
✠1896	Thompson, W.	Lansdown, Stroud
✠1889	Upton, Charles	Rooksmoor, TuffleyAvenue, Gloucester
1889	Waller, F. W.	Horton Road, Gloucester
1894	Washbourn, William	Blackfriars, Gloucester
1911	Watkinson, A.	Mickleton, Campden, Glos.
1889	Watson, Dept. Surgeon-Gen. G. A. ..	Hendre, Cheltenham
1910	Weaver, Henry J., M.I.C.E.I. M.I.M.E., F.G.S.	Churchdown, nr. Gloucester
1905	Wenden, Major J. G., V.D. ..	The Chantry, Dursley
✠1880	Wethered, E. B., J.P., F.G.S. ..	The Uplands, Cheltenham
1912	Wilson, E. T., M.B., F.R.C.P. ..	Westal, Cheltenham
✠1884	Winnington-Ingram, Rev. A. R. ..	Lassington Rectory, Gloucester
✠1876	Winwood, Rev. H. H., M.A., F.G.S.	11 Cavendish Crescent, Bath
✠1896	Witchell, E. Northam	Lansdown, Stroud
1885	Wood, Walter B.	Barnwood, Gloucester
1913	Woodcock, F., M.A.	Claremont, Wotton-under-Edge

A cross signifies those who have contributed papers printed in the "Proceedings" of the Club.

(Any corrections in this List should be notified to the Hon. Secretary)

LIST OF SOCIETIES, INSTITUTIONS, &c.,

To whom Copies of the Club's Publications are presented.

An asterisk denotes those from whom publications are received in exchange.
All publications sent in exchange should be addressed to the Librarian, Cotteswold Club, Public Library, Gloucester.

* THE AMERICAN MUSEUM OF NATURAL HISTORY, Central Park, 77th Street and 8th Avenue, New York City, U.S. America, c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

†BIRMINGHAM NAT. HIST. & PHIL. SOCIETY, c/o The Librarian, Avebury House, 55 Newhall Street, Birmingham.

*†BOURNEMOUTH NATURAL SCIENCE SOCIETY, c/o Hon. Secretary, "San Remo," Boscombe, Bournemouth.

*†THE BRISTOL AND GLOUCESTERSHIRE ARCHÆOLOGICAL SOCIETY, c/o The Librarian, Eastgate, Gloucester.

*†THE BRISTOL NATURALISTS' SOCIETY, c/o C. King Rudge, L.R.C.P., 145 White Ladies Road, Redland, Bristol.

THE BRITISH MUSEUM (Natural History), The Librarian, Cromwell Road, London, W.

THE BRITISH MUSEUM (Copyright Office), London, W.C.

THE BRITISH ASSOCIATION, The Secretary, Burlington House, London, W.

THE CAMBRIDGE UNIVERSITY LIBRARY, c/o The Librarian, Cambridge.

*†The CARDIFF NATURALISTS' SOCIETY, c/o The Hon. Librarian, 98 Bute Street, Cardiff.

THE DERBYSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY, c/o P. H. Currey, Market Place, Derby.

THE GEOLOGICAL MAGAZINE, The Editor of, 13 Arundel Gardens, Notting Hill, W.

THE GEOLOGICAL SOCIETY, c/o The Librarian, Burlington House, Piccadilly, London, W.

* THE GEOLOGICAL SURVEY, c/o The Librarian, The School of Mines, Jermyn Street, London, S.W.

*†THE GEOLOGISTS' ASSOCIATION, c/o The Librarian, University College, Gower STREET, London, W.C.

* THE GLASGOW GEOLOGICAL SOCIETY, c/o The Librarian, 207 Bath Street, Glasgow.

THE GLOUCESTER MUNICIPAL LIBRARY, Brunswick Road, Gloucester.

THE LIBRARY, County Education Office, Shire Hall, Gloucester.

NATURE, The Editor of, c/o Messrs Macmillan & Co., St. Martin's Street, London, W.C.

*†THE NORTH STAFFORDSHIRE FIELD CLUB, c/o W. Wells-Bladen, Stone, Staffordshire

THE ROYAL SOCIETY, c/o The Librarian, Burlington House, Piccadilly, W.

THE SMITHSONIAN INSTITUTION (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

* THE U.S. GEOLOGICAL SURVEY (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*†THE WARWICKSHIRE NATURALISTS' AND ARCHÆOLOGISTS' FIELD CLUB, The Museum, Warwick.

*†THE WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY, The Museum, Devizes.

*†THE WOOLHOPE NATURALISTS' FIELD CLUB, c/o Hon. Librarian, Woolhope Club, Free Library, Hereford.

†The Presidents and Secretaries of these Societies are considered as Ex-officio Members of the Club, and are cordially invited to the Meetings; Programmes of Meetings to be sent to them as invitations.

INCOME AND EXPENDITURE FOR THE YEAR ENDING DECEMBER 31st, 1913

INCOME

	£ s d	£ s d
To Balance from 1912	3 18 1	
,, 1 Subscription for 1911 @ 15/-	0 15 0	
,, 3 Subscriptions for 1912 @ 15/-	2 5 0	
,, 103 do. 1913 @ 15/-	77 5 0	
,, 2 do. 1913 @ 10/-	1 0 0	
,, 8 Entrance Fees 1913	8 0 0	93 3 1
,, Archæological Society, Share of Rent to 31st Dec., 1913	14 0 0	
,, Sale of Proceedings	1 17 7	15 17 7
		£109 0 8

[Cash Assets—

Balance as on other side ..	£4 2 11
Subscriptions in arrear ..	3 15 0
	£7 17 11

and Subscriptions for 1914].

J. H. JONES, *Hon. Treasurer.*
Gloucester, 20th January, 1914.

EXPENDITURE

	£ s d	£ s d
By Hon. Secretary's Expenses..	10 4 2	
,, Treasurer's do.	15 0	
,, Cheque Book	5 0	
,, Bellows—Rent to 25th December, 1913 ..	12 0 0	
,, Library Expenses	7 6	
,, Public Library Rent and Insurance to 31st Dec...	1 3 6	
,, Pitcher—Lantern	18 0	
,, Bellows—Printing "Proceedings," &c. ..	46 3 8	
,, Printing, Stationery, etc. ..	1 10 6	
,, E. J. Burrow & Co., Blocks	1 1 0	
,, Coffee House Co.—Refreshments	3 0 0	
,, L. Herbert—Do.	2 8 0	
,, John Jennings—Printing Index	11 18 10	
,, Norman, Sawyer & Co.—Printing.. ..	11 10 1	
,, "Flora" Expenses, July, 1911—Nov., 1913	1 12 6	
		104 17 9
Balance in hands of Hon. Treasurer ..		4 2 11
		£109 0 8

Audited and found correct,
F. HANNAM-CLARK.
9th February, 1914

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to obtain the record of all details of geological interest, to promote the preservation of all antiquities, and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member, he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club; one dissentient in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (See Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot); but the President shall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in January, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and other Members forming the Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—All papers communicated to the Club shall be submitted to a Publication Committee, which shall consist of the President, Honorary Treasurer, Honorary Secretary, and two other Members appointed at the Annual Meeting. The decision of the Publication Committee shall be final. Any gentleman who favours the Club with Lectures on any subject shall be invited to furnish an abstract of the lecture for publication in the Proceedings of the Club.

13.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

S. S. BUCKMAN, F.G.S.
Honorary Secretary, 1898–1904.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

AT THE

ANNUAL GENERAL MEETING

21st JANUARY, 1913

THE REV. WALTER BUTT, M.A., J.P.

IN THE CHAIR

The Minutes of the last Annual Meeting were read, confirmed and signed by the Chairman.

The Hon. Treasurer presented his Financial Report, which was approved.

Letters of apology for inability to be present were read from the Rev. H. H. Winwood and Mr G. M. Currie.

The President then delivered his

ANNUAL ADDRESS[1]

We are holding this our Sixty-fifth Annual Meeting in January instead of April. The reasons for this change of date are various. The most important is probably this: the earlier date gives the Secretary a longer time to make arrangements for the Field Meetings, the first of which is held

1. In his Address the President gave some details of the monastic buildings, etc., at Abbotsbury. These have already appeared in the Proceedings, vol. xviii., pt. 1 (1912) pp. 35-38.—Ed

in May. We shall also be able to publish the reports of the Field Meetings, and the papers read at the Winter Meetings, earlier than heretofore. As regards the condition of the Club, I am glad to be able to report continued progress. We have lost by resignation several Members: by death, two. The death of Mr G. B. Witts was in a sense sudden, and will mean much for the welfare of the Archæology of our County—especially in its prehistoric aspect. Mr Cockshott had not been out with the Club of recent years. He was a most distinguished mathematical scholar, and did much to enhance the reputation of the School—my own—"where grateful Science still adores her Henry's holy Shade."

The Field Meetings were well attended, and I believe, and hope, passed off satisfactorily. I much regret that for a cause well known to you all, I was deprived of the pleasure of entertaining the Club at my house and of showing them the scenic and natural history attractions of Tidenham Chase. I ask to be allowed to have that pleasure this year.

I was only able to be present at the Long Excursion at Bridport. It was a most enjoyable one, its only drawback, so far as I know, being that we had no local archæologist to direct us. On our visit to Abbotsbury, we learnt but little or nothing about the Monastery.

I hope to be able in a few minutes to lay before you some information about it which may prove interesting, both to those who spent the only really hot day of the year in its vicinity—I include the Swannery, Gardens, Chesil Bank, and St. Catherine's Chapel—and to those too who are not of our Company.

The Club is greatly indebted to Mr Charles Bailey and to Mr J. M. Collett, for their generous hospitality. The visits to Haymesgarth, with its wonderful Herbarium, and to Kimsbury House, were much appreciated. Thanks are also due to Mr St. Clair Baddeley, an indispensable guide when Painswick or its neighbourhood is visited, and to Mr Winwood, one of our Vice-Presidents, for organizing and acting as leader when the Club visited Bath.

During the year a letter was received from the County Council enquiring which ancient Monuments the Club considered worthy of preservation under the "Ancient Monuments Act." On your behalf the Council replied that it thought the following ancient Monuments were worthy of permanent and adequate protection.

1. The Long Stone, Woeful Danes Bottom, near Minchinhampton.
2. The Hoar and Whittle Stones, near Lower Swell.
3. A Barrow at Nympsfield (this is in the field above Frocester Hill, and opposite to the entrance to Woodchester Park).
4. Belas Knap Tumulus, near Winchcombe.
5. Cleeve Hill Camp.
6. Uley-Bury Camp near Dursley.

The Hon. Secretary was instructed further to say that a few years ago Lieut.-Col. Fairfax Rhodes, of Brockhampton Park, at the suggestion of the Club, very readily took steps to protect Belas Knap; but that the "monument" was now mentioned because it was thought that if "officially" protected, it would receive yet greater respect from the public.

With regard to Uley-Bury Camp, he was asked to state that the Club had approached the owner, Mr Nigel R. F. Kingscote, with the view of staying quarrying at the foot of the rampart near the entrance (Proceedings, Vol. xvi., p. 195), and that Mr Kingscote had very kindly undertaken to see that quarrying should cease; but that the Council urged that this fine Camp should receive reasonable protection.

The Members will recollect that after the reading of Mr A. E. W. Paine's paper on a Cave in the Wye Valley, it was decided to co-operate with the Bristol and Gloucestershire Archæological Society in its exploration. Permission has been obtained from Mr Runciman to excavate, and it is hoped that during the present year it will be possible to proceed. The question is really very much one of finance.

The Club will be glad to know that our books have now been transferred to the Gloucester Public Library, on terms very satisfactory to ourselves and to the Library Committee. The books may now be borrowed at any time by the Members, and are available for reference by the Public. The indefatigable Librarian, Mr Roland Austin, has already made a complete list of the books, but it is thought advisable to delay its publication for a time.

With regard to the work that the Club is doing, you will be glad to hear that good progress is being made with the preparation of the County Flora. Mr Riddelsdell is doing a vast amount of research and collation in connection with it, and he is being ably helped by a number of botanists. Among these I should like to mention Mr S. J. Coley, and Mr W. Thompson, of Stroud, who both rendered Mr Riddelsdell and myself much assistance in the summer. Mr Jolly, of Sheepscombe, and Mr J. W. Skinner, of the Edge, also piloted us most usefully. Mr E. M. Day, of Minchinhampton, is one of our most tireless workers. He has been good enough for some years to take a particular district and work it thoroughly, visiting it regularly at different times of the year, and so being able to make a complete list of the plants within it. Mr H. H. Knight, apart from his special work on the Mosses and Lichens, is deserving of all praise for the assistance he has given to our general Editor. Another enthusiastic worker is Mr W. J. Greenwood, of Cirencester. He is always finding new and rare plants.

I hope that Members will do their best to assist those who are working at the Natural History of our County. Any plants that they think may be rare or have escaped notice, may be sent to me, and I will promise that they receive proper attention. And any plants that Members wish to have named, may also be sent to me, and if I am unable to name them, Mr Riddelsdell will be able to do so. Let me also say that the Herbarium at my house is open to the inspection of any Member. Information concerning temporary excavations or of damage, actual or possible, to Camps, Tumuli, and such like, should be communicated to our Hon. Secretary. He is careful to see that progress is made in the acquisition of information with regard to the Geology of the County, and has prepared two very valuable maps showing the distribution of the gravel, sand, and clay in the neighbourhood of Cheltenham.

Mr C. Bowly proposed a vote of thanks to the President for his useful address, and particularly for the great interest he had shown in the Club. He felt sure that every Member would warmly support his proposal that Mr Butt should be asked to serve for another year. Mr E. N. Witchell seconded, and the proposition was carried unanimously. Mr Butt then thanked the Members for this fresh expression of confidence in him.

The Vice-Presidents were re-elected, with the addition of Mr William Crooke.

The Hon. Treasurer, Hon. Librarian, Hon. Secretary, Hon. Assistant Secretary, and the four "elected members" of the Council, were re-elected.

The places and dates for Field Meetings were fixed as follows:—

Bournville and Birmingham University, May 20th.

Cirencester District, May 31st.

Tidenham Chase, near Chepstow, June 10th.

"The Junction," Gloucester-Sharpness Canal, June 28th.

Sherborne District, July 16th-18th.

Wotton-under-Edge, September 18th.

Mr P. Nevine Palin, J.P., was proposed for Membership, and the Rev. H. J. Riddelsdell was elected an Honorary Member.

ORDINARY WINTER MEETINGS

Tuesday, February 18th, 1913.

Rev. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

In a few words, sympathetically expressed, the President asked the Members to pass a vote of condolence with Dr E. T. Wilson, of Cheltenham, a respected Member of the Club, whose gifted son was amongst the little band which perished so nobly near the South Pole. Every one of them must feel deeply for the family—for the bereaved father and wife—but on such occasions the less said the better. They could not do better than leave it to the Secretary to convey this message of sympathy to Dr Wilson.

The President next introduced a subject with which Dr Wilson is intimately concerned, and to which, with the late Mr G. B. Witts, he has devoted much time and attention. This is the preparation of a list of the worked flints which have been found in Gloucestershire, and to this end Dr Wilson invites communications from anyone able to render assistance. The President brought to this meeting boxes containing many flints which had been collected by Mr Rooke in the neighbourhood of St. Briavels, and others collected by Mr C. H. Chapman and handed to Mr Rooke. The latter supplied the President with notes descriptive of the country where his flints were found. The President also mentioned that Mr W. Thompson, on behalf of Mr Eric Boucher, of Stroud, had brought some very fine specimens of arrowheads, found at Brimpsfield and neighbouring places.

THE STROUD MUSEUM

The President reported that at the Council Meeting held previous to the Ordinary Meeting the subject of the Stroud Museum and the apparent want of activity of those associated with it formed a subject for discussion. Letters, which had appeared in the Stroud papers complaining of the lack of organisation and initiative, were produced, and it was said that although a considerable sum of money had been bequeathed by a Stroud man for the special purpose of providing rooms at the Technical Schools, to be used as a Museum, the matter was now in abeyance, although numerous objects of interest had been contributed, and were already stored in the rooms, and others it was said would be given if the Museum were properly established. To this end the Council recommended that a letter should be forwarded to the solicitor acting for the Trust in question, and it was hoped the Members of the Club would sanction this procedure. It was felt that as their Club had shown interest in the Gloucester Museum and occupied a certain status in the county as an organisation formed to promote the study of Natural Science, it might very well endeavour to stimulate interest in the Stroud institution, which, if successfully established, would undoubtedly be much appreciated.

The Meeting cordially ratified the Council's suggestion.

Mr T. S. Ellis then gave a lantern lecture on "The Natural History of Rivers."

In reply to a request from the President to open the discussion, Mr Richardson said it was well-known to the Members that his views on river-development did not altogether coincide with Dr Ellis's. He said, however, that Dr Ellis's suggestion, made thirty years ago, had initiated the research into the history of the development of the Severn System, and his continued work had stimulated other investigators. He had drawn attention to the fact that most tributaries entered the parent river on the convex side, and the feature had been admitted. Also tributaries did influence, it was agreed, the deviation of the main river, but as to the manner in which the influence was effected he (Mr Richardson) differed from the author. He thought the Club was indebted to Dr Ellis for keeping the matter before the Members.

P. Nevine Palin, J.P., was elected a Member.

Tuesday, April 1st, 1913.

Rev. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

The following papers were read :—

1. "BOLLITREE, THE SUPPOSED SITE OF ARICONIUM." By *The Rev. Canon Bazeley, M.A.*

2. "NOTES ON THE LARGE BLUE (*Lycæna arion*) ON THE COTTESWOLD HILLS." By *C. Granville Clutterbuck, F.E.S.*[1]

Tuesday, November 11th, 1913.

Rev. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

It was announced that Messrs R. Austin, St. Clair Baddeley, A. E. Hurry, C. O. Hanson, W. Nash Skillicorne, and Dr Middleton Martin had been elected Members during the summer.

The Rev. A. R. Winnington-Ingram exhibited some fungi.

The following papers were read :—

1. "ANOTHER GLOUCESTERSHIRE ORCHID : *Epipactis atroviridis*, W. R. Linton." By *The Rev. H. J. Riddelsdell, M.A.*[2]

2. "THE WATER SUPPLY OF CIRENCESTER." By *T. Hibbert and L. Richardson.*[3]

Tuesday, December 16th, 1913.

Rev. WALTER BUTT, M.A., President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

Messrs Charles Bathurst, M.P., Walter Butt, J. D. Crewdson, G. H. Pavey-Smith, and R. E. Leach were elected Members.

1. Pages 157-158. 2. Pages 159-162. 3. Pages 175-184.

Mr St. Clair Baddeley exhibited a very fine sepcimen of a celt, the property of Mr T. D. Grimké-Drayton, found some years ago near the River Conway in North Wales.

Mr Charles Bailey exhibited French specimens of *Hypericum desestrangsii* Lamotte, a St. John's-wort, which Mr E. C. Salman has found growing at Lewes, in Sussex. This species has also occurred at Richmond, in Yorkshire, and Mr Bailey said local botanists should keep a look-out for its appearance on the Cotteswolds.

Mr Charles Upton exhibited specimens of the fresh-water shell *Amphipeplea glutinosa* (Muller) from Chalford—a new record for the County and a species not hitherto recorded from the West of England.

The following communications were made :—

1.—" Notes on Moreton-in-Marsh," by T. S. Ellis.

2.—" On a New Species of *Chara* and its Influence on our Water Supply," by G. Embrey, F.I.C., F.C.S., County Analyst.

Mr Ellis said in connection with the name Moreton-in-Marsh that he rejected the idea that " marsh " was a corruption of " march " or " mark," a boundary, and cited historical evidence to prove that the old name was Moreton (or Mereton) Hen-marsh. There was, he said, no inherent improbability of a marsh : on the contrary, the town is in just such a place as marshes commonly appear, *i.e.*, on the divide between two streams flowing in opposite directions—the Evenlode flowing southwards, and tributaries of the Stour flowing northward. Authorities teach us, he continued, that where, as at Moreton, two streams flow in opposite directions from what Mackintosh calls " the culminating area of a pass," a marsh is to be explained by supposing that these two streams are working backwards towards each other, and that sooner or later they will meet ; in other words, that it indicates a continuity of water for the far distant future. From this view Mr Ellis entirely dissents : his view is that it indicates a continuity of water in the far distant past.

Mr St. Clair Baddeley said that with regard to the name, the earliest evidence he had found went back to 1236. The suffix, prior to the 13th century, was Henmersche, Hennemers, Henmerse, Enmerse. In 1482 Morton-in-Henmerssh occurs. Hendred in Berkshire means Henril, a place where wild fowl were found. In Domesday Book Moreton appeared as a manor. The speaker pointed out that in near proximity to Moreton-in-the-Marsh were places named in much the same way—Bourton-on-the-Water, Bourton-on-the-Hill, Stow-on-the-Wold—and hence it might have happened that a sympathetic affinity of nomenclature was set up. The " the " was assumed in later times.

Mr Roland Austin, Librarian of the Gloucester Public Library, quoted the spelling of the name as given in a number of maps and documents, all being something like "Henmershe." The oldest map of the county, published in 1577, with the authority of Queen Elizabeth, gives the name as Moreton Henmershe.

With reference to the claim that the name means Moreton-in-March, *i.e.*, Moreton-on-the-mark, or boundary, Mr John Sawyer stated that the singular fact came to light when an Ordnance Survey index-map of the county was published a few years ago, that throughout almost all its length in Gloucestershire the Foss Way is a parochial boundary, and Moreton is on one side bounded by that famous road. Further, no other road in the county, ancient or modern, is a parish boundary for more than a short distance, so that the Foss Way was probably a tribal as well as parish boundary. While agreeing that historical records show that Moreton-in-the-Marsh is the right name, it was, he added, a singular coincidence that the other name should also have topographical support.

To this Mr St. Clair Baddeley rejoined that it was only a coincidence that a place with such a name should have been near a road or boundary. They must not confuse the Saxon word *mære*, a boundary, with the word *mere*, a moor.

Mr Embrey next spoke on what after investigation he had come to regard as a new species of *Chara*, a water-plant which formerly grew freely in the reservoirs supplying Gloucester with water, and for the removal of which an algicide (copper sulphate) had been employed with good effect, as also at Newport. The speaker referred to his student days and association with Ray Lankester, Thistleton Dyer, and other distinguished botanists. It was then that he prepared the drawings which he now proposed to show as lantern-slides. Twelve years ago the water supply at Gloucester was very bad, an offensive odour being always present. The speaker said he traced the cause of this to a fresh-water sponge attached to the *Chara*. When this was removed the odour was non-existent. This led him to the conclusion that it was not *Chara fœtida*, and after microscopic examination and culture of the plant he also felt sure that it was not *Chara fragilis*. By the lantern-slides the reproductive parts of the plant were shown, and it was upon the position of these and their general appearance that the speaker based his claim to have discovered a new species.

This opinion was not shared by Mr Charles Bailey, F.L.S., and the President, the latter pointing out that there were 14 species of *Chara*, *fragilis* having eight varieties and *vulgaris* six. Mr Bailey said he believed Dr Garrett had always regarded this particular *Chara* as *vulgaris*.

It was decided to leave the question open until next Spring, when complete specimens of the plant are obtainable.

EXCURSIONS

1913

EXCURSION TO BOURNVILLE AND BIRMINGHAM UNIVERSITY.

TUESDAY, MAY 20th, 1913.

Director : LOUIS BARROW.

(*Report by* L. RICHARDSON)

The First Field Meeting of the Club for 1913 was held on May 20th in the Birmingham district. Amongst those present were the Rev. Walter Butt (President), Mr W. Crooke (Vice-President), Mr L. Richardson, A. Inst. W.E. (Hon. Secretary), Lieut.-Col. J. C. Duke, Dep. Surg.-Gen. G. A. Watson, Messrs Charles Bailey, F.L.S., F. H. Bretherton, O. Brown, C. G. Clutterbuck, F.E.S., A. J. Cullis, A.M.I.C.E., G. M. Currie, G. Embrey, F.C.S., J. W. Gray, F.G.S., F. Hannam-Clark, J. N. Hobbs. E. Lawrence, F. J. Mylius, A. E. Smith, A. J. Stephens, etc.

The Members arrived at Bournville Station at 11.20 a.m. Here they were met by Mr Louis Barrow, of Messrs Cadbury Bros., Prof. Charles Lapworth, F.R.S., F.G.S., Dr J. Humphreys, F.L.S., F.G.S., Councillor Johnson (representing the Birmingham Park Committee), Mr A. Hayes (Principal of the Midland Institute), Mr W. J. Harris, and several Members of the Birmingham Natural History and Philosophical Society.

First the large boulders by the side of Bournville Lane were inspected. Prof. Lapworth gave a brief address, in which he told how these boulders were probably transported from the Arenig country to Birmingham, and of the climatic conditions that obtained during the Glacial Period.[1]

A move was then made to Cotteridge Park. Here, during the laying out of the park, a large number of boulders were unearthed. Mr Barrow has had many of them collected at one end of the park, and has presented a "Glacial Indicator" to show whence they came and by what routes. Boulders from the Arenigs predominate, and Mr Barrow gave a short discourse on the Arenig Glacier.[2]

Returning *via* the station, the Members then visited the magnificent baths for the girls' department, after which they proceeded by way of the men's recreation grounds to those of the girls. Here in the pavilion, Messrs Cadbury entertained the Members at lunch.

1. See pages 163–170
2. *Vide* Trans. Worcestershire Nat. Club, vol. v., pt. 2 (1912), pp. 268-269.

After lunch the President (Rev. Walter Butt) thanked the firm on behalf of the Club for their bounteous hospitality, and expressed pleasure at Dr Humphrey's presence. Mr Barrow and Dr Humphreys replied.

Mr Roland Austin and Mr A. E. Hurry were elected Members of the Club.

Mr William Crooke was appointed to represent the Club at the forthcoming meeting of the British Association at Birmingham.

Mr Butt stated that he had attended a reception given by the Lord Mayor of Bristol in connection with the jubilee celebrations of the Bristol Naturalists' Society. Their secretary, Mr Richardson, had unavoidably been prevented from doing so. As this was the first meeting of the Club after the event, he would like to propose that they congratulate the Bristol Society on the useful work that it has done, and offer their best wishes for its future. Mr Lawrence seconded, and the resolution was carried.

Leaving by way of the girls' recreation grounds and the almshouses, the Members boarded brakes and drove to the University buildings at Bournbrook. The Great Hall, Engineering, Mining, Metallurgical, Electrical, and other departments were inspected with the aid of Prof. Turner and Prof. Cadman, after which the Members proceeded into the city by tram, and left by the 5.40 p.m. train.

HALF-DAY EXCURSION DOWN THE COLN VALLEY.

SATURDAY, 31st MAY, 1913.

Director: E. C. SEWELL.

(*Report by* L. RICHARDSON)

The first half-day Meeting of the Club for 1913 consisted of an excursion down the far-famed Coln Valley. Those present included the Rev. Walter Butt (President), Messrs C. Bowly, F.R.A.I., and W. R. Carles, C.M.G. (Vice-Presidents), Mr L. Richardson (Hon. Secretary), Rev. C. H. Davies, Lieut.-Colonel J. C. Duke, Dr C. Paget Hooker, Messrs. C. Bailey, F.L.S., W. Bellows, F. H. Bretherton, A. J. Morton Ball, E. Hartland, H. H. Knight, E. Lawrence, F. Pearce, E. C. Sewell, J. W. Skinner, A. Slater, A. E. Smith, and several visitors.

The Gloucester and Cheltenham Members motored out to the Fosse Bridge Hotel, leaving the G.W.R. Station at Cheltenham at 2.15 p.m., and arriving at the hotel about 3.15. Here they were joined by Members from Cirencester, who included the President and Hon. Secretary. The procession of motor-cars then started on their journey down the valley. At Coln St. Dennis Church they were met by the rector, the Rev. L. B. Bubb, M.A., who showed them the interesting Church in his charge. It was raining when the Members entered, but shortly after leaving, it cleared up, the sun came out, and for the rest of the day the weather left nothing to be desired.

At Coln Rogers the Members had a glance at the Church and the fine old yew tree. Passing through Winson, the next halt was at Ablington, to see the home of their for all-too-brief-a-time and lamented fellow-member, the late J. A. Gibbs, author of "A Cotswold Village," a book that caused to be directed renewed attention to the beautiful scenery of and the quiet village life in the Coln Valley. Lieut-Col. Cyril Martyr most courteously gave the Members permission to view the Manor and grounds. The privilege was much appreciated, and the beautiful house, grounds, and river were seen under ideal conditions. The house was built in 1590, by John Coxwell, and the manor remains the property of his successors. Arlington Row, which has been represented on the walls of the Royal Academy, was also viewed and admired.

By kind permission of Mrs Cooper, the members had the opportunity of seeing Bibury Court and grounds. This beautiful house was built by Sir Thomas Sackville, a former lord of the manor, about the time of James I., and the date 1623 appears on the front of the house.[1]

The handsome Parish Church, which was also visited, occupies the site of an earlier Norman building, for there was a priest here in 1086, and there is some stone-work in the chancel wall which is thought to be Saxon.

Bibury is well-known in connection with its springs—the "Bibury Springs." These are situated in a garden, well cared for by the tenant of the Swan Hotel. The water issues forth from the junction of the Great-Oolite beds with the Fullers'-Earth clay—the same geological horizon as the Bisley Springs. It was unnecessary to remind the Members that the Coln is a river beloved of anglers: fish and fishermen were much in evidence. At Coln St. Aldwyn, the Manor House, the residence of Lord St. Aldwyn, was pointed out, beautifully situated on a flat projecting spur of high ground. At Quenington, the two richly-carved Norman doorways of the Church of St. Swithin were inspected. Surprise was exhibited at the ornate work and at the extreme interest of the tympana.

The subject of the tympanum of the North doorway is the Triumph of Christ over Death and Satan. Three souls are arising from Hades, symbolised by a whale, and are adoring their Saviour. Satan lies on his back, bound hand and foot, pierced through the mouth by the staff of our Lord's cross. The figure of a sun represents the First Person of the Holy Trinity. Above the doorway is a ram's head, much mutilated.

The subject of the tympanum of the South doorway is the mythical Coronation of the Virgin Mother, which, when thus treated, was considered to be symbolical of the Church Triumphant. The Second Person of the Holy Trinity is placing a crown on the head of his Mother, who holds a dove, the symbol of purity, and also of the Third Person. On either side are two symbols of the Evangelists: on the right, the Angel of St. Matthew and the Lion of St. Mark; on the left, the Bull of St. Luke and the Eagle of St. John.

The Members also climbed up into the building commonly called a "barn," and saw a very curious piece of roof work. From Quenington the party motored to Cirencester, across open Cotteswold country, fresh with unrestrained breezes, and part of an extensive tract over which in all directions pleasing views were obtained.

At The Beeches, Cirencester, Mr and Mrs E. C. Sewell entertained the Members at tea. The President, in well-chosen words, expressed the Club's appreciation of the welcome that had been extended to them; and Mr Sewell, in reply, said he had long awaited an opportunity of entertaining the Club, but he had always been forestalled by his friend Mr Bowly.

The party from Cheltenham then returned by way of the Cerneys and Colesborne to Cheltenham, arriving at the G.W.R. Station at 7.15, and so ended an excursion which was a source of pleasure to all concerned.

1. An account of Bibury Court and Ablington Manor will be found in "Country Life," Sept. 7th, 1912, or vol. xxxii., pp. 324–329.

EXCURSION TO TIDENHAM CHASE AND TINTERN

TUESDAY, JUNE 10th, 1913.

Directors: THE PRESIDENT, THE REV. H. J. RIDDELSDELL *and* L. RICHARDSON.

(*Report by:* L. RICHARDSON, THE REV. H. J. RIDDELSDELL, J. SAWYER *and* W. THOMPSON)

From time to time the Members pay return visits to the Wye Valley, for in addition to the geological and botanical attractions there is always the superb and well-nigh unrivalled scenery, to say nothing of the noble ruin at Tintern, the historical features of which have more then once been exploited. There were special reasons why this excursion should rank as one of the most enjoyable yet taken in this delightful locality. After a night of storm, persisting long after day had broken, an agreeable change brought the Cotteswoldians their almost invariable good fortune—a bright June day, at times quite balmy and never unpleasant. If the circumstances of the meeting had been ordinary there would have been a good attendance, but they were exceptional, for the genial and popular President, the Rev. Walter Butt, has acquired a charming property near Chepstow, and the day's programme included an invitation to visit Oakwood and partake of Mr Butt's hospitality in the form of luncheon. Hence, it was not matter for surprise that from various parts of the county a larger party than usual travelled to Chepstow.

Those present were: the Rev. Walter Butt (President), Mr W. R. Carles, C.M.G. (Vice-President), Mr J. H. Jones (Hon. Treasurer), Mr L. Richardson (Hon. Secretary), the Rev. H. J. Riddelsdell, Surgeon-Major I. Newton, Dep.-Surg.-Gen. G. A. Watson, Lieut-Col. J. C. Duke, Dr T. S. Ellis, Dr E. T. Wilson, Dr J. H. Garrett, Dr W. Shoolbred, Messrs R. Austin, Charles Bailey, O. A. Brown, H. W. Bruton, F. H. Bretherton, W. J. S. Burder, J. M. Collett, G. Embrey, R. G. Foster, O. H. Fowler, G. W. Hedley, H. Haigh, F. Hannam-Clark, H. E. Norris, W. Margetson, A. J. Morton Ball, F. J. Mylius, R. Price, J. Sawyer, W. N. Skillicorne, A. E. Smith, E. C. Sewell, J. W. Skinner, W. J. Stanton, W. Thompson, Chas. Upton, etc.

At Chepstow Station, which was reached at 10.10 a.m., the Members were welcomed by the President and his son-in-law the Rev. H. J. Riddelsdell. Three brakes and a motor-car provided driving accommodation, and having crossed the Wye the hill on the Gloucestershire side[1] was ascended to the residence of Mr W. R. Lysaght, who had kindly granted the necessary permission for the inspection of his remarkably fine collection of birds and his beautiful and extensive rock garden. Both are of super-excellence, and it is doubtful whether they are surpassed in Gloucestershire. Necessarily, only a limited time could be spared for this preliminary treat, and it was with some regret that farewell was said to Mr Lysaght's treasures. It seemed almost incredible that a rock garden containing nearly a thousand varieties of flowers had been created in so short a period as two years. In every respect the blending of art with nature has been so successfully accomplished as to produce just the effect desirable in this particular class of floriculture. The visit was well-timed, for June is *par excellence* the month when rock gardens furnish the greatest amount of satisfaction to the critical eye. [W.T.]

From Mr Lysaght's house the drive was continued to Oakwood, Mr Butt's residence. Oakwood also has its rock garden, in which its owner takes a keen pride, as was evidenced by the way in which he led his guests along its winding paths, drew attention to plant after plant of special interest or beauty, and rattled off their Latin names with an ease and accuracy which betokened long and loving study.

1. In the small cliff alongside the road is the little anticline depicted in Plate I. of vol. xv. of the Proceedings of the Club.—ED.

From the garden Mr Butt led the way through a wild coppice on his estate to an open spot on the edge of the cliffs, where the party looked over one of the most enchanting bits of scenery in the Lower Wye Valley. To their left, on the opposite side of the river, rose up the limestone cliffs of the Windcliff, crowned with their dark clump of trees, which is so well-known a landmark. Below them and to the right were limestone cliffs, wooded where-ever possible. In front, up the valley, was pointed out the conical hill beneath which is situated that far-renowned ruin, Tintern Abbey. Again the valley was seen under ideal conditions of light and shade, and after its beauty had been appreciated numerous questions arose as the reasons for the deep-cut valley and the precipitous cliffs. Mr Richardson, on being asked to say something on this point, in reply gave a brief outline of the geology of the district.

Returning to the house, many of the party inspected with great interest a collection of flint implements made by Mr Rooke at Newland and Bigsweir, and by Mr Burder from a field near Tidenham Chase. The flints are of a rude type, and it is difficult to decide whether the shape of some of them is due to man's handiwork or to natural causes. What is certain about them is that they were carried there by man, for the nearest rocks in which flints occur are many miles to the east. It is probable that they belong to the Neolithic Period, and they may be contemporaneous with man's occupation of the Lower Wye district at a very early date.

An early morning start from home, and the invigorating air of the high ground which had been traversed, had by this time created an appetite, and the party cheerfully accepted the kind invitation of the President to a sumptuous luncheon in his house, his hospitality being gracefully and gratefully acknowledged on behalf of the company by Mr W. R. Carles, a Vice-President of the Club.

TIDENHAM CHASE.

From Oakwood the drive was continued for a short distance and then the brakes were left and the party walked for about a mile and a half over the wind-swept and flower-decked moorland known as Tidenham Chase. The archæologists of the party at once made for a tall, tapering stone near the edge of the cliff which they took to be a menhir, or long-stone, such as was erected by man in prehistoric times. They were disappointed. Colonel Marling, V.C., of Sedbury Park, had the stone hauled there and set up as a memorial of the Queen's Jubilee! A few yards from the stone is a mound not unlike a round barrow, which is said to be the site of a Roman altar. About this nothing could be definitely advanced, but the President read the following notes, from George Ormerod's 'Strigulensia,' supplied by Mr Roland Austin, the Librarian of Gloucester Public Library.

"The village of Stroat [near this place] lies on the vicinal road from Venta to Glevum, which Leman, in his Commentary on Roman Roads (Hatcher's Richard of Circencester, p. 114), has included in his Ryknield Street. Its distances are between eight and nine miles from Caerwent, and four from the Roman Camp and Temple at Lydney. At this point of Stroat, on a rising ground to the south-west of the village, are vestiges of excavations and earthworks, much reduced and altered by agricultural operations and of unknown origin, which, combined with the former marshy banks of the Severn, would inclose a space of about ten acres, nearly oblong, but somewhat rounded on the south-west side, and which it is difficult to refer to anything but military purposes. The Gaerston Hill farm, adjoining, and Dinnegar to the north, evidently derive their names from them (as ancient names of unknown origin), but the appellations of "Street" preserved in the name of the village, and of the "Oldbury Field" (situated within the traces of earthworks), point as far as they go to Roman origin. A Camp, considered to be Roman, and authenticated by an uninscribed altar presented by the author to the Archæological Institute, exists on the Hill to the North of Stroat and Madgetts. Coins have been lately found in Tidenham Churchyard, and a Roman position discovered on the cliffs in Sedbury, within this parish, as described in subsequent pages." [J.S.]

The botanical work of the excursion was carried out almost entirely on Tidenham Chase. This is an extensive heath area at a considerable elevation, due to the occurrence of a Millstone-Grit-like deposit which in places caps the limestone district through which the Wye here flows. The character of the flora changes at once with the change of soil. The calcophile species—Rock-rose, Yew, Whitebeam, and the like—practically cease : the rare things of the Wye Cliffs, such as *Sedum rupestre*, *Viola calcarea*, are not to be found. The Heather and the two Heaths, *Erica cinerea* and *E. tetralix*, along with the Gorse, the Foxglove, and the Whortleberry, compose the mass of the vegetation, give a distinct facies to the whole district, and account for the peaty nature of the soil. The coarser sandy nature of the sub-soil, the presence of peat, and the much greater frequency of water, combine, with an enforced absence of cultivation, to account for almost every noteworthy botanical feature of the neighbourhood. The absence of these factors in a district like that of the Cotteswolds, and their presence, or the presence of similar factors in the colliery districts of the Forest of Dean, serve to show the connection of geological cause and botanical effect.

A few interesting cases of identity only serve to point the general contrast. The best one to mention is that of the fragrant Orchid, *Habenaria conopsea*, which is found in identical form both on the dry or wet spots of Tidenham Chase, and on the very driest slopes of the Cotteswolds, such as Selsley Hill or Rodborough Common. We may contrast with this the common Spotted Orchis. On the limestone, whether on the Carboniferous Limestone of Tutshill or that of the Oolitic Series of the Cotteswolds, it is found in a form which (under the name of *Orchis maculata*) shows three equal lobes to the lower lip of the corolla : but on the heathland, besides other variations, it differs by a great broadening of the two side lobes and a shortening and shrinking of the central lobe, which gives to the flower a new facies, and a new name, *Orchis ericetorum*.

The drier parts of the heath have their own peculiar vegetation, including the above-mentioned plants, several grasses (especially the rigid wiry *Nardus*, and the beautiful *Aira flexuosa*, the " Hair-grass "), little eyebrights, and so on. The great prize, however, is the local *Viola lactea*, a violet with pale blue or white flowers and very narrow leaves. Tidenham Chase, indeed, is probably the only place in England where this violet is known to hybridise with the common broad-flowered Dog Violet, *V. Riviniana*. *V. lactea* is here in considerable abundance, and so is the *true* Dog Violet, *V. canina*, which also occurs in a wood belonging to the President of the Club at 200 feet less elevation. It is quite possible that some of the puzzling forms found were hybrids between *V. canina* and *V. lactea*, but the specimens must be submitted to experts before a decision can be come to.

Perhaps the group of plants found in the wetter spots of the Chase excited the most general interest. A pond or two and a number of shallow gullies, widening here and there into bits of bog, sometimes containing quantities of *Sphagnum*—that is the sum total of the wet ground. Two lots of *Narthecium* were most welcome, a scarce plant in Gloucestershire and rarely flowering there, though near Bridport last year we saw a bog of many acres simply yellow with its fragrant spikes. A tiny white Buttercup with ivy-shaped leaves, *Ranunculus hederaceus*, occurred in a few spots; a square yard of Adder's-tongue fern ; a pond full of a beautiful representative—*Nitella opaca* of a low type of botanical organisms called *Characeæ*. The *Nitella* has long thread-like stems, with simple branches, all semi-diaphanous to the eye and softly silky to the touch, with the spores grouped in little red "nucules" about the branches; it lives wholly under water. Several Sedges, all thoroughly characteristic of the heath vegetation and none rare, together with some other closely allied plants, *Scirpus setaceus*—a tiny grass-like thing with a little blackish head of flowers near the top of its stem—and a very few stems of Cotton-grass (*Eriophorum angustifolium*). The last is curiously scarce in West Gloucestershire; there are many spots in the Forest of Dean that might be expected to have it, but they haven't. The most remarkable plants besides these were the lesser Lousewort, *Pedicularis sylvatica*, which this year has flowered so profusely as to give the whole common a red tinge; the small Marsh Pennywort, *Hydrocotyle*, with small leaves about the size of a shilling borne on a stalk which springs from the centre of the leaf, the whole plant trailing inconspicuously along the surface of the marsh and bearing tiny simple umbels of reddish flowers. The Purslane, *Peplis portula*, is frequent; its foliage, like so much of the smaller foliage of the marsh ground, is strongly tinged with red; the white heath Bedstraw, *Galium saxatile*, is common, and will in a few days, when it opens, be a prominent feature of the vegetation, as is also the Sheep's Sorrel and the Wood Betony. The chief rarity of the neighbourhood is the handsome *Rosa pomifera*. Three bushes, and three only, are known here; it is extremely scarce wherever it grows in England—and such places may be counted on the fingers of one hand. [H.J.R.]

After having studied the botany, the Members went to a place best described as situated below the "a" in the word "Chase" of Tidenham Chase on the Geological Survey Map, Sheet xxxv. Here there is a deep "swallow-hole."

The Secretary explained that the district in which they were was geologically, of synclinal structure. On the east, in the neighbourhood of Woolston, the Old Red Sandstone dipped westwards; on the west, in the neighbourhood of Tintern, eastwards. Above it came the Lower Limestone Shales (which contain rather clayey beds), Carboniferous Limestone, and, in two small outliers, clayey shales and gritty beds, which—on the Survey Map—are represented as Millstone-Grit. The gritty beds, especially when weathered, are very receptive of water, and the shaly beds hold it up until there is sufficient quantity or conditions are suitable for it to outflow.

On the south-west side of the Oakhill Wood outlier—the outlier to the north of that on which they were stood—water was to be seen, and some had been collected and was made use of at the neighbouring saw-mills.

On the Tidenham Chase outlier a considerable amount of the water available supplies Chase Farm, but it is obvious that the combined yield of the two outliers would be inadequate to rely upon as a safe source of supply for the elevated hamlet of Tutshill. At the place on the edge of the Chase located above, water from the gritty and associated clayey beds has found its way down through the limestone. It doubtless helps to swell the volume of water that issues forth near the place marked by the well in the bank of the Wye below "Oakwood," whence is derived the supply which at present supplies Tutshill. A large funnel-shaped depression has been originated at the place in question on the Chase. In wet weather it is partially filled, but the water soon disappears. There is a large hollow, apparently a "swallow-hole," in the field near Chase Farm, and another best described as "⅛-inch north of the 'e' in Dennel Hill" on the Geological Survey Map. [L.R.]

TINTERN ABBEY.

The ride was then resumed, Tintern being the objective, *via* Brockweir. The road is of a switchback character, necessitating frequent descent from the vehicles, but the views obtained during this part of the journey more than compensated for such slight inconvenience, and it was easy to understand how the poet Wordsworth rejoiced in his return visit to a country so rich in natural beauties.

"Though absent long,
These forms of beauty have not been to me
As is a landscape to a blind man's eye;
But oft, in lonely rooms, and 'mid the din
Of towns and cities, I have owed to them,
In hours of weariness, sensations sweet
Felt in the blood, and felt along the heart."

Familiar as the majestic ruined Abbey was to nearly every one of the Members, not a few were drawn within its grassy precincts once more to reflect upon the nobility of its design and the great structural skill displayed in its erection. Since passing into the hands of the Crown, steps have been taken to check the progress of weakening and decay at points where such attention was most needed. The heavy wooden supports will be tolerated because they were absolutely necessary, and there is no reason why the ruin, as it now stands, should not endure for many generations to come.

The story of Tintern Abbey begins in the closing years of the eleventh century. The Abbot of a Benedictine House in Burgundy, lamenting the degeneracy of the Benedictine Order, endeavoured to call back its disciples to the strictness of St. Benedict's rule by the establishment of a new Order. Its mother house was founded at Cistercium, a small hamlet in Eastern France, and hence the Order came to bear the name Cistercian. It quickly aroused the active sympathy of a large number of persons who were anxious to reform the Benedictine Order, and in less than a century nearly 2,000 Abbeys in Europe had adopted the Cistercian rule. The first Cistercian Abbey in England was founded at Waverley, a little town on the border of Hampshire; Furness was probably the second, and Tintern ranks third. The Order was a poor man's Order. "*Laborare est orare*" was a guiding principle of their life. That labour was spent upon the soil. The Cistercians were, in fact, farmers; agriculture was their business. Under their skilful planning and hard toil the solitary place was made to blossom as the rose; and, as Wordsworth puts it in his well-known sonnet on a Cistercian Abbey:—

"A gentler life spreads round the holy spires:
Where'er they rise the sylvan waste retires,
And aëry harvests crown the fertile lea."

The Cistercian house was, in truth, a house of hard work, without a taint of pauperism and without the dangers which attended the Mendicant Orders in later days. In accord with one of the guiding principles of the Order, the number of monks was small. Theirs it was to maintain the exacting offices of the Church and to direct and assist the labours of the tillers of the soil. The tillage was the work of a large number of lay brothers or Conversi, mostly illiterate, and taken from the lowest classes of the people. Yet all formed one family: employers and employed were in a true sense co-partners, all striving to maintain the dignity of labour. Thus, if we would picture Tintern in its palmy days, we must imagine the conventual buildings on the north side of the church peopled with two classes of inmates: a few white-habited monks, who for four hours a day recited the choir offices in their grand church, and devoted the rest of their waking hours to the cultivation and development of the Abbey lands; and a crowd of lay brothers, whose business it was to cultivate the soil to the best advantage, ever working with the inspiring guidance of men who regarded their high calling as involving a duty to man as well as to God.

E. Ballard, Photo.

View from the Windcliff over the horse-shoe bend of the Wye to Tidenham Cliffs, with the Severn estuary beyond.

The church to-day is not the church erected in the year 1131 by the founder of the Abbey, Walter de Clare, founder of the powerful family of Clare. That disappeared a century and a half afterwards, to make room for the edifice which, even to-day, despite its roofless walls, dismantled windows, and ruined mouldings, is without a peer. Its ground-plan is simple—just an ordinary cruciform, with a comparatively short Nave. Yet the visitor has only to step inside the west door to be struck with its noble proportions. For this effect there are two primary causes. One is that the entrance is down a flight of steps, a very unusual arrangement in England, though common on the Continent; the other is that the shortness of the Nave brings the Transepts and the Choir into prominent view. The grandeur of the edifice is, however, best seen from the crossing. There the majestic height and proportions of the arches, and the great piers of the arcades, with their small detached shafts, are exceedingly impressive. There, too, one can see how the four great arms of the church were filled with great windows, the beauty of which is indicated, though feebly, by the central mullion and the scanty remains of tracery in the eastern window. To the student of window tracery the tracery is of special interest, because, as Mr Blashill points out, "while it retains in its general design the purity of detail which marks the style of the thirteenth century, it seems to grasp all that is really admirable in the style of the forthcoming age." One feature of the church is in striking contrast to the churches of the period. As the Cistercians insisted upon quiet and repose in daily life and work, so they also insisted upon simplicity in their sacred buildings. Towers and peals of bells, sculpture and pictures, coloured glass in windows, were alike forbidden, while even the number of candles and lights was strictly limited. At Tintern the carving is limited to bosses which were necessary to hide the intersection of the vaulting ribs, and the same limited use of carving appears to have been true of the Cistercian Abbey of Hayles, which lies in a sequestered nook near the ancient town of Winchcombe. Finally, as to the general design of the church, it may be noted that, unlike Continental churches belonging to the Cistercian Order, the eastern limb of all English Cistercian churches has a square end, and there is no Lady Chapel. The square end is said to be due to the influence of a Dorsetshire monk who was one of the founders of the Cistercian Order, while the absence of a Lady Chapel is due to the fact that all the churches of the Order were dedicated to St. Mary.

Time permitted for a refreshing cup of tea on a lawn commanding an excellent view of the ruined Abbey, to which so many Americans as well as Englishmen make pilgrimage, and around whose dismantled walls and arches circle noisy jackdaws, as they have doubtless done for centuries.

The return journey to Chepstow was by way of the road which passes the Moss Cottage and the steps leading up the Windcliff. From this point the party looked across the valley to Mr Butt's summer-house, perched high on the cliff, and so were able to take farewell of Oakwood, and to carry away to Chepstow station, and thence to towns and villages of Gloucestershire, recollections of unqualified enjoyment. [J.S.]

HALF-DAY EXCURSION DOWN THE GLOUCESTER AND SHARPNESS CANAL TO "THE JUNCTION."

SATURDAY, JUNE 28th, 1913.

Directors: A. J. CULLIS, C. UPTON *and* THE PRESIDENT.

(*Report by* W. THOMPSON *and* L. RICHARDSON)

The Members who attended this excursion were:—The Rev. Walter Butt (President), Mr Charles Upton (Vice-President), Mr J. H. Jones (Hon. Treasurer), the Rev. A. R. Winnington-Ingram, Dep.-Surg.-Gen. G. A

Watson, Lieut.-Col. J. C. Duke, Messrs Charles Bailey, F.L.S., F. H. Bretherton, C. G. Clutterbuck, F.E.S., J. M. Collett, F.C.S., A. J. Cullis, F. J. Cullis, F.G.S., G. M. Currie, J. S. Daniels, T. S. Ellis, O. H. Fowler, J. N. Hobbs, H. Knowles, F. Hannam-Clark, E. P. Little, E. Lawrence, A. S. Montgomrey, W. J. Stanton, A. J. Stephens, and W. Thompson.

Assembling at Llanthony Bridge at 2 p.m., the Members were welcomed on board the launch Sabrina, the property of the Sharpness Docks and Canal Company, by Mr A. J. Cullis, their engineer, and Mr J. H. Jones, the Vice-Chairman of the Company. The run to "The Junction" was made without a stop, the time being occupied in conversation and noting such flowers as *Genista tinctoria* (Dyer's Greenweed) and *Melilotus officinalis* (Yellow Melilot), which are rather abundant by this waterway. [W.T.]

Between the end of the straight length of the Canal near Quedgeley Court and the portion half-a-mile to the west of Hardwicke Court, the waterway is for the most part in cuttings in the Lower Lias.

When the tow-path immediately to the north of Upper Rea or Sym's Bridge was lowered, pieces of *Ammonites* (*Arietites*) *turneri* Wr. *pars* non Sow., were found (L.R.) which showed that the clay from which they came was of *turneri* hemera.

Between Sym's and Lower Rea Bridge two beds of limestone floor the edge of the tow-path. They contain *Gryphæa arcuata* (Lam.), *Rhynchonella* sp., *Lima gigantea* (Sow.), etc. The clay immediately below them is very fossiliferous, containing *Ammonites* (*Arnioceras*) *miserabilis* Quenstedt,[1] *Amm.* (*Agassizoceras*) *sauzeanus* (*d'Orb.*), *Gryphæa arcuata* (Lam.), *Lima, Pecten* (*Chlamys*), *Nuculana, Rhynchonella, Spiriferina,* etc. [L.R.]

At "The Junction" the party disembarked, and, led by the President, walked along the tow-path of the Stroudwater Canal to the Severn. Mr C. Granville Clutterbuck found *en route* the tortricid moth, *Epiblema* (*Ephippiphora*) *turbidana* Tr. The specimen has since been submitted to Mr E. Meyrick, F.E.S., who has confirmed the identification. This moth has not been previously recorded from the County.

The River Frome, just completing its course, runs parallel with the last bit of the Stroudwater Canal, and growing between the fast-flowing stream and the stagnant waterway is a large quantity of Hemlock (*Conium maculatum*). There was no mistaking the red stems and finely-cut leaves. Indeed, the whole habit of the plant is distinct. The canal-bank bears Comfrey (*Symphytum officinale*), white and purple in abundance, and on the surface of the water rest the showy *Nymphæa lutea* (Yellow Water Lily), and the leaves of *Sagittaria sagittifolia* (Arrowhead). The flowers of the latter have yet to appear. The yellow water lily throws off an odour resembling brandy, and in some places is called the brandy bottle. The Turks are said to prepare a cooling drink from the flower, but it is questionable whether the confirmed drinker of *cognac* would be inclined to abandon his favourite "tipple" for the Turkish brew. Other flowers noted were *Juncus effusus* (Soft Rush), *Acorus Calamus* (Sweet Sedge) *Ranunculus circinatus, Scutellaria galericulata* (Greater Skullcap) *Rumex Hydrolapathum* (Great Water Dock), and *Lepidium Draba* (Pepperwort) The last named is not a native of Britain, but was brought over from Flanders at the close of the Walcheren Expedition in the bedding used by the troops. Owing to the Plague, the bedding had to be destroyed, but the Pepperwort managed to seed, and now is widely distributed. Among other places it is to be found on the canal bank near Hempsted, in Tuffley Avenue, and between "The Junction" and the Severn. One of the first places where it established itself after it first put in

1. Specimens of *Ammonites miserabilis* have also been found (by L.R. in 1903) in the old disused clay-pit at Lower Rea, which has now (1913) been abandoned some 25 to 30 years.

an appearance on the banks of the Medway, where the troops were put in quarantine, was in a field close to Chepstow Castle, and it is still found there in quantity. Several years ago, when the Club was driving near Northleach, this plant was noticed and commented on.

Among other plants noticed were *Plantago maritima, Plantago Coronopus, Cardamine amara, Œnanthe fistulosa, Cnicus arvensis* (var. *setosus*), *Spergularia marginata, Glaux maritima, Butomus umbellatus, Carex riparia, Callitriche stagnalis, Potamogeton perfoliatus, Potamogeton crispus, Potamogeton pectinatus, Lathyrus Nissolia, Galium palustre, Radicula* (*Nasturtium*) *aquatica, Senebiera pinnatifida, Scrophularia nodosa, Lythrum Salicaria, Sclerochloa distans* (not native), *Myriophyllum spicatum, Lycopus europœus, Myosotis scorpioides.*

Whilst seated on the Severn bank, near the mouth of the Frome, Mr T. S. Ellis directed attention to the theory he tenaciously holds with regard to the action of a tributary on the bank of the river it joins. Briefly stated, this is that the tributary, in combination with the current against which it sets, has the effect of making the bank through which it has cut concave, and does not, as some assert, cause the main stream to set up concavity on the opposite side of the river bed. Certainly the entrance of the Frome into the Severn would seem to corroborate Mr Ellis's contention. On Saturday the little stream which travels down the Chalford Valley, and then passes by way of Stroud, Dudbridge, Ryeford, and Kingstanley to the Severn, was both rapid and foul. Even while the Cotteswoldians watched its junction with the greater river the volume perceptibly increased, and this was said to be attributable to the opening of hatches—a customary week-end undertaking—along the line of mills which for so many years has been indebted to the Frome for assistance.

The President, referring to the Roman altar which is supposed to have once stood on Tidenham Chase, said that since the last meeting he had received a communication from Stonehouse to the effect that the missing stone was to be seen at Sedbury Park. Unfortunately this was not the case. He had seen what was visible at that place, and the relics were certainly not of Roman origin, but of a comparatively modern date. The mysterious thing was that local archæologists should have permitted anything in the nature of a Roman altar to pass entirely from human vision.

The return trip to Gloucester was made in time to enable Members from Cirencester, Stroud, and Cheltenham to make use of convenient trains, but before the final disembarkation the President in the name of the Club thanked Mr Cullis for his great kindness, and Mr J. H. Jones for the travelling facilities provided by the Canal Company. [L.R.]

EXCURSION TO THE SHERBORNE DISTRICT, DORSET.

WEDNESDAY—FRIDAY, JULY 16th TO 18th, 1913.

(*Report by* L. RICHARDSON)

Directors: REV. CANON GORDON WICKHAM, REV. H. C. SYDENHAM, REV. C. F. POWYS, ALFRED GATES, REV. S. A. SELWYN *and* L. RICHARDSON.

Last year the Long Excursion of the Club was held in South Dorset; this year in North Dorset.

WEDNESDAY

The Members met at the Digby Hotel, Sherborne, at 12 o'clock on the Wednesday, and after lunch drove out to Half-way House, a hamlet half-way between Sherborne and Yeovil. On the outskirts of the town they saw the Sherborne Ladies' College, modelled on the lines of that at Cheltenham, and run by Miss B. C. Mulliner, M.A., late of the Cheltenham Ladies' College. At Half-way House the Members were met by the Hon. Secretary and Mr Charles Upton.

The Rock-Cottage Quarry was entered, and the Hon. Secretary proceeded to give a brief account of the geography and geology of the district. He said that, as the Members knew well enough, above the Middle Lias came the Upper Lias, and above the latter the Inferior Oolite. The Upper Lias in this district was some 150 to 200 feet thick. The bottom-portion consisted of thin limestones and clays, which graduated up into yellow sands—the Yeovil Sands. The top-bed of the Sands was very hard, was called the "Dew-Bed," and was the rock they saw at the bottom of the quarry, and on whose very level surface some of them were seated. At about five feet above the top of the Dew-Bed was a rubbly-looking deposit, almost composed of the valves of a shell called *Astarte obliqua* (see Plate XII., fig. 1). This *Astarte-obliqua*-Bed was of the same age as the Upper *Trigonia*-Grit of the Cotteswolds (*garantianæ*), so that here, between the top of the Upper Lias and the rock of *garantianæ* date, they had some 5 feet of rock as against some 194 feet at Leckhampton Hill, near Cheltenham. The intervening rock here at Rock Cottage Quarry was full of ammonites, and many specimens were obtained.

From Half-way House the Members drove *via* Babylon Hill, to the top of "Bradford Hollow Way" (Plate XII., fig. 2). Here they got out of the brake and walked a short distance down the lane, which is very deeply-sunk in the Yeovil Sands. The trackway is an old one, and most likely the lowering of it has been mainly effected by the traffic of bygone days.

The next stop was at the Baggerbush-Lane Quarry. Here crowds of ammonites were found—some loose, others packed like plates in the rock.

From the quarry the Members went to Bradford-Abbas Church, where they were received by the Vicar, the Rev. Canon Gordon Wickham. The Church was erected about 1480 by Abbot Bradford of Sherborne and is perpendicular throughout. At the eastern end of the south wall is "the Priests' Porch" which was much admired. The Tower, which reminds one of those in Somerset, is regarded as the best example of its kind in the County. After having pointed out the principal features of interest in his Church, the Canon and Mrs Gordon Wickham most kindly entertained the Members at tea, and showed them round their charming garden, which extends down to the Yeo.

On the way back to Sherborne a brief visit was paid to Wyke Grange, a moated farm-house, which is said to have been used by the Abbots of Sherborne as their summer-quarters. The manor was afterwards held by the family of Horsey for a long period. Over the main door is the date 1650, the year in which the building was restored or altered. Near by are two mediæval barns with fine timbered roofs.

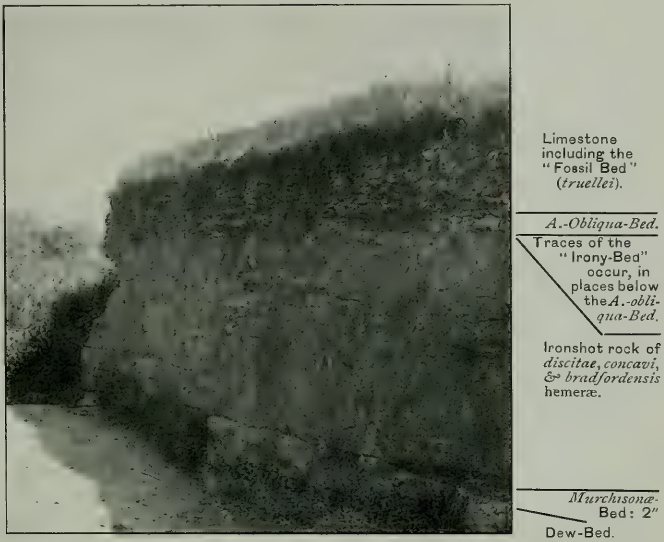
THURSDAY

On Thursday the Members left Sherborne at 9.37 a.m., and went by train to Yeovil.

At the Church of St. John the Baptist the Members were met by the Vicar, the Rev. H. C. Sydenham, who very kindly pointed out the chief features of interest in his Church.

It is built mainly of whitish Upper-Lias limestone, quarried near by, and has been called "The Lantern of the West," on account of the very narrow wall spaces between the windows.

At 11.37 a.m., train was taken to Montacute. From the station the Members walked to Montacute House. This magnificent mansion belongs



T. W. Reader, Photo.

Fig. 1.—View of a portion of the Rock-Cottage Quarry, Halfway House, near Sherborne.

T. W. Reader, Photo.

Fig. 2.—View of "Bradford Hollow-Way" (in the Yeovil Sands), near Yeovil.

T. W. Reader, Photo.

Fig. 1—View of a portion of the large quarry in the Ham Hill Stone on Ham Hill.

Fig. 2.—Tower of East-Stoke Church and the truncated conical St. Michael's Hill.

to the Phelips family, but at present is in the occupation of Mr R. Davidson. Mr Davidson had very kindly given permission for the Members to walk through the grounds, and thereby obtain near views of the house.[1]

The grounds are laid out in the Italian style. The house is constructed entirely of Ham Hill Stone, and is believed to have been planned about 1580, by John of Padua, for Sir Edward Phelips, at that time Master of the Rolls and Speaker in the House of Commons. It is built in the form of the letter E, both east and west sides. Between the wings of the western side has been inserted a gorgeous "screen," which was removed from Clifton Maybank, near Bradford Abbas.

From the house the Members proceeded to the Church, where they were met by the Vicar, the Rev. C. F. Powys.

After a bread-and-cheese meal at the village inn, the Members commenced the ascent, from the back, of Ham Hill. Before leaving the village, the beautiful remains of the Cluniac Priory[2] were viewed and admired. All that is left is a gateway, a tower, and a small wing, now used as a farmhouse. Mounting high above the old Priory buildings is the conical, tower-crowned hill now known as St. Michael's Hill, but formerly as Mons Acutus. It is steeped in Danish tradition.

The tower on this hill (shown in Pl. XIII., fig. 2) was built in 1791 by one of the Phelips's as a sort of look-out tower—a "folly" in fact.

The road up the hill is deeply-sunk in the Yeovil Sands, and "burrs," hard masses in the sands, project from the sides.

At the top of the hill, Dr T. S. Ellis made some remarks on the origin of the combes near by, and then the Members went into the Rocks Quarry. Here, in the upper portion of the quarry face, was displayed yellow sand full of sand-martin holes; in the lower, brownish rock practically made up of shell fragments, with sandy layers. In the sandy layers, crushed specimens of a *Rhynchonella* of the *Rhyn.-cynocephala*-Group is not uncommon. This shelly rock is on the horizon of "The Riddings" of the next quarry that the Members visited. At the Rocks Quarry it is worked for road-stone.

From this quarry the Members walked to the works and quarries belonging to the United Stone Firms, Ltd. The works are fitted with saws, planing and moulding machines for sawing and moulding the stone, and include extensive masonry shops, where work can be carried on continuously in any weather.

The stone is of a very pleasing colour, and harmonises well with any surroundings. It dresses well, and it is not surprising that it has long been worked and has furnished material for most of the renowned towers, churches, and mansions in the West Country.

The great quarry is about 90 feet deep (Plate XIII., fig. 1). In descending order there is exposed :—

1. Sand—seen about		10ft.
2. "Riddings"		30
3. Ham Hill Stone	Yellow Beds	33
	Grey Beds	15
4. Bottom Bed—hard sandstone		1½

Below the "Bottom-Bed," it is generally believed, come yellow sands, and therefore the Members were surprised to find water standing in a fissure in the bottom of the quarry. The foreman had been equally surprised at the discovery, and that was why he pointed it out.

1. A well-illustrated account of Montacute House will be found in "Country Life," vol. iii., pp. 464, 496 and vol. xv., p. 424.

2. The Cluniac Rule was founded by Odo, Abbot of Clugni (Burgundy) in the 10th century, in order to revive the strictness of the Benedictine Order coupled with an additional regulation which gave an idea of greater sanctity.

The Ham Hill Stone belongs to the Upper Lias, and to the *Moorei*-Zone of that Stage. It is therefore contemporaneous with a portion of the Cephalopod-Bed in the neighbourhood of Stroud, and with clay with limestone-masses at Bredon Hill.

The top of Ham Hill has been very much disturbed by quarrying operations. Fortunately the great ramparts and ditches of the ancient camp have not been interfered with much, and are very well preserved at the northern end of the hill. They are three miles in circumference and enclose 210 acres. The camp dates from pre-Roman times, but was occupied by the Romans, for many Roman remains have been found, and at the northern end is a hollow—probably once a Roman amphitheatre.

A very fine view was obtained from the hill-top—Pilsdon Hill, the Quantock Hills, Glastonbury Tor, Cranmore Tower on the Mendips, and Cadbury Castle near Sparkford, being plainly visible.

At 5.30 p.m., after tea at the Fleur-de-lis, in Stoke-sub-Hamdon, the drive was commenced for Yeovil. *En route*, as time permitted, a stop was made to see the church at East Stoke (Plate XIII., fig. 2). It is built entirely of Ham Hill Stone, possesses a very interesting tympanum, and a richly-ornate Norman arch between the chancel and nave.

The Members caught the 6.7 p.m. train from Yeovil, and arrived at Sherborne at 6.50.

Mr W. N. Skillicorne was elected a Member of the Club, and Mr St. Clair Baddeley and Mr C. O. Hanson were proposed for membership.

FRIDAY

On Friday morning the first item on the agenda was a visit to the milk factory of the West Surrey Central Dairy Co. Ltd., at Sherborne. Mr Alfred Gates, the manager, very kindly conducted the Members round the Works.

In this factory, milk, direct from the cows, is converted into a powder, "drymilk," of which there are three grades—with cream, with half-cream, and without cream. The milk is delivered by a pipe into the hollow between two highly-heated cylinders, set "iron to iron." The milk is almost instantaneously deprived of its water. The solid matter passes between the cylinders, and is rolled out into very thin paper-like sheets. This substance is put through a machine, consisting of a perforated cylinder in which revolves a brush, which works the powdered matter through the holes into a bin. The greater quantity of the powder is sold in this form, principally for infants' food, but some is mixed with cocoa. All that is necessary to convert the substance into a milk, or cocoa and milk, is to add boiling water. Above five tons of the powder are manufactured each week.

The advantage of the "dry milk" is that its process of manufacture destroys all germs and spores but does not alter the milk constituents. Various other methods have been practised for reducing the number of germs, for retarding their development, and for destroying them—the principal of which are :—

1. The exercise of greater cleanliness in dairying. This has done much to reduce the number of germs, but, unfortunately, the reduced number present multiply so rapidly in the course of a few hours that at the end of that time the milk is thoroughly infected.

2. Refrigeration, or the cooling of milk down to a low temperature. This only retards the development of the bacteria present, and does not deprive them of their vitality.

3. Pasteurisation. This consists in slowly heating milk to a temperature of about 70 degrees C., in an ineffectual attempt to preserve its digestibility while killing many of the less-resistent germs.

4. So-called "Sterilisation." This consists in heating milk to the higher temperature of about 100 degrees C. (which kills all the germs but not the spores), but it so alters the nutritive constituents of the milk that it is unsuitable except for limited periods, for infant feeding.

A visit was then paid to the Castle ruins, which are situated on a low circular hill.

Photo. A. Gosney.

Fig. 1.—Lantern Entrance, Old Castle Ruins. Sherborne.[1]

Little now remains of what must once have been an imposing pile. Among the most striking features of the ruins is the creeper-clad Norman gateway (fig. 1), with Tudor windows, and a Norman pillar and vaulting in the keep.

1. Block kindly lent by Mr. E. J. Burrow.

The old Castle was built by Bishop Roger (1107-1139), and was the episcopal residence when Sherborne was a Bishop's See. In 1645 it was besieged and taken by Fairfax. The present Castle, the seat of Mr F. J. B. Wingfield Digby, was built by Sir Walter Raleigh.[1]

From the Castle the Members went to the Abbey (Plate XIV.), where they were received by the vicar, the Rev. S. A. Selwyn.

Sherborne was constituted the head of a Bishop's See in 705, by Ina, King of the West Saxons, and remained a cathedral city for 336 years. Aldhelm was bishop here, and remains of his Saxon church are to be found in the old blocked-up doorway, with its long and short work, in the wall at the west end of the north aisle. At the north-eastern end of the ambulatory is a brass tablet, bearing the words :—" Near this spot were interred the mortal remains of Ethelbald and Ethelbert, his brother, each of whom in his turn succeeded to the throne of Ethelwolf, their father, King of the West Saxons, and were succeeded in the kingdom by their youngest brother, Alfred the Great."

In Norman times the church was largely re-constructed, and in the fifteenth century was transformed into the Perpendicular style by a great restoration.

The choir is excellent Perpendicular, with very fine fan-tracery, and was re-built in this style by Abbot Bradford. Abbot Ransom (1475-1504) re-built the nave. In 1848-51 the nave was restored by the Earl of Digby and others, while the late George Wingfield Digby, Esq., restored the choir in 1896.

The tower is 106 feet high, contains some fine bells, amongst which is the Wolsey bell. Curfew is rung each evening at 8 p.m.

From the Abbey the Members went to the School, which was founded in 705. Part of the monastic buildings, the guesten and abbot's halls, abbot's lodging and kitchen, survive, somewhat transformed, in the present school.

The Members were shown over the school buildings, and the well-arranged museum and excellent open-air swimming bath came in for special commendation.

After lunch the Members left by the 3.2 p.m. train.

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Richardson, L., Rev. H. H. Winwood and others.—" Excursion to . . . . Ham Hill and Bradford Abbas." Proc. Geol. Assoc., vol. xxii. (1911), pp. 246—263.

1. The Sherborne Urban District Council obtains its water from a deep boring in Castleton. The bore-hole has a diameter of 12 inches, is 207½ feet deep, and passes through the Inferior Oolite (about 145 feet) Yeovil Sands (135 ft.), Upper Lias clays, and limestones (17 feet), and 10 feet 6 inches into the Middle Lias (*vide* H. B. Woodward, " Jurassic Rocks of Britain — The Lower Oolitic Rocks of England (Yorkshire excepted)," vol. iv., 1894, p. 80). The borehole is lined with an iron tube to a depth of 50 feet. Mr Duncan T. G. Brown, A.R.S.I., the Surveyor, informs the Editor that the yield per day is 210,000 gallons.

A. Gosney, Photo.

SHERBORNE ABBEY

(Block kindly lent by E. J. Burrow.)

R. Winterburn, Photo.

Fig. 1.—The Abbey Gateway, Kingswood.

G. A. Powell, Photo.

Fig. 2.—Hugh Perry's Alms Houses in Church Street, Wotton-under-Edge.

(Blocks kindly lent by E. J. Burrow).

EXCURSION TO WOTTON-UNDER-EDGE.

THURSDAY, 18th SEPTEMBER, 1913.

Directors: H. GOLDINGHAM, V. R. PERKINS, AND L. RICHARDSON.

(*Report by* ST. CLAIR BADDELEY AND L. RICHARDSON).

The Members arrived at Charfield Station at 10.56 a.m. Amongst those present were: Mr W. R. Carles, C.M.G., F.L.S. (Vice-President), Mr L. Richardson, F.R.S. Edin. (Hon. Secretary), Surgeon-Gen. I. Newton, Dr. J. H. Garrett, F.L.S., Mr V. R. Perkins, Mr H. Goldingham, the Rev. F. J. Greenham, Messrs Charles Bailey, F.L.S., St. Clair Baddeley, F. H. Bretherton, F. Hannam-Clark, G. M. Currie, O. H. Fowler, E. Hartland, F.S.A., A. E. Hurry, E. Lawrence, E. P. Little, W. Margetson, J. W. Skinner, A. E. Smith, W. J. P. Smith, W. N. Skillicorne, C.C., W. G. Cottrell, etc.

From the Station the Members drove to Kingswood. On the way there, Mr Richardson pointed out, on the south side of the road, Hellbury Hill or Alderman's Bury. He said he understood that some people regarded this hill as a tumulus, and that it had been dug into under the direction of Mr R. B. Hale, but that nothing had been discovered.[1] He was not surprised however, because he held that it was simply a knoll of Keuper Marl, produced by the ordinary agents of denudation.

The first hill to be climbed on the Wotton road marks the outcrop of the Rhætic Series. Recently, Mr Richardson said, the bank alongside the "down" platform at Berkeley Road Station had been cut back and a portion of this Series, including the sandstone-bed (the equivalent to the well-known "bone-bed") had been exposed to view.

KINGSWOOD ABBEY.

Leaving the Wotton road, the Members then drove to Kingswood, alighting near the old Abbey Gateway (Plate XV., Fig. 1.). The gateway was purchased in commemoration of Queen Victoria's Diamond Jubilee (1897) by the Committee appointed to carry out the celebrations. It was bought of Messrs Terrett, of Kingswood, and vested in Trustees.

Mr V. R. Perkins, of Wotton, read a short paper on the history of the ruins. The first Abbey at Kingswood was founded by William de Berkeley in 1139, at the suggestion of the Cistercian Monks at Tintern. Some of these Monks came and settled at Kingswood, but, finding the place not sufficiently quiet during the wars between Stephen and Maud, purchased a place called Hazeldean, now a hamlet of Rodmarton, not far from Tetbury. Here however, the water-supply was inadequate and they moved to Tetbury, where Reginald of S. Waleric gave them land. The Kingswood Abbey went down, and eventually became simply a grange to Tetbury. This displeased Roger of Berkeley, the descendant of the founder of Kingswood, but his remonstrances to the King to require the return of the Monks to Kingswood were of no avail. Whilst the matter was being debated the Abbot of Waverley in Surrey proposed to restore Kingswood Abbey. In spite of opposition, the Abbot of Waverley set about his task, and in the end the members of the brotherhood at Tetbury, not being satisfied with their site there, as there was not room to expand, decided to move back to Kingswood They did not return to the old site, but obtained forty acres of land from Roger de Berkeley at Merriford, about a mile to the north of the old site, and founded the new Abbey there in 1170. Some of the building materials were obtained from the old Abbey, the site of which is now marked by a farm-house.[2] The

1. *Vide* M. & I. Tait, "Wotton-under-Edge" (1897, Wotton), p. 63.

2. There is a small building still called "the Old Abbey" on the Trench Farm. The approach to it is up Trench Lane and Trench fields.

fine Church which the monks built remained until the dissolution of their Abbey in the 31st year of Henry VIII.'s reign, but then it was pulled down, except the Lady Chapel, which was left to function as the Parish Church. The present Church, however, was built in the reign of George I.

All that now remains of the actual Abbey are the entrance gateway and the external walls which have been utilized to form the front walls of ranges of cottages.

Some little doubt seems to have existed in regard to the age of the gateway. Mr Perkins, in 1886, considered that the upper storey was of later date than the lower. In this Sir John Maclean concurred, but thought that the whole was of later date than Mr Perkins imagined, believing that no portion of it was earlier than the end of the 15th century. Mr Perkins now assigns it to the 16th century.

Kingswood, along with Bristol and Malmesbury, refused to take in the body of Edward II., who had been murdered at Berkeley Castle. Abbot Thoky (or Thokey), however, went with a considerable retinue to Berkeley and fetched it to Gloucester. Out of offerings made by pilgrims to the shrine of the murdered King, Abbot Wigmore built the transepts, the greater portion of the choir, and certain other parts of the Cathedral.

From the Gateway the Members proceeded to see, by kind permission of Mr Stanley Tubbs, the "Silk Factory"—the Langford Mills.

In what is called for purposes of higher education the "Wotton Area" (the district containing Wotton-under-Edge and some twenty-two villages' with a population of about 12,000) there are the following industries :—

Industries in the Wotton Area.

1. *Agriculture.*—Main industry.
2. *Brickmaking*—Wotton.
3. *Brewing.*—Messrs Arnold, Perrett & Co., Wickwar; Messrs John Arnold & Sons, High Street, Wickwar.
4. *Elastic Fabrics, etc.*—Messrs Tubbs, Lewis & Co.[1]

    New Mills (elastic fabrics. Sandow's Developers are manufactured here).

    Abbey Mills (silk, cotton and flax fishing-lines, elastic cords and braids). Adjoining these mills are well-appointed dye-works.

    Langford Mills (silk-throwing. The silk is transformed direct from the raw material to the finished article).

    Charfield Mills.[2]—(Pins, all kinds of bone articles such as crochet-needles, knitting-needles, pen-holders, etc).

    The Abbey Mills were acquired by the Firm in 1870, the Langford Mills immediately afterwards, and the New Mills a few years later. The entire staff of operatives aggregates 700, all of whom reside in the immediate neighbourhood.

1 An illustrated article on this Company's Works has been published in "Industrial Gloucestershire," 1904, pp. 22-23. Chance & Bland, Gloucester. 1s.

2 Until 1893 these mills were owned by Messrs Samuel Long & Co., who manufactured cloths, etc., but in that year they were purchased by Firth & Co. (collotype and photo-mechanical printers). In 1904, however, Frith & Co. sold the mills to Messrs Tubbs, Lewis & Co. A portion of the business was transferred by the Cotswold Printing Society to Britannia Mill, Wotton, but Frith's returned to Reigate.

5. *Engineering.*—Terrett Bros., Walk Mills (part of), Kingswood.
6. *Flock.*—Nind Mill (part of), Wotton.[1]
7. *Grist.*—Hack Mill, Wotton (Berkeley Farmers' Association); North Nibley Mill; Walk Mills (part of), Kingswood.
8. *Photographic Works.*—"Cotswold" (collotype), Wotton.
9. *Printing.*—Wotton.
10. *Stone-quarrying.*—Wickwar, Cromhall,[2] etc. (Carboniferous Limestone); Wotton Hill, etc. (Inferior Oolite).

From Kingswood the Members drove into Wotton, the final ascent before entering the town being over the lower beds of the Middle Lias, while the upper bed, the hard Marlstone, gives rise to the platform so noticeable from the summit of Wotton Hill and upon which the house called "Ellemcroft," is situated. This Marlstone is very rich in fossils, and in 1886, when some excavations were made at Bournstream, many specimens were obtained.[3]

Mr St. Clair Baddeley and Mr C. O. Hanson, Principal of the Crown School of Forestry, Forest of Dean, were elected Members.

PLACES OF INTEREST IN WOTTON.

After lunch at the Swan Hotel the Members proceeded to see the places of interest in Wotton (population 3,021)[4] under the guidance of Mr H. Goldingham.

After having pointed out the quaint bell turret upon the "Tolsey" building, Mr Goldingham conducted the Members to the quaint old Alms Houses (Plate XV., fig. 2) and Chapel in Church Street, which were founded by Hugh Perry, a native of Wotton, in 1638. There are two other groups of alms houses in Wotton—"Bearpackers" and "Rowland Hill's"—and the three are controlled by a public body called the "Trustees of the General Charities." Wotton abounds in Charities.

At the Alms Houses Mr Goldingham exhibited :—

1.—"A booke of accounts concerning the new Almshouse of Mr Hugh Perry, his foundation." 1648. Wotton-under-Edge.

2.—"A booke of Accounts of those Writings that are belonging to the Parish of Wotton and Remaining in the Overseers' Hands." 1685.

3.—Copy collated by J. Pennell, notary public, attested by H. Ballard, W. Archard, and G. Smyth, of the deed of foundation (temp. Richard II.) of the School at Wotton-under-Edge, by Katharine, wife of Thomas Lord Berkeley.

4.—"A True Survey, etc." of the Grammar School lands with order in Chancery in the Smyth litigation, 29th Aug. 5 Geo. I. . . .

Mr Goldingham said that he had put out at his office a number of other books of equal if not greater interest than those he was exhibiting, but lack of time prevented the Members from studying these interesting documents.

A brief visit was next paid to the Grammar School. This is the seventh oldest endowed school in the country, being preceded by those at Carlisle, Derby, Huntingdon, Salisbury, St. David's and Hereford. [L.R.]

1 Until 1909 the Nind Mills were occupied by Messrs Millman, Hunt & Co., who manufactured fine wollen cloths, printers' blanketing, serges, worsted coatings, etc., but then a part became a grist mill for a time (now discontinued) and part a flock mill, which is still (Dec., 1913) running.

2 "Good lime, the only supply in the district, is made at Cromhall."—W. G. Cottrell (*in litt.*)

3 Proc. Cotteswold Nat. F.C., vol. ix., pt. 2. (1887), p. 83.

4 Sir Isaac Pitman lived in Wotton from 1836 to 1839, and was master at the British School in Sim Lane. On 26th Nov., 1913, the centenary of his birth, a tablet was affixed to the house where he lived in Orchard Street, in which he invented his system of Shorthand known as Phonography.

From the School the Members proceeded to "Lisle House," outside which Mr St. Clair Baddeley made some remarks on

THE WOTTON BRASS AND LISLE HOUSE.[1]

To the Antiquarian at Wotton-under-Edge, there is no object concentrating in itself so much of local historical interest as the brass of Margaret, Lady Berkeley, at the head of the north aisle, and that of her Lord, Thomas, 5th Lord Berkeley. For, being born in 1352-3, the latter became ward during his minority to Warin de Lisle Viscount Lisle, who, at the age of fifteen years, married him to his sole daughter and heiress, Margaret, aged 7, in the year 1367. This juvenile pair remained apart until she was 12-13. Nineteen years later, in 1386, was born to them Elizabeth, their sole offspring and heiress, who married Richard Beauchamp, 12th Earl of Warwick. In right of his wife, Lord Berkeley styled himself Lord de Lisle; and it is from this fact that the castellated Manor House at Wotton-under-Edge took its name of Lisle House. Margaret died March 20th, 1391-2, while her husband survived until 1417 (July 13th). Both were buried at Wotton, where they had so much lived.

Now, Wotton was, of course, long previous to this date, a member of the barony of Berkeley. According to Smyth (*Lives of the Berkeleys*) the house was built by Thomas, Lord Berkeley, in *c.* 1210, whose wife was known in her widowhood as *Domine* de Wotton, or Lady de Wotton (daughter of Ralph de Somery). Therefore, the house merely may be supposed to have been given a new name when it became amplified in honour of the great heiress and daughter of Warin de Lisle in Edward the Third's time, as above shown. After the decease of Lord Berkeley in 1417, his nephew and heir male, James (b. *c.* 1394), succeeded to the Castle of Berkeley and other estates of his great-grandfather, and he was summoned to Parliament as Baron Berkeley by a Writ in 1421.

Now began the trouble that was to be crowned by that great tragedy, the last private battle in England, which took place at Nibley Green fifty years later.

For, Richard Beauchamp, Earl of Warwick, in right of his wife, the great heiress-general of the last lord, as well as of the De Lisle heritage, finding themselves, at the last Lord's death, in actual possession of Berkeley, with all the title-deeds, obtained from King Henry V. a grant of the custody of all the late lord's Castles, Manors and lands, so long as these should be in the King's hands, to the exclusion of Lord Berkeley.

The latter, in consequence, procured the issue of a Writ of "*diem clausit extremum*" addressed to the King's Excheator for the County of Gloucester Robert Gilbert, under whom a competent jury presently came to the conclusion that James, Lord Berkeley, was indeed the heir male to his late uncle and should inherit the Castle of Berkeley and the twelve manors which constituted the Barony (of which we have seen that Wotton was one), together with the advowsons of Wotton and Slimbridge; but that all the late Baron's other lands had descended to the Countess of Warwick. Upon this, Lord Berkeley became accepted as the King's tenant-in-chief, and he did fealty for the Castle and his barony.

None the less, and although the Earl and Countess sued their livery and paid relief for their own manors, they continued, as Executors of the last lord, to hold the Castle and estates, and, what is more, the documentary evidences, the Manor-Courts, and to receive the rents thereof. In the last year of Henry V. that King is said to have ordered their surrender by Lord

1. Mr Baddeley, in response to a request, has very kindly furnished this account.—Ed.

Warwick, and Lord Berkeley then obtained possession of the Castle. Taking advantage, however, of the accession of the boy king, Henry VI., the strife became renewed with violence, even to the destruction of certain portions of the town of Berkeley. By an arbitration arrived at in 1426, Lord Warwick was allowed to retain Coaley, Symond's Hall, and Wotton, together with Lisle House. Lord Berkeley was now knighted, and was living at Berkeley; and there his wife, Isabel, daughter of Thomas Mowbray, Duke of Norfolk, gave birth to William de Berkeley, Lord Berkeley (1463-92), the subsequent victor of Nibley Green, 20th March, 1469-70.

After the death of Warwick, at Rouen, in 1439, the hereditary quarrel was renewed on the part of his three daughters and co-heiresses, and especially by Margaret, the eldest of these, then second wife of John Talbot, Lord Talbot, presently first Earl of Shrewsbury, by whom she had a son, John, Viscount (de) Lisle. In 1452, Margaret, Countess of Shrewsbury, contrived to capture the person of Isabel, Lady Berkeley, while in Gloucester, when preparing her appeal to the King in Council, on behalf of her lord, and closely imprisoned her so that she died Sept. 27th, and was buried in the Church of the Franciscans there.

The Talbots were in their own rights, of much power in the County, being the Lords of Painswick, the largest Manor therein, as well as of Moreton Valence, and Whaddon. But though Lord Talbot had been occupied chiefly with the war in France at this period, his son Lord Lisle had experienced some "shrewd brushes" with Lord Berkeley, who in turn had attacked and plundered Lisle House, where the Countess of Shrewsbury was then living. Lord Lisle also had his revenge, and he managed to break into the Castle at Berkeley, and there he carried off Lord Berkeley and his sons, whom he retained, probably at Lisle House, for eleven weeks.

In 1452, the great Talbot and his son, then Lord Lisle, fell together at Chastillon. These events may have lulled, they did not quell, the implacability of the now widowed Countess of Shrewsbury, who presently became the Custodian of her grandson, Thomas Talbot, now 2nd Viscount Lisle, the ill-fated heir to all this tragical doing, and who had been born in 1450, to his father and to Joan, daughter and heiress of Sir Thomas Cheddar (of Cheddar, Co. Somerset).

Lord Berkeley now married (July 25th, 1457), incredible as it sounds, a step-daughter of the same Countess, in the person of Joan, daughter of the Earl of Shrewsbury by his first wife, a daughter of Thomas Nevill, Lord Furnival. Possibly, this marriage helped to bring about their reconciliation of 1463 (Oct. 22nd), soon after which Lord Berkeley himself died, leaving Lady Shrewsbury to face his son and heir, William, Lord Berkeley, aged 41, to whose mother she had caused the miserable death in Gloucester Castle twelve years before. It is certain that the Countess renewed the war upon him, for he petitioned the Crown against her arrogant claims to his estates; but while the matter was impending, she died in June, 1468.

The long and great quarrel, like some perilous mass of loosened rock needing but a tremor of the earth to launch itself upon a path of devastation, now needed but one fresh stimulus in order to bring matters to a supreme decision. It was thenceforth no longer women and a man; it was man against man: young Lord Lisle against the mature William de Berkeley. The famous fight does not need description again. There can be no doubt that Lady Shrewsbury had educated her grandson in the way in which she meant him to fight the cause of her family. Unfortunately, neither her training, nor his own temper, not yet his youthfulness promised to favour its issue in his hands; although his craft was almost precocious in his endeavouring, albeit in vain, to bribe King, the porter at Berkeley, to deliver up that Castle to him. His fury at King's refusal, perhaps, was the immediate cause of his sending a rash-written and insulting challenge to his kinsman, inviting to meet him half-way and fight at once. The answer was not delayed, and was not unnaturally of a humiliating and contemptuous character. The battle followed on immediately, and Smyth (vol. ii., 615) gives many felicitous details as to the numbers and manœuvring of each party, and as to the actual encounter when Lord Lisle and his followers at sunrise moved down from Nibley Green to meet Lord Berkeley and his brother Maurice and all their men at Fowleshard (now Foley's Grove) and Micklewood (miscalled Michaelwood).

The statement, sometime made, to the effect that after the victors, led by Lord Berkeley, had reached Wotton and pillaged Lisle House over Lady Lisle's head, they destroyed that stronghold, is not supported by any solid evidence. Even sacking a house is not necessarily destroying it, especially if it be a fortress as strong as was Lisle House. But there was, over and above, good reason for their not doing so. The quarrel on Lord Berkeley's part resulted in his recovering this very important member of his ancient barony and its stronghold, where his Berkeley ancestors had so often resided. The last thing he can have desired was to destroy his own ancestral property, and probably, with it, the invaluable documents which the Lisles and Warwicks had taken from Berkeley Castle. Smyth says nothing whatever calculated to support this statement.

Lady Lisle was driven out, and we know that she obtained presently a composition of £100 p.a. from Lord Berkeley, and soon became re-wedded to Sir Henry Bodrugan, having meanwhile (and but sixteen days after the fight) brought forth a still-born child.

An interesting question remains: what became of Lord Lisle's body, Where was he buried? It is clear that Lord Berkeley did not entertain such feelings of generosity to his hereditary enemy as to wish him buried at Wotton or Nibley as a perpetual reminder. Nor is there any record of his having been interred at either place.

I venture, therefore, to repeat here a suggestion made by me some years back that Lord Lisle may well have been removed by his vassals, as the manor-lord, to one of his Talbot and undisputed Gloucestershire manors —Painswick being the most important of these—and there interred.

It is perhaps, more than coincidence that a contemporary and now nameless altar-tomb of handsome design and proportion, survives there in St. Peter's Chapel, which after having been at least twice appropriated and used as a tomb for later lords of the Manor, was finally to be utilized as a shelf for the 17th c. effigies of a Copy-holder in the person of Dr John Seaman and his wife (1623), together with other remains of his now vanished monument, which was formerly located in the Chancel of the Church.

It is known, therefore, to have been appropriated by Lady Kingston in 1540 for the tomb and brass of her husband, Sir William Kingston, K.G. Forty years before that date, apparently, a canopy, decorated with the Tudor flower-ornament had been added to it so as to enrich the much-weathered tomb, probably by one of the later Lisles. But the body of the tomb is plainly older than this by a generation.

As it cannot be the tomb of Lord Lisle's father, John, who was slain, together with Lord Shrewsbury, in 1452, in France, nor probably that of the Lady Lisle, who re-married after her husband's slaying, there is not a little probability that it may veritably be the tomb of Thomas, their son, the victim of the Wotton tragedy. [St. C. B.]

View of Wotton Hill and the pit in the sandy basal Upper-Lias Clays, Wotton-under-Edge.

At the Church the Members were met by the Vicar (the Rev. F. J. Greenham). Time permitted of only a brief inspection. The organ was built by Christopher Schneider in 1726. It was originally the gift of George I. to the Church of St. Martin-in-the-Fields, London, where it was frequently played upon by Handel. It was bought and presented to Wotton by one of the former Vicars. Special attention was directed to the tomb of Katharine Lady Berkeley, who died in 1392, and was the founder of the Grammar School (that bears her name) in 1384.

Near the Church is the Blue Coat School, founded at least as early as 1637. It is now a Public Elementary School.

From the School the Members went on to Wotton Hill, to obtain a general idea of the geology and geography of the surrounding country.

GEOLOGY

In Old Town, Mr Richardson said they were above the horizon of the Marlstone. When excavations for sewers were made some years back, multitudes of ammonites belonging to the genus *Harpoceras* were obtained and many were still to be seen on the cottage window-sills and rockeries. They were characteristic of the bottom-portion of the Upper Lias. The clay dug at the brickworks (Plate XVa), near the Tabernacle is Upper Lias.[1] It is more loamy in its upper portion, graduating upwards into the Cotteswold Sands. The Cotteswold Sands are admirably exposed in a pit alongside the road that climbs Wotton Hill, where they are succeeded by the Cephalopod-Bed and this by the *Scissum*-Beds of the Inferior-Oolite Series.

The freestone exposed in the large quarry belongs partly to the Lower Limestone division of the Inferior Oolite and, presumably, partly to the Lower Freestone. A rubbly-bed, six inches thick, he thought, was on the horizon of the Pea-Grit.

Above the freestone come the Upper *Trigonia*-Grit, very thin representatives of the Dundry Freestone and Upper Coral-Bed, and *Clypeus*-Grit.[2]

From the knoll at the clump of trees (planted to commemorate Queen Victoria's 1887 Jubilee) a fine view was obtained over the surrounding country, while to the north-east is the higher ground of Symonds Hall Hill, formed of Fuller's-Earth Clay and Great Oolite. Wotton is now supplied with spring water which issues from near the junction of the Great Oolite with the underlying Fuller's-Earth Clay.

In Wotton-under-Edge the party was entertained to tea by Mr Perkins at his highly-interesting residence in Long Street. The house was once a cloth-mill *plus* the owner's residence. In the drawing-room is hand-painted wall-paper of the date 1688, and in the dining-room fine panelling and carved mantel-board of oak.

In the garden Mr Perkins pointed out a carved Roman mile-stone, found on Symonds Hall Hill, which he had had built into his garden-wall.

Mr Perkins was very warmly thanked for his hospitality and for his valuable assistance in drawing up the programme of the meeting.
The party left Charfield Station by the 5.49 p.m. train.

1. See Richardson and Webb. Proc. Cheltenham Nat. Sci. Soc., vol. i., pt. 4 (1910), p. 247.

2. The sections in the quarries near Wotton are described in detail in the "Proceedings" of the Club, vol. xvii., pt. 1 (1908), pp. 309-311.

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SECOND EDITION, 1903.

GLOUCESTERSHIRE. SHEET XXVI. S.E.

CHARACTERISTICS AND SYMBOLS

County Boundary — Antiquities, Site of — Parish Boundary — Arrow, shewing direction of flow of water — Contours (Instrumental, Sketched) — Trigonometrical Station

For other information see Characteristic Sheet

Scale Six Inches to One Statute Mile or 880 Feet to One Inch

Heliozincographed from 2500 Plans and Published by the Director General at the Ordnance Survey Office, Southampton. N.B.—The representation on this map of a Road, Track, or Footpath, is no evidence of the existence of a right of way.

Geologically surveyed by L. Richardson, F.R.S.E., F.L.S., F.G.S., 1902-12.

MEMOIR EXPLANATORY OF A MAP OF A PART OF CHELTENHAM AND NEIGHBOURHOOD, SHOWING THE DISTRIBUTION OF THE SAND, GRAVEL AND CLAY

(6-inch Series XXVI., S.E.)

BY

L. RICHARDSON, F.R.S.E., F.L.S, F.G.S.

In part, 3 volume xvii., of the "Proceedings" of the Club, a map was published which showed the distribution of the sand, gravel and clay in the northern part of Cheltenham and in the surrounding country, together with a descriptive memoir.[1]

A map (Plate XVI.) showing the geographical distribution of similar deposits in the district immediately to the south of that represented on the above-mentioned map, is now published, and the present memoir is in explanation.

The geological information given on this map has taken many years to acquire: it was obtained principally between 1902 and 1912. As in the case of the previous district, its collection was not always an easy matter, for considerable portions are built over or are covered with private gardens.

LIAS.—This is the name given to the series of rocks that comes between the Rhætic (which crops out above the Keuper Marls at Wainlode Cliff, on the banks of the Severn), and the limestones that cap Leckhampton Hill, which have been and still are so extensively quarried there.

The Liassic Series has been divided into three Stages:

(1) Upper,
(2) Middle, and
(3) Lower.

1 Proc. Cotteswold Nat. F.C., vol. xvii., pt. 3 (1912), pp. 297-319, and pls. xxxiii.-xxxvi.

Each of these Stages has been sub-divided into "zones." A list of these zones will be found in the writer's "Handbook to the Geology of Cheltenham" (1904), Table ii.

LOWER LIAS.—The blue clay, which, over the whole of the district under consideration, underlies the deposits of sand and gravel, or the "Superficial Deposits" as they are often called, belongs to the Lower Lias.

These blue clays dip under the newer rocks of Leckhampton Hill. At the present time (1913) they are well exposed in small pits at Leckhampton Station and at the neighbouring, but recently-closed, Cotswold Potteries.

Towards the upper part of the Lower Lias, namely, in the portion or zone called the "*Striatus*-Beds," limestone-nodules are abundant and contain a very interesting and distinctive series of fossils.

The succeeding zone of deposit, the *Capricornus*-Zone, contains two bands of impure limestone—which were formerly very well exposed at Pilford (10 on the map, plate XVI.)—and becomes increasingly sandy as it is traced upwards. The lower portion of the Middle Lias, the Lower *Margaritatus*- or *Algovianus*-Beds, is also very sandy, so that as regards rock-structure the Lower Lias graduates into the Middle Lias, and this makes the precise line of demarcation between the two Stages, in the absence of characteristic ammonites, very difficult to determine.

The details given below concerning certain exposures of the Lower Lias may be of interest.

1. Evidence for the *Obtusus*-Zone has been obtained here.
2. A trace of gravel was observed on blue clay that yielded the ammonite *Microceras subplanicosta* (Oppel) and belemnites. Formerly there were extensive clay-pits on the Fairfield Estate and at Leckhampton Station. It was from these pits that Ralph Tate obtained many of the fossils mentioned in his useful paper "On the Paleontology of the Junction-Beds of the Lower and Middle Lias in Gloucestershire." The clays exposed belonged to the *Armatus*-*Valdani*-Zones or the *Jamesoni*-Zone of Tate.[1]
3. The small pit at the Cotswold Potteries (3) is in the *Valdani*-Clays.

1 Quart. Journ. Geol. Soc., vol. xxvi. (1870), pp. 394-408: see also Richardson, *id.*, vol. lxiii. (1906), p. 577 (footnote).

4-8. Formerly there were clay-pits on the site of the present Leckhampton Branch of the Public Library (4); near "Laracor" (5); Bafford Farm (6); near Sefton Cottage (7); and near Southfield Farm (8). This last, which was called "Dil Dowel," was closed between 60 and 70 years ago.

7a. Clay and limestone-nodules, precisely similar to those that occur in the "Yellow Lias" (a portion of the *Striatus*-Beds) at the Battledown Brickworks, were thrown out when the well at this locality[1] was deepened. The nodules were full of fossils, which included, *Monodonta modesta* Tate (common), *Chemnitzia liassica* (Quenstedt), *Turbo admirandus* Tate, *Arca stricklandi* Tate, *Cardinia attenuata* (Stutch.), *Cardita multicostata* (Phillips), *Gervillia lævis* J. Buckman, *Grammatodon buckmani* (G. F. Richardson), *Gryphæa concava* J. Buckman,[2] *Nuculana galatea* (auctt.), *Limea acuticosta* Munster, *Plicatula spinosa* Sow., *Rhynchonella fimbria* L. Richardson,[3] *Acrosalenia* (radiole), and *Isocrinus*-columnals.

9. Here, at about five feet above the 400-foot contour-line, some very tough blue clay[4] was exposed in some temporary excavations, and above it, at 9a, a brown sandy limestone full of specimens of *Pteria* (*Oxytoma*) *inæquivalis* (J. Sow.).

10. This is the site of the Pilford or Pilley clay-pit, whence so many magnificently-preserved fossils have been obtained from the impure limestones of the *Capricornus*-Beds.[5] It is now fast becoming built over.

11. Formerly a clay-pit (locally called "Oulans") was situated here, probably in the *Capricornus*-Beds.

12. This small pit is in sandy beds, probably of *Capricornus* date.[6] It was opened some thirty years ago for the purpose of supplying clay to the Potteries near Leckhampton Station; but the clay was found to be unsuitable.

The tracts where the Lower Lias clay occurs, which are not covered with houses or their gardens, are—for the most part—laid down to pasture, although orchards are not infrequent.[7]

Water.—Water obtained from wells sunk in the Lower Lias is not generally suitable for immediate use, being usually mineralized and hard. It is unlikely that any attempt at boring for it would be attended with satisfactory results.

1 Locally known as "Ledmores."

2 Murchison's "Outline of the Geology of Cheltenham, etc.," 2nd ed., by H. E. Strickland and James Buckman (1844), p. 98.

3 "Handbook to the Geology of Cheltenham" (1904), pl. xv., figs. 5a, b, c, d.

4 *Cf.* clay exposed at 9 on Battledown Hill, sheet xxvi., N.E., Proc. Cotteswold Nat. F.C., vol. xvii., p. 300 (item 9).

5 L. Richardson, "Hand. Geol. Cheltenham,' pp. 46-47. 6 *Vide*, id., p. 47.

7 The remarks made in connection with soils derived from the Lower-Lias clays, their improvement, etc., on page 301 of the previous memoir (Proc. Cotteswold Nat. F.C., vol. xvii., pp. 297-319), apply to this district also.

Commercial Uses.—In times past the Lower-Lias clay has been extensively used for brickmaking. That dug at the Cotswold Potteries, however, had to have a "lighter loam" from Leckhampton Hill (24) mixed with it before it was fit for use.[1]

Middle Lias.—For a reason already given (p. 126), the precise line of demarcation between Lower and Middle Lias is difficult to determine. Roughly speaking, however, the lower portion comprises sandy, shaly clays (more so than those participating in the formation of the upper portion of the *Capricornus*-Zone) and a Rock Bed, which is generally called the "Marlstone."

The tract where the Middle Lias crops out has been mapped as accurately as possible, but, although the outcrop areas of both "Sandy Beds" and Marlstone are approximately shown, it must be mentioned that from a soil standpoint the ground is clay land.

For purposes of applied geology it is unfortunate that the division-line between the Lower and Middle Lias has to be drawn between the *Capricornus*- and *Algovianus*-Beds, because the upper part of the former and practically the whole of the latter is sandy, which means that the spring-line does not coincide precisely with the lower limit of the Middle Lias.

The Sandy Beds are best seen in the old sunken trackway near Timbercombe (17), whilst their characteristic flora is to be seen on the slope of Shurdington Hill (16).

The Marlstone is but poorly exposed in the area under consideration, being visible only at:

16. Where it is seen as a very red rock, being highly-coloured by iron oxide, and at
17. Where it is seen above the Sandy Beds in the sides and near the top of the deeply sunken ancient trackway.

Water.—At or near the base of the Middle Lias is an important horizon as regards water-supply, because many springs issue thereat.

1 *Vide* L. Richardson and R. Webb, "Brick-earths, Pottery, and Brick-making in Gloucestershire," Proc. Cheltenham Nat. Sci. Soc., n.s., vol. i., pt. 4 (1910), pp. 261-264.

The ornamental lake at Leckhampton Court is situated on the Lower Lias, immediately below the lower limit of the Middle Lias.

Water derived from the neighbourhood of the Marlstone is frequently ferruginous—red, because the Marlstone contains a moderate amount of iron, although not in sufficient quantity in this neighbourhood to make it worth while working for iron.

At Leckhampton Court is a weak chalybeate spring. According to an analysis made of it by Dr J. H. Garrett in 1902, it contained only three-eighths of a grain of iron per gallon. Dr Garrett informs me that there was evidence of a good deal of iron having been deposited before the water came out, but that he doubted if a very considerable quantity has ever been in solution.

A well sunk at (18) is 31 feet deep. The late Mr G. B. Witts told me that water was not obtained until a hard bed was penetrated at 30 feet down, after which it rose and had a rest-level 12 feet 9 inches from the surface.

At (19) water derived from the neighbourhood of the Marlstone (for there is a slight deposit of iron) and the gravel-tract is collected and led by a pipe into the Leckhampton reservoir.[1] The average daily yield of these springs (three years' average) is 77,000 gallons.

There is very damp ground in the neighbourhood of the junction of the Middle and Lower Lias a quarter of a mile to the west of Vineyard Farm, and water comes out in Timbercombe about the same horizon.

UPPER LIAS.—The Upper Lias is about 230 feet thick at Leckhampton Hill, and only the topmost 10 to 20 feet is sandy and of a Cotteswold-Sand facies. It is of interest to note that a deep well on Leckhampton Hill proved that the Inferior Oolite rests upon this sand without the intervention of any Cephalopod-Bed, and that this immediate subjacent sandy deposit is of *variabilis* hemera.[2]

Similar sandy beds, which have slipped forward, are exposed in a small pit near "Daisy Bank" (24) and are in evidence at and around the places indicated by the figures

1 This reservoir was opened in 1824 and holds 1,756,000 gallons of water.

2 See Geol. Mag., dec. 5, vol. vii. (1910), pp. 101-104.

(25) and (26) on the map. At (27) a temporary excavation revealed Upper Lias (near to the base of the Stage) with numerous ammonites belonging to the genus *Dactylioceras*. At (28) blue clay is exposed.

Water.—See page 132.

Commercial Uses.—The sandy clay from (24) has been used to "lighten" the clays at the Cotswold Potteries.

INFERIOR OOLITE.—The freestone, which is obtained for building-purposes from the large quarries on Leckhampton Hill, and the Ragstone, which is drawn from the shallow workings on the summit, both belong to the Inferior-Oolite Series.

The following are the subdivisions of the Inferior Oolite at Leckhampton Hill and Charlton Kings Common, with their average thicknesses.[1]

		Ft.	Ins.
I.-III.	*Clypeus*-Grit		
	Non-sequence.		
VI.	Upper *Trigonia*-Grit: seen	5	0
	Non-sequence.		
XI.	Notgrove Freestone	2	10
XII.	Gryphite-Grit	4	11
XIII.	*Buckmani*-Grit	16	0
XIV.	Lower *Trigonia*-Grit	7	4
XV.	Snowshill Clay (present only on Charlton Common).		
	Non-sequence.		
XX.	Upper Freestone	32	0
XXI.	Oolite Marl	10	0
XXII.	Lower Freestone	77	9
	(*a*) The Freestone.		
	(*b*) The Roestone.		
XXIII.-IV.	Pea-Grit and Lower Limestone	38	0
XXV.	*Scissum*-Beds	4	4½

The Inferior-Oolite Beds at Leckhampton Hill and Charlton Common are so well-known that it is unnecessary to say much about them here. The following notes, however, may be of some service.

The *Scissum*-Beds are not clearly exposed in the district under consideration.

The Pea-Grit is seen in the main quarry at Leckhampton Hill; in a slipped mass alongside the path at (29); at (30); in the quarry in the isolated mass at (31), where its top-portion is visible below the basement beds of the Lower Freestone, and in a quarry near (26).

1 A detailed section of Leckhampton Hill and references to previous literature is given in an account of an excursion made by the Club to the hill in 1905: Proc. Cotteswold Nat. F.C., vol. xv. pt. 3 (1906), pp. 182-189.

The Lower Freestone is well exposed in the large quarries. Its commercial uses are dealt with later (p. 132).

The Oolite Marl contains an interesting series of brachiopods, which may be sought for at (32).

The Snowshill Clay is clearly exposed at only one place in the district under consideration—on Charlton Common (33).

The Lower *Trigonia*- and *Buckmani*-Grits are very rich in fossils. In the former, on Charlton Common, at (34), at 2 feet 10 inches above the top of the Upper Freestone, is a thin marly layer crowded with specimens of *Aulacothyris meriani* (Oppel). The Gryphite-Grit is well-known. It is extensively used for the top-stones of walls and specimens of its characteristic oyster are prominent in weathered masses. The rock is seen at (35) and (36), where detached oysters strew the ground. The Notgrove Freestone is relatively thin at Leckhampton Hill. Its top-bed is riddled with annelid borings, as may be very well observed in the shallow working (37) on the summit of the hill, where it is overlaid by the Upper *Trigonia*-Grit.

GRAVEL ON THE HILL-SIDES.—The greater portion of the superficial extent of the Upper Lias in the neighbourhood of Leckhampton Hill and Charlton Common is covered with gravel. In the gravel, here and there, are great masses of Oolite, which have become detached and have slipped down from the main mass above.

It has not been an easy matter to map this gravel. Traces on the clay-land of the Vale, insufficient to represent by a separate colour on the map, and irrespective of age, are indicated by the symbol (G).

Subsidence, fracturing, slipping and complete detachment of masses of Oolite, is not infrequent on the Cotteswold edge.

On the eastern side of Charlton Common is a slipped mass of rock, chiefly Pea-Grit. Mountains-Knoll Wood covers similar rock *plus* Lower Freestone.

The old workings along a line drawn southwards from (24) are instructive. They show very clearly indeed the faulted condition of the rock on the hill-side.

At (29) is a slipped mass of Pea-Grit ; at (38) of Lower-Freestone ; and at (39) of Freestone, but on the horizon of the Roestone.

Gravel encompasses these masses. The more recent additions to the gravel are angular ; but, as I have mentioned elsewhere, the older portion is much more "granular."[1]

1 Proc. Cotteswold Nat. F.C. vol. xvii., pt. 1 (1910), p. 40.

Water.—The main horizon for springs is, of course, about where the Inferior Oolite and Upper Lias meet. Owing, however, to the extensive spread of gravel, the water does not generally show itself before the limits of the gravel patch are reached.

To the south of Vineyards Farm the spring, marked by a windmill, derives its supply from the Oolite and gravel-bed. Its output is about 2000 gallons per day.

At (40) is a good spring, gauged at the end of a very dry summer to yield 2000 gallons per day. The water from it is taken in a pipe to a reservoir at (41). This reservoir furnishes the water-supply for Lilleybrook. At (42) is a strong spring coming out of the gravel-bed.

Commercial Uses.[1]—As is obvious from the many quarries on Charlton Common and Leckhampton Hill, the Inferior-Oolite Ragstones, Freestones and Pea-Grit have been quarried on and off for centuries. At the present time (1913) the quarries are being worked by the Cotswold Lime and Stone Firms Ltd., the commercial names of the stones that are quarried being "Cotswold-Dale Weatherstone" (Pea-Grit), "Cotswold-Dale Building-Stone" (Lower Freestone), and "Trigonyx" (Gryphite-Grit).

Cotswold-Dale Weather-Stone (Pea-Grit) is used where damp may be encountered—for plinths, copings, bridges, culverts, foundationings, etc. A sample submitted to the test developed a slight fracture at a weight of 372·9 tons to the square foot.

Cotswold-Dale Freestone is of a slightly pinkish-cream tint. It has remarkably good weathering qualities, and while fairly easy to work, hardens rapidly on exposure. With this stone there is no "erosion" (or gradual crumbling away) or "blowing." In a test made by David Kirkaldy & Son, it only cracked slightly at a stress weight of 458·6 tons to the square foot. The weight is 16 cubic feet to the ton. It has been used in the construction of Leckhampton (erected in the early part of the 14th century), Holy Apostles', St. Philips and St. James, the Presbyterian and Bentham Churches, the ceiling of Cheltenham College Chapel (beautiful traceries and carving), Leckhampton Court, Chestnut Close (Ascott, Oxon.), Malvern

1 I am indebted to Mr A. E. Painter, of the Cotswold Lime and Stone Firms Ltd., for the information given under this heading.

Road Station, Cheltenham (dressings of), and of many hundreds of ashlar-fronted houses in Cheltenham. The stone takes a pleasing " egg-shell " polish. The following analysis was made by The Royal Institute of Public Health in October, 1908 :

Moisture	0·09
Insoluble Siliceous Matter	0·30
Calcium Carbonate	97·53
Magnesium Oxide	0·74
Oxide of Irons and Alumina	0·52
Sulphur and Phosphorus	traces only
	100·00

" Trigonyx " is the commercial name in use for the Gryphite-Grit, which is quarried for roadstone, garden-edging, crazy paths, and rockery work. It is in much request for Alpine Gardens. It takes a fairly high polish, and has been most successfully used for stair-cases and chimney-pieces. A sample submitted to a test fractured slightly at a weight of 884·2 tons to the square foot.

Stone (Freestone) from this Company's Quarries burns to a very pure lime, as the following analysis made by Mr J. T. Norman of the City Central Laboratory, London, proves. The sample submitted was taken at random from the kilns :

Sandy Matter	0·61
Iron and Aluminium Oxides	1·68
Lime (total)	95·38
Magnesia	0·79
Sulphates as Sulphur Trioxide	0·94
Loss (Carbon Dioxide and Water)	0·60
	100·00

GRAVEL.—Gravel, similar to that which occurs below the yellow sand, in the district to the north of the present area, occurs also in this district. It is to be observed in all the tracts coloured green, but is most in evidence on the arable field at Naunton Bank, and in the bank-side by the brook in the picturesque Spring Bottom, Charlton Kings.

When the reservoir was put in at Southfield Farm, a large quantity of gravel was excavated. Gravel is still worked in a pit near this farm—near (8).

Sand.—The sand is of the same kind as that which occurs in the district to the north, and in some places contains a considerable amount of gravel. This gravel, however, is much smaller-sized and has a more bleached aspect than that which is met with at the base of the sand-deposit—that represented by the green colour on the map.

Gravel occurs with the sand in the Tynings outlier on the Shurdington Road, but, as the latter predominates, it was thought advisable to represent the Superficial Deposit here as Sand, and to print the words "sand and gravel" across the tract. The deposit gives rise to a soil very suitable for market-gardening purposes, and the fact has been appreciated. The dry site and the availability of water doubtless determined the origin of the hamlet.

The outlier between the Leckhampton Bridge on the Shurdington Road and Leckhampton Church, is becoming covered with market-gardens. The sand has been worked in the past near "The Vineries."

Leckhampton village originated on the sand-bed. Formerly there was a sand-pit at (43),[1] and very good sand has been dug at (44). At (45), in The Park, it is about 8 feet thick.

A considerable quantity of water occurs in this sand-bed, issuing forth on the south-west side. Some of this water has given rise to the now mostly-drained peaty bog to the north-west of Southend Lodge (see page 136).

The following details have been recorded concerning the main sand-bed:

46. The limit of the sand-bed was observed here.
47. The sand is 2 to 3 feet thick: then clay.
48. Pure yellow sand was exposed in an excavation to the depth of 13 feet without the base being seen.
49. In an excavation at Newick House 14 feet of sand was observed by Mr C. I. Gardiner.
50. A well sunk at Kilchoman House (50) in November, 1911, proved 35 feet of sand and then 5 feet of sand and gravel. The man who dug this well stated that his father had told him that in any sinking in this neighbourhood, at 35 feet the sand was penetrated and gravel encountered. [C.I.G.]

1 "Handbook Geol. Cheltenham" (1904), p. 194.

51. At Christowe, 42 feet of pure yellow sand was proved in a well, and then sand and gravel.

The Cheltenham College Baths derive their water-supply from five wells sunk in the sand-bed on the playground between Sandford Road and the Chelt. "On an average they are 25 feet deep, six feet in diameter, and yield on an average 150,000 gallons per week. The water is said to be quite satisfactory and sufficient in quality."[1] The soil in the gardens at Southwood House, Christowe and Boyne House, however, is said to be clayey, and at Christowe "brown clay, at least 4 feet thick, [was] seen." [C.I.G.] Below, of course, must be sand (*vide* item 51).

52. At (52) 12 feet of sand was seen, without the base, and at (52a) there is a sand-pit.

53. The sand is at least 30 feet thick here.

54. The sand, with which a considerable amount of gravel is associated, is admirably exposed in the railway-cutting to the west of Sandy Lane Bridge. Further west the clay-top rises and it is interesting to note the rich growth of grass in the neighbourhood of the junction of the sand with the clay. The sand is constantly slipping in this cutting and occasioning trouble.

55. At (55) gravel is to be observed below the sand.

56. Sand and gravel is seen here in a small, but now mostly overgrown pit.

57. Near Charlton Kings Station is a gravel-pit. The soil and subsoil does not contain any gravel, only sand; while pure sand has been dug at Glenure House (58).

59. The large sand-pit near the Diamond Laundry, Charlton Kings, has already been pictured and referred to.[2]

60. Formerly there was a deep sand-pit here.

61-63. In Ryeworth there were formerly sand-pits at (61)[3] and (62), and there is one still open at (63).

Water.—There is plenty of water in the main sand-bed, and to this circumstance, together with the fact that the surface of the deposit affords a dry site, must be attributed the primary reason for the selection of the site of Charlton Kings.

The well at "The Pump House" to the north-west by north of Leckhampton Church is from 20 to 25 feet deep, and has never been known to run dry. It supplies the cottages (Restall's) on the west side of the road.

ALLUVIUM.—As will be seen on reference to the map, a tract in the neighbourhood of the Chelt is represented by a

1 Trans. Inst. Water Engineers, vol. xvii. (1912), p. 191.

2 Proc. Cotteswold Nat. F.C., vol. xvii., pt. 3, (1912) pls. xxxvi., xxxv., fig. 2, and p. 299.

3 "Handbook Geol. Cheltenham" (1904), pl. xii. ["Cooper's Sand-hole"], p. 193.

separate colour. This tract is where clayey matter deposited by the Chelt occurs. Below the Alluvium, in most places, is gravel. Thus at (64) in Charlton Park, gravel (8 feet thick) is seen resting on yellow alluvial clay.

Peaty Tracts.—Peaty tracts occur at three places in the area under consideration, at—

1. In Charlton Park.
2. Moorend, Charlton Kings; and
3. Moorend, Leckhampton.

The extent of the second patch is shown by the extremely black soil, which is said to overlie gravel, and this in turn clay.

The third patch occurs in a district also known as "Moorend." The greater portion of this tract is covered with fruit-trees and market gardens. The ground is black in some places, brown in others. The peaty matter is very fibrous and must be several feet thick. The portion of this tract in the pasture-field has not yet been drained and is a veritable bog.

Mammalian Remains.—Remains of mammoth[1] and a deer horn have been found in the Superficial Deposit exposed in the railway-cutting between Charlton-Kings and Leckhampton Stations, at (54)[2].

1 Some of these, presented by Mr S. S. Buckman, are now in the Cheltenham Town Museum.

2 Proc. Cotteswold Nat. F.C., vol. xvii. pt. 3 (1912), p. 310.

THE CLIMATE AND TOPOGRAPHY OF CHELTENHAM AND ITS NEAR NEIGHBOURHOOD

BY

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By the aid of instruments for the measurement of temperature, of bright sunshine, of rainfall and the humidity of the atmosphere, and of the atmospheric pressure, we acquaint ourselves in a scientific way with any differences in these particulars that pertain to change of season, or position upon the earth's surface, and we thus arrive at the main facts of climate so far as these admit of exact measurement and statement.

I give below some figures taken or deduced from the records of the late Mr R. Tyrer and Mr A. C. Saxby, which have been published in my Annual Health Reports, and, further on, others from the summarised records published by the Meteorological Office at South Kensington.

The following is a statistical table giving the normals derived from the records of 35 years (1878-1912) of atmospheric pressure, air temperatures, humidity and rainfall for Cheltenham.

COMPARATIVE TABLE OF THE METEOROLOGY OF CHELTENHAM FOR THE YEARS 1878-1912.

The first 25 years are records made by Mr Tyrer at his house in Prestbury Road. The last 10 years are Mr Saxby's records made at The Montpellier Gardens.

Year	Atmospheric Pressure	Mean Air Temperatures				Humidity		Rainfall	
		Max.	Min.	Mean	Range	9 a.m.	9 p.m.	Inches	Days
	INCHES	°	°	°	°	%	%		
1878	29·913	56·1	41·5	48·8	14·6	83	88	33·18	176
1879	29·944	52·2	38·5	45·3	13·7	87	89	32·63	212
1880	29·971	55·8	40·5	48·1	15·3	85	88	33·72	177
1881	29·957	55·0	38·9	46·9	16·1	82	85	25·28	185
1882	29·914	55·9	41·5	48·7	14·4	81	86	37·92	214
1883	29·964	55·6	40·6	48·1	15·0	85	89	29·93	204
1884	29·978	56·8	41·9	49·3	14·9	84	89	24·04	190
1885	29·930	54·8	40·0	47·4	14·8	84	87	26·45	193
1886	29·912	55·0	40·6	47·8	14·4	83	86	32·55	193
1887	30·029	55·3	38·6	46·9	16·7	80	83	22·78	153
1888	29·959	53·8	40·1	46·9	13·7	82	84	28·85	195
1889	29·971	55·4	40·6	48·0	14·8	84	87	27·07	181
1890	29·959	55·6	40·1	47·8	15·5	84	88	20·09	191
1891	29·957	55·1	40·0	47·5	15·1	83	87	33·14	192
1892	29·948	54·6	38·7	46·6	15·9	82	85	19·45	175
1893	29·990	59·1	41·3	50·2	17·8	81	83	19·91	169
1894	29·963	56·2	41·6	48·9	14·6	83	87	29·12	194
1895	29·923	56·2	39·6	47·9	16·6	83	87	24·99	174
1896	30·030	57·0	41·4	49·2	15·6	83	86	21·54	185
1897	29·969	56·8	42·8	49·8	14·0	82	86	26·23	191
1898	30·009	58·2	42·5	50·3	15·7	82	85	24·23	173
1899	29·989	58·5	41·2	49·8	17·3	81	85	25·72	162
1900	29·928	57·3	41·1	49·2	16·2	80	84	28·44	203
1901	29·966	56·2	40·1	48·1	16·1	79	83	23·27	169
1902	29·906	56·9	42·4	49·6	14·5	84	87	22·53	176
Means	**29·959**	**55·9**	**40·6**	**48·2**	**15·3**	**82**	**86**	**26·92**	**185**
1903	29·883	55·8	43·0	49·4	12·8	82	84	35·75	215
1904	29·988	55·7	42·8	49·2	12·9	80	84	22·41	177
1905	30·005	55·7	42·9	49·3	12·8	79	83	23·79	165
1906	29·985	56·8	43·4	50·1	13·4	78	82	24·49	164
1907	29·966	55·4	43·1	49·2	12·3	80	85	29·00	174
1908	29·803	56·8	41·9	49·3	14·9	81	84	20·16	158
1909	29·956	55·1	41·7	49·3	13·4	82	84	27·9	191
1910	29·968	55·6	43·0	52·6	12·6	85	87	31·3	175
1911	29·780	59·3	43·9	50·6	15·4	81	83	22·3	145
1912	29·955	56·5	43·3	49·8	13·5	82	88	29·5	190
Means	**29·928**	**56·2**	**42·9**	**50·8**	**13·4**	**81**	**84**	**26·66**	**195**

In reference to the foregoing table it may be said at once that the items of information which it records show the climate of Cheltenham to be a moderate English climate.

THE BAROMETRIC PRESSURE.—So far as barometric pressure is concerned, the day-to-day observations serve rather as local indications of temporary change in the weather than as a contrast in climate between two or more places at the same season of the year. The actual mean pressure of every month of the year upon an average of years shows no more difference than is observed for the several whole years in the table above, as will be seen from the following :—

AVERAGE MONTHLY MEAN PRESSURE AT CHELTENHAM FOR 7 YEARS—1892–1897.

IN INCHES

January	February	March	April	May	June
29·963	30·010	29·982	30·001	30·052	29·993
July	August	September	October	November	December
29·954	29·935	29·981	29·891	30·030	29·923

The range of pressure of the months, however, that is, the difference between the highest and lowest pressure registered, taken through a number of years, is found to be greater in the six months on the Winter side of the year than in the six months on the Summer side :—

AVERAGE RANGE OF PRESSURE IN THE 12 MONTHS AT CHELTENHAM FOR TEN YEARS—1892–1901.

IN INCHES.

January	February	March	April	May	June
1·361	1·424	1·359	·987	·974	·876
July	August	September	October	November	December
·774	·828	1·006	1·304	1·456	1·362

THE MAXIMUM AND MINIMUM TEMPERATURES.—As to temperature, the figures of the table may be further supplemented.

The mean monthly maximum and minimum temperatures show a very gradual rise and fall from Winter to Summer and from Summer back to Winter, and prove the temperate character of the climate in the matter of heat and cold.

Monthly normals of Maximum and Minimum Temperatures derived from record of 21 *years* (1892–1912), *being the average of the monthly means for those years.*

	January	February	March
Maximum ..	43·6	45·1	49·6
Minimum ..	33·6	34·1	35·4
	April	May	June
Maximum ..	60·3	61·9	67·4
Minimum ..	38·4	43·7	49·4

	July	August	September
Maximum ..	71·6	69·4	64·6
Minimum	53·4	52·2	47·5
	October	November	December
Maximum ..	56·0	48·9	46·0
Minimum ..	42·4	37·9	35·7

In the 21 years as above the highest mean monthly temperature

fell 12 years in July
,, 5 years in August
,, 1 year in September

And an equal maximum was recorded in June and July 1 year.
,, ,, ,, ,, ,, June and August 1 year
,, ,, ,, ,, ,, July and August 1 year

July may therefore be looked upon as the warmest month in Cheltenham, especially as the minimum mean temperature in these summer months fell chiefly in June and never solely in July.

IN THE 21 YEARS AS ABOVE THE LOWEST MEAN MONTHLY TEMPERATURE

fell 8 years in January.
,, 8 years in February.
,, 3 years in December.

And an equal minimum was recorded in Jan. and Feb. 1 year.
,, ,, ,, ,, ,, Jan. and Dec. 1 year.

In these three Winter months the mean maximum temperature in the same 21 years fell 10 years in December, 7 years in February, 3 years in January, and 1 year equally in December and February. January is, therefore, decidedly the coldest month, and next to that February. In 16 of the 21 years June was warmer than September, in 5 years September was warmer than June.

September compared to May is usually the warmer month in Cheltenham, the mean temperatures being higher in September than in May in 16 years of the 21.

The Autumn months October and November are usually mild in Cheltenham, the period of leaf-fall being prolonged through the greater part, or even the whole of November, there being as a rule very little frost before December.

There has not been much opportunity for skating during these 21 years in Cheltenham. When ice covered the lakes of such thickness as to be safe for the pastime, it has been rare for the skating to extend beyond the third day, or at most beyond the fourth, the thaw setting in to spoil the ice by that time, or earlier. In several years the lake waters were not covered with ice, or barely so, at any time of the winter. The snow-fall in Cheltenham has also been very light and evanescent of duration. In one year of the 21, namely 1894-5, the winter was more severe, with longer frosts, especially in the first quarter of 1895.

The following table gives the highest and lowest actual shade temperatures upon any day of each year of the 21 years 1892–1912.

Year	Date	Highest Temperature degrees F.	Date	Lowest Temperature degrees F.	Year
1892	July 3rd . .	81	February 18th .	9	1892
1893	August 18th .	87	January 3rd .	12	1893
1894	July 1st . .	83	January 6th .	14	1894
1895	June 25th . .	84	February 9th .	6·5	1895
1896	July 20th . .	86	Feb. 19th Nov. 12th	21	1896
1897	July 16th . .	86	Feb. 18th & 24th .	20	1897
1898	September 8th .	86	February 21st .	20	1898
1899	July 20th . .	86	December 15th .	14	1899
1900	July 19th . .	90	February 8th .	15	1900
1901	July 19th . .	89	February 14th .	11	1901
1902	June 28th, July 14th	85	December 7th .	13	1902
1903	June 27th . .	82	January 14th .	18	1903
1904	July 10th, Aug. 3rd	82	March 12th .	22	1904
1905	July 8th . .	80	January 27th .	22	1905
1906	September 1st .	90	December 29th .	22	1906
1907	July 19th . .	79	January 25th .	17	1907
1908	July 3rd . .	85	January 6th .	19	1908
1909	August 12th .	85	March 3rd . .	12	1909
1910	June 20th . .	78	January 27th .	16	1910
1911	Sept. 8th,* Aug. 9th	93	February 1st .	21	1911
1912	July 15th . .	87	February 3rd .	15	1912

* 91°

THE RAINFALL.—The Rainfall Measurement shows considerable variation, and it sometimes happens that a run of especially dry or wet years vitiates the average unless a long series of years be taken. Thus, whilst the normal rainfall is found to be 27 inches per annum over the period of 35 years, as given in the first table, for the 21 years 1892–1912, there happened to be several very dry years, with the result that the annual average for that period was no more than 25·3 inches. The extremes of annual rain measured in the whole 35 years are represented by the minimum of 19·4 inches in 1892, and 37·9 inches in 1882.

The number of days upon which rain fell averaged for the 21 years 177 days per annum, and in the 35 years 195 days.

The Humidity of the Atmosphere.—The percentage humidity has been recorded twice daily at 9 a.m. and 9 p.m. during 35 years in Cheltenham, 25 years by the late Mr Tyrer at Southam House, Prestbury Road, and 10 years by Mr Saxby at the Montpellier Gardens. The difference in these locations, the first-mentioned being near the Wyman's brook, which expanded into a pond in Mr Tyrer's garden, and the latter being on slightly higher ground, not near to any expanse of water, apparently caused a difference in the humidity averaging 1 per cent. This fact shows that variations in humidity may occur in the same town in different parts, and I should expect a greater difference than noted as between the two stations above mentioned would be obtained between a part thickly covered with trees and a part bare of trees upon some days in summer time.

The mean annual humidity at 9 p.m. invariably worked out to a higher figure than at 9 a.m., though this may not mean that it was so upon every day of every year, but only that it was usually so.

The normal annual humidity for a long period of years is 82 per cent. in the morning at 9 o'clock and 85 per cent. in the evening at 9 o'clock, with daily minimums occasionally well below 70 per cent., and daily maximums occasionally well over 90 per cent., after the means between morning and evening reckonings have been struck.

The relative humidity of the air is greater in the winter than in the summer months when temperatures are higher. This observation, like many of those above, is in no way peculiar to this or any other limited district, being practically of universal application in this country.

THE HOURS OF BRIGHT SUNSHINE.—

A daily measurement of bright sunshine has been recorded for 10 years in Cheltenham by a Campbell-Stokes recorder mounted on the top of Pittville Pump Room, and, therefore, well exposed to all horizons.

The following table gives the approximate bright sunshine in Cheltenham in each of the months in the 10 years 1903–1912 in hours.

APPROXIMATE BRIGHT SUNSHINE IN CHELTENHAM, TEN YEARS, 1903–12.

IN HOURS.

Year	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	Yearly Average
Jan. .	59	35	85	50	65	72	51	68	66	37	58·8
Feb. .	67	58	70	83	99	73	104	81	61	56	75·2
March.	105	100	150	114	207	93	83	165	76	90	118·3
April .	146	170	99	228	160	129	228	125	142	265	169·2
May .	183	155	237	131	146	209	284	221	192	140	189·8
June .	193	233	177	199	142	265	131	185	219	151	189·5
July .	191	239	233	251	193	221	191	138	315	130	210·2
August	185	223	165	215	176	197	230	142	234	90	185·7
Sept. .	178	176	114	186	162	116	84	125	212	120	147·3
Oct. .	96	103	103	75	129	109	108	58	112	125	101·8
Nov. .	53	71	55	56	68	74	80	84	62	29	63·2
Dec. .	47	40	54	38	42	33	59	39	55	31	43·8
Yearly Totals	1503	1603	1542	1626	1589	1591	1633	1431	1746	1264	1552·8

The amount of bright sunshine experienced naturally bears some relation to the possible amount of sunshine, which varies at different times of the year in accordance with the length of time the sun is above the horizon. From mid-winter to mid-summer and from mid-summer back to mid-winter the daylight grows longer and then again grows shorter, the arc of the sun's apparent daily course being higher and longer in summer than in winter, and this is the main consideration in determining the number of hours of bright sunshine, so that our expectancy is rightly based when we anticipate more bright sunshine in the summer than in the winter months.

The increase or diminution of bright sunshine with the change of season is, however, affected by the presence or absence of more or less cloud to obscure the sun's rays, but inasmuch as there is more cloud in Winter than in Summer, the whole effect of cloud is to accentuate rather than minimise the difference caused by the seasonal change in the length of the daylight.

Speaking roundly, possible sunshine is twice as great in July as in January, but the actual number of hours of bright sunshine experienced here is four times as great in July as in January.

In the foregoing table it will be noticed that the greatest monthly average of bright sunshine for the 10 years stands to the credit of July, whilst May, June and August have averaged a nearly equal amount ; but the uncertainty in any particular year occasioned by a cloudy wet period setting in during either of the summer months to lessen the amount of bright sunshine during that period is shown by the fact that the amount of bright sunshine registered in Cheltenham was greatest in one of the ten years in March ; in one year greatest in April ; in three years greatest in May ; in two years greatest in June ; in three years greatest in July.

In May, 1909, when rain only fell in Cheltenham on 6 days and the rainfall registered was but ·89 inch, the bright sunshine for the month amounted to 284 hours.

In August, 1912, when rain fell on 27 days, and 7 inches were measured, there were only 90 hours of bright sunshine in the month.

From the Spring Equinox onwards, the amount of bright sunshine increases with great rapidity. As over January and February there is usually a large increase in April, the average bright sunshine of April being nearly three times that of January. At the time of the Autumn Equinox, the lessening of bright sunshine is just as rapid, with an average of above four times more in September than in December, the last-mentioned being the month of the whole year with least bright sunshine and most cloud.

Some of these points are useful to have in mind in regard to the English climate generally and of that of Cheltenham in particular when one is thinking of the effect of light and bright sunshine upon the body's health, and upon the convenience afforded by fine weather and extended daylight. A very pleasant season of the year in Cheltenham is from April to June inclusive, a good increase occurring in the bright sunlight and warmth and relative dryness of the air in April and onwards, the air being freshened at the same time with a greater amount of ozone, and the eyes delighted with the new foliage that is so abundant in the streets.

THE DIRECTION OF WIND.—A once a day observation of Wind taken by the late Mr Tyrer for a consecutive 5095 times, extending through 14 years, gave the following aggregate direction of wind and calms.

Direction of Wind .	N	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calms	Totals
No. of times	328	251	180	362	655	877	864	436	1142	5095
Percentage of times . .	6·4	4·9	3·5	7·1	12·7	17·1	16·9	8·5	22·4	99·5

The prevailing quarter of the compass from which the wind came was from South to North-West inclusive. In 46·7 per cent. of all observations the wind was blowing from S., S.W., or W. But omitting calms, the percentage of the wind from these points was 60 per cent. These winds are the mild, moist winds.

The winds from the comparatively dry and cold section of the compass, N., N.E., and E., only blew 14·8 per cent. of the whole number recorded. Calms were very frequent, being as 1 : 4·4 of all observations.

These facts concerning wind form one of the most distinctive features in the climate of Cheltenham.

Having given the above Meteorological statistics, which concern the climate of Cheltenham, it will be interesting so far as possible to study similar statistics of other places with the view of making a comparison. The result of such a study is somewhat in the nature of a surprise that the differences in the figures obtained for one place and another throughout England and Wales are so slight as they are found to be.

The readings of barometrical pressure are practically of no service in making such a comparison of climate.

The normal or mean temperatures averaged through a succession of years show much less divergence than might be supposed. But these small differences, together with the differences in measurement of rainfall and number of rainy days and the number of hours of bright sunshine, constitute the statistical data available for any reliable comparison.

So far as temperature normals are concerned, a little difference is noticed between the North and South of the country, though not nearly so great a difference as might be expected. The fact of the place where the observations are made being inland or on the coast makes a difference, particularly in the minimum temperatures, which are higher at the coast than inland. The altitude of the town makes a difference to the temperature, a few hundred feet tending to slightly reduce both maximum and minimum. There is more bright sunshine in the South than in the North of the country, especially more upon the South coast, and for most places in the East and South there are fewer rain-days and a rather smaller rainfall ; particularly is this the case for places in the East Midlands and further East.

In comparing Cheltenham first with other inland towns, we find our town has a medium annual rain-fall, and an ordinary or average annual number of rain-days. The normal temperatures for the year, both maximum and minimum, are hardly distinguishable from those of a number of other towns variously placed. A greater difference is noticed in the number of hours of bright sunshine, of which Cheltenham appears to get about as much as any inland town, so far as available records allow of a comparison being made.

In comparison with sea-side towns in the South of England, Cheltenham, in common with all inland towns, cedes position in regard to sunshine, and, as has been already stated, the minimum temperatures are not so low in these same seaside towns, and the divergence between day and night temperatures not quite so great, so that as regards cold, seaside places in the South of England are slightly milder than Cheltenham in Winter.

I. INLAND TOWNS.

Altitude in Feet	TOWN	Annual Rainfall		Annual Temperature		Annual Bright Sunshine	
		Rain-Days	Inches	Degrees F. Maximum	Minimum	Hours	Per cent. of Possible
184	Cheltenham	184	27·63	56·1	41·0	1552	36
208	Oxford	168	25·03	56·1	42·0	1498	34
291	Hereford	173	27·00	56·3	41·1	—	—
421	Tunbridge Wells	180	29·58	55·5	41·5	1588	36
476	Harrogate	194	29·45	53·0	40·5	1475	33
336	Durham	189	27·24	53·8	39·8	1317	30
987	Buxton	209	50·59	52·5	38·1	—	—
41	Cambridge	167	22·66	57·2	40·5	1560	35
58	Lincoln	150	23·34	55·7	41·1	—	—
38	York	185	25·27	55·2	41·0	1276	29
18	Kew	167	24·04	56·1	42·8	1467	33
180	Salisbury	184	32·23	58·8	39·1	—	—
424	Marlborough	185	31·88	55·7	39·9	1396	32
722	Shaftesbury	178	33·49	53·8	42·0	—	—
229	Clifton	170	34·60	55·9	43·9	—	—
66	Bath	160	30·47	—	—	1484	34
202	Cullompton, Devon	190	35·66	56·9	42·1	1488	44
535	Birmingham (Edgbaston)	171	27·35	54·1	42·0	1183	27
429	Sheffield	181	32·56	55·2	41·8	1295	29
180	Glasgow	204	38·73	52·5	41·6	1095	25

II. SEASIDE TOWNS.

Altitude in Feet	TOWN	Annual Rainfall		Annual Temperature		Annual Bright Sunshine	
		Rain-Days	Inches	Degrees F. Maximum	Minimum	Hours	Per cent. of Possible
62	Scarborough	188	27·27	53·0	42·5	1393	32
9	Yarmouth	185	25·32	53·0	43·2	—	—
84	Lowestoft	167	23·65	54·2	42·7	1732	39
83	Margate	165	23·21	55·5	44·2	1540	35
31	Brighton	164	27·58	56·2	44·6	1731	39
178	Hastings	184	29·07	55·1	44·4	1783	40
33	Worthing	157	26·96	55·5	43·6	1792	41
39	Eastbourne	175	30·89	55·8	44·4	1739	39
80	Ventnor	165	29·59	56·6	46·0	1726	39
167	Falmouth	211	45·43	55·3	46·6	1766	40
166	Plymouth	188	35·88	56·7	45·1	1650	37
250	Newquay	201	35·04	55·2	47·0	1687	38
59	Woolacombe	184	31·9	56·7	47·7	1626	37
71	Llandudno	188	30·83	55·3	44·6	1456	33
66	Blackpool	188	33·77	54·2	42·3	1409	32
131	Scilly	213	33·63	56·0	48·6	1811	41
295	Guernsey	201	37·55	56·3	47·2	1880	43

All these points may be seen in more exact detail in the foregoing lists, which are taken from Appendix III. of the weather reports of the Meteorological Office for 1906, being the last summary of the sort published to date. The statement represents a series of normals averaged from the records of the 35 years 1871 to 1905. The Cheltenham sunshine is the local record for 10 years 1903-1912.

But, further, in regard to the climate of any place, there are other differences besides such as admit of measurement and record like those set out above, and which give to places situated not far apart a distinctive character that is effective upon the sensibilities, well being and activity of the human body. These differences become evident in any place by the influence they actually exert upon us in the course of personal experience.

Altitude has an important effect, and differences in air pressure can always be obtained by going up or going down a hill. Position and aspect are of great importance in the exposure they cause to prevailing winds, or in protecting from them, and in increasing or lessening the amount of possible bright sunshine, or even the daily amount of light, as in the case of a town close under a high hill, which being to East or West of it, puts the town into shadow some hours after sunrise or some hours before sunset ; or, as in the case of a town that is entirely surrounded by high hills. Exposure upon a hill side that faces South may prove too hot during the mid-day hours of summer, and exposure in an elevated position to a too moist wind, or to a too dry wind like the South-West wind from the sea, or the East wind respectively, may prove productive of discomfort or ill health. The relative humidity of the atmosphere, combined with the degree of temperature, is effective, a comparatively dry air, if not from the East, being more pleasant and invigorating than a comparatively damp air, a damp, warm air being particularly oppressive.

The variation in the relative proportion of the component gases of the air has effect upon climate, the ozonisation of the air in particular being a varying factor, and in conjunction with the varying humidity, probably bringing about that relative freshness or stuffiness as the case may be which causes respiration to be more or less easy, and which are conditions within everyone's experience.

The climate of Cheltenham is affected by its position in the country, being West rather than East of the Cotteswold Hills. There is an open sweep from the sea of the Bristol Channel up the Severn Valley, which lies in the direction of the prevailing South-West wind. As the town stands upon the foot of the escarpment with widely guarding outliers to North and South, it is protected by a crescent of hills on the Eastern side, and the winds from that side are deflected and broken in force, which renders the climate in Winter and Spring comparatively less rigorous from the effect of the dry and roughening East wind. It is seldom that the wind blows from the East. Very strong wind from any quarter is comparatively infrequent in the town. Calms are frequent, and especially about the centre of the town, as in the Promenade, a still air is most usually experienced.

The very large number of trees and shrubs, which add so greatly to the beauty of Cheltenham, also produce their effect upon the climatic conditions for at least 6 months of the year. Being for the main part trees of deciduous foliage, it can hardly be supposed that their bare boughs can exert any considerable influence during the Winter months. The effect of foliage upon the air is well known. The leaves exercise a sort of respiration, their total effect being to remove some carbonic acid gas and give forth some oxygen, and in this regard they might be expected to have a freshening effect upon the atmosphere. But this chemical influence is perhaps minor compared to the effect a rich foliage exerts by the water distilled into the air from the leaf surfaces. It is true they intercept some of the rainfall, but when the ground beneath them has been once rendered wet, they greatly interfere with evaporation and retard the drying of the surface. On a clay soil this is very noticeable. Thick foliaged trees further break the force of the wind and help to bring about the calms before referred to as commonly existing in the centre of the town. Beneath their branches the intensity of the daylight is much reduced.

This combination of circumstances no doubt leads to the comparatively moist, quiet and lifeless atmosphere so well known to the inhabitants of Cheltenham as a matter of experience. When the conditions are at their maximum and the weather is warm, the result is sedative, or at least unstimulating, and occasionally a little stuffy in the central districts, so that a difference is noticed in moving into the suburbs or surrounding open country, particularly in the direction of the hill slopes, where a quite bracing air is soon reached. Thus, whilst this quiet unstimulating and unirritating kind of climate suits some people and some conditions of body remarkably well, a more stimulating and ozonic air is obtainable as the result of no great amount of effort or exercise.

Frost and fog are modified here. As compared with many inland towns, the buildings of Cheltenham become but little weather stained. This result may be partly due to the relatively clean condition of the atmosphere, on account of there being no factory chimneys worth mention, and partly to the fact that we do not get that dense and often sudden fine precipitation that results in the smoky fog, which is not infrequently brought to pass by a cold wind setting slightly from that quarter from which the wind rarely sets in Cheltenham—the East. Snow is of infrequent occurrence in Winter, and it will often lie upon the Eastern side of the Cotteswold hill-line when it fails to lie at Cheltenham and in the neighbouring Severn Vale.

In the search for a settlement for agricultural and pastoral pursuits the settlers are not bound as in the case of some mercantile adventure or manufactory, where the convenience of carriage by land and water, and the near presence of necessary materials dictates the site of the embryo city. And the origin of Cheltenham being after the former rather than the latter sort, we find this town occupying a situation well chosen from the point of view of health and pleasant surroundings. There was the combe running back into the hills along with the stream we call the Chelt, and there was that stream coming down the centre of its own pretty valley, whose retiring hill slopes open gradually to the greater Severn Vale. This was an eligible site where drainage was easy, pure water available and the lands fertile in woods, fields and meadows. The sunny slopes were inviting, and the villages of Charlton Kings and Cheltenham, forming at first but one manor and always contiguous and closely associated, arose along the length of the brook, where its valley was widening and debouching to the more open country.

For many hundreds of years the place was but of village dimensions, until the pleasantness of its position in the midst of as clean and rural a country as England possesses became known to the outside world. This took place when the local mineral waters had been discovered and the fashion prevailed of drinking such waters for various ailments. Then the town expanded, and filled the whole space between the hills until it touched the hill-foot villages of Prestbury and Leckhampton, and extended along the main road that led through Cheltenham from London and Oxford.

The hills above-mentioned, which lie behind Cheltenham and upon the sides of the town, are a part of the Cotteswold Hills, which form a long escarpment that passes almost from one extreme end to the other of Gloucestershire, and is abutted upon the edge of the broad Severn Valley. Some island-hills, or outliers, standing out from the main hill mass, as if detached from a high coast, assist with the intervening and more regular heights to form a broad enclosing crescent, in the hollow and centre of which this town has its place, as may be well seen from any of the nearer hill-tops.

The Lias Clay, which is chiefly responsible for the surface-features of this part of the Severn Vale, passes under and about Cheltenham, and extends up the Cotteswold escarpment, to pass beneath the limestone rocks which are characteristic of these hills. The clay in and about the town is waved into an irregular surface that varies the altitude and appearance of the ground, especially towards the hills, down whose slopes there has also been some tumbling over of the superimposed Inferior Oolite. The more definite minor hills thus formed produce some gentle gradients in the town and on its outskirts, the most prominent of which are known as Battledown, Marle

Hill and Bayshill. Apart from any such irregularities there is a tendency for the whole of the land to fall away Westward towards the Severn, and the three brooks that bear the name of the Chelt, the Wyman's Brook and the Hatherley Brook, which run within or mark the boundaries of the borough, take their slightly divergent courses in the same general direction.

The nature of the actual subsoil is varied by reason of the clay being overlaid in places by sand and other deposits, as shown in Mr Richardson's Map, and we are indebted to his laborious and minute survey for the precise and valuable information of the surface-geology of the district which these maps display. These maps should be of constant service in connection with the Public Health statistics of the town, and be of great use to new comers seeking a residence in Cheltenham.

The influence of the soil and subsoil may be taken as a part of the climate, or at least as closely associated with it, in the effect produced upon the body. Omitting mention of the quite minor areas of alluvial deposits near the streams, within the town bounds you are practically limited to a sandy or clay subsoil.

The surface of the clay is more moist than that of the sand, taking longer to dry after rain. The sand being quite porous, the water sinks through its upper part to find a level of saturation at some considerable distance below the surface as a rule, any capillary water retained in the upper sand or sandy soil being quickly dried out when the rain ceases. The sand with its air-filled pores is also a slower conductor of heat than the clay, and gives a warmer site for the house. The clayey surface, on the other hand, being more retentive of moisture, and the clay subsoil being to a large extent impenetrable by water, takes a much longer time to dry. Nevertheless, a site upon the clay ground may have compensating advantages in being at a higher elevation than the sand, and, not infrequently being upon a decided slope, the greater part of the water may be easily drained from it.

Within four miles of the centre of Cheltenham a quite different climate from that described above for the town itself is experienced. This is the climate of the Cotteswold Hills.

As the hill-slopes are ascended the movement of air is much more considerable, in fact, in many of the more exposed positions there is more wind, from time to time, than is suitable for a good house site. Upon the hill summits it is rare that some movement of air cannot be felt. The clay of the Vale rises up the hill slopes usually to a height of some hundreds of feet, until, at a varying altitude, the rocks of the Oolite are reached. These for the greater part are very porous, giving a dry calcareous soil.

The atmosphere of the hills is often less humid than that of the town, though the annual rainfall may be rather greater on the hills ; the temperature is somewhat cooler ; the effect of the sunlight combined with that of the wind stronger, more invigorating and colouring to the exposed skin. No greater contrast of climate could be found within many hundreds of miles than that obtained by going from Cheltenham to the top of Cleeve Hill, which is but four miles distant.

There are also appreciable differences of climate within the bounds of the town itself, which, if minor, are yet sufficiently marked to produce their effect, and persons moving from one part to another often find themselves better or worse suited. The district of Leckhampton is favoured by a gently increasing elevation up to the foot of the steep rise of Leckhampton Hill, and the air is perhaps fresher there than in any other quarter of the town, and people often find a change to that locality beneficial. Up-Hatherley and St. Marks are on the windward side of the town, and benefit most from the breezes that have not passed over the houses, but their altitude is lower and they lie on the clay. Arle and Alstone lie comparatively low, and the same is true of the poorer district of the North Ward off the Lower High Street and Tewkesbury Road, and these parts are perhaps least bracing, though they lie upon a sandy soil that is comparatively dry at the surface. Pittville is greatly beautified by trees, and the air there is perhaps very slightly more heavy and damp in comparison to other parts, though people live quite healthily and happily in the attractive squares and avenues in this locality. The North-East and East side of the town towards Battledown is the leeward side, and Battledown itself, though giving an altitude up to nearly 500 feet, is of stiff clay and there are but few houses upon it. The village of Prestbury has a fair altitude, and is moderately mild, for the main part on sand, near to the hills, and to the leeward of the town. At the hamlet of Southam the air is fresher, clearer and more pleasant to respire, though close under the hill.

The suburb of Charlton Kings has an altitude rather greater than Prestbury Village, and being much protected by hills, is mild, comparatively windless, and affords many pleasant house sites upon or near the main roads to Oxford and Cirencester.

To gain the higher altitudes and the much more bracing climate pertaining to them it needs to ascend either Cleeve Hill or Leckhampton Hill; Cleeve Hill offers the greater number of houses at an altitude of 500 feet and upwards. The great common on the top of Cleeve Hill gives a wide space of treeless turf for walking and riding exercise in the bracing climate of the Cotteswold Hills. The hill tops are rendered most accessible from Cheltenham by means of a tram line to Cleeve Hill, with passenger cars running frequently, and Leckhampton Hill is also brought nearer by the tram line.

The actual altitudes in feet above mean sea level in Cheltenham and its near neighbourhood are given in grouped districts on opposite page.

HIGH STREET DISTRICT.

High Street at Hewlett St.	210 feet
,, Clarence St.	194 ,,
,, St. George's Square..	191 ,,
,, Gloucester Road ..	175 ,,
Tewkesbury Road at Elm Street	161 ,,
Swindon Village	146 ,,
Arle Village	135 ,,

PITTVILLE DISTRICT

Clarence Square	193 feet
Pittville Circus	205 ,,
Pittvile Pump Room ..	213 ,,
Evesham Rd. (top of Marle Hill)	248 ,,
Bishop's Cleeve Village ..	200 ,,

THE PARK DISTRICT.

Park Drive (near " Broadlands ")	230 feet
St. Philip's Church ..	222 ,,
Tivoli Street (about) ..	220 ,,
Shurdington Village ..	220 ,,

LECKHAMPTON DISTRICT

Leckhampton Road (at Hall Road)	280 feet
Leckhampton Road (near Malvern Inn).. ..	305 ,,
Leckhampton Road (near Ladies' College Sanatorium)	340 ,,
Leckhampton Road (near junction of Old Bath Road)	370 ,,
Moorend Grove	260 ,,
Leckhampton Village Church	318 ,,
Leckhampton Hill (at " Hill House ")	500 ,,
Leckhampton Hill (at " Cotteswold ") ..	600 ,,
Leckhampton Hill (at " Bartlow ")	650 ,,
Highest part of Leckhampton Hill (no houses) ..	965 ,,

PROMENADE AND LANSDOWN DISTRICT

Promenade, near fountain	188 feet
Top of Bayshill (Parabola Road)	238 ,,
Christchurch Road ..	214 ,,
St. Marks (near Church) ..	185 ,,
Queen's Road (near Railway Station)	185 ,,
Lansdown Place (Gordon Lamp)	223 ,,
Lansdown Road (junction with Queen's Road) ..	204 ,,

CHARLTON KINGS DISTRICT

Charlton Parish Church ..	292 feet
Holy Apostles Church ..	264 ,,
East End	300 ,,
Sandy Lane	287 ,,
Charlton Common (no houses) ..	700–950 ,,
Battledown (roads with houses) ..	280–430 ,,

BATH ROAD DISTRICT.

St. Luke's Church.. ..	205 feet
Bath Rd. (at Sandford Rd.)	220 ,,
College Gymnasium ..	238 ,,
Bath Road (near " Norwood Arms ")	235 ,,

PRESTBURY AND CLEEVE HILL DISTRICT.

Cemetery Road (near Cemetery)	239 feet
Prestbury Rd. (at Nursery)	224 ,,
Prestbury Village Church .	258 ,,
Southam	300 ,,
Cleeve Hill at Haymes Rd.	400 ,,
Cleeve Hill at "Rising Sun"	650 ,,
Cleeve Hill at "Post Office Lane	700 ,,
Cleeve Hill at highest point of high-road	786 ,,
Cleeve Common (highest parts)	900–1070 ,,

THE LARGE BLUE BUTTERFLY (*Lycæna arion*) ON THE COTTESWOLD HILLS

BY

C. GRANVILLE CLUTTERBUCK, F.E.S.

(*Read April* 1st, 1913)

In 1886, Prof. Allen Harker expressed the fear that the "Large Blue" would soon become extinct.[1] Fortunately, his fears have not been realized. I have taken specimens on the hills on the dates given below.

Records.—5th July, 1885; July, 1886 (one specimen); 2nd and 6th July, 1887; 30th June and 19th July, 1888 (a very cold and wet season—6 specimens); 21st, 22nd and 25th June, 1896 (abundant); 6th June, 1897 (the earliest record, apparently), 13th and 23rd June, 1897; 27th June, 3rd and 7th July, 1898 (abundant); 14th June, 1899; 22nd June, 1900; 26th and 27th June, 1902; 28th and 30th June, 1903; 22nd and 28th June and 6th July, 1904; 13th July, 1905 and 20th June, 1912.

The Rev. A. G. Butler found numerous specimens on the 23rd June, 1890.

Mr W. B. Davis informs me that he last saw the species on 24th June, 1910.

In the very fine and hot season of 1911, Mr E. W. Lifton took a pair on the 19th June.

My earliest date for the species is the 6th June, and my latest the 19th July, but the best time to look for it is between the 20th and the 30th June. The butterfly is found in the clearings in the beech woods, where the wild thyme (*Thymus serpyllum*) grows freely on the ant-hills made by the Mound Ant (*Formica flava*). When on the wing it is easily recognised by its iron-blue colour, its size, and slow, heavy flight.

The life-history of the species has long been a mystery, and since the days of Mr Merrin, who first discovered it in the neighbourhood of Gloucester in 1858, successive generations of local collectors have searched in vain for the larva after

1. Proc. Cotteswold Nat. F.C., vol. ix., pt. 1 (1887), p. 83.

hibernation. It was known that the eggs were laid on the blossoms of the thyme, but all attempts to keep the young larvæ through the winter failed. The late Mr C. J. Watkins, F.E.S., told me that in the seventies he spent many hours in the spring crawling about amongst the thyme in its known haunts, but could find no trace of a larva. My own experience and that of other friends who joined in the search year after year, was similar.

I talked the matter over with the late Mr C. G. Barrett, F.E.S., the author of "Barrett's British Lepidoptera," and he suggested searching by day under the stones in the neighbourhood of the plants of thyme frequented by the butterflies in the previous summer, but this method ended in failure. A year or two ago, Dr T. A. Chapman, F.E.S., and Mr W. B. Davis spent about a fortnight in the spring digging in and around the thyme-covered ant-hills in a locality near Stroud, and still the search proved fruitless. I was unable to subscribe to a friend's theory that the larvæ spent the winter up in the trees. In its Cornish locality, Mr Frohawk says there are no trees. However, the honour of discovering the larva of this interesting butterfly in its Cornish locality (discovered in 1891 by Mr E. A. Waterhouse) is enjoyed by Mr F. W. Frohawk, F.E.S., who published an excellent article on it in "The Field," Christmas Number, for 1912, to which the reader is referred. Cornish specimens are more brightly coloured than the Cotteswold examples. The species appears to be on the wing later in North Cornwall than on our hills, owing, no doubt, to the locality being more exposed. Mr Frohawk has sent me some beautiful specimens taken in July, whereas my experience has been to find it very worn in that month from contact with the long grasses which abound in its favourite haunts. The discovery of the underground habits of the larva during the winter, which it passes in the ants' nests, apparently disposes of the theory that its extinction in other localities has arisen from the practice of burning the grass. If the roots of the grass do not suffer, it is fairly safe to assume that a larva living amongst them would also survive.

ANOTHER GLOUCESTERSHIRE ORCHID:

Epipactis Atroviridis W. R. Linton.

BY

The Rev. H. J. RIDDELSDELL, M.A.

(*Read 11th November*, 1913.)

In 1912 the President of the Club, the Rev. Walter Butt, and myself spent some weeks botanising at Cranham, a village on the Cotteswolds about three miles from Painswick. When there, we were interested in the various *Epipactis*-forms which occur frequently in the woods, but both of us had to leave before they came into flower, and so could do nothing with them. Clearly there were at least two forms, one of which, roughly speaking, would go under *E. latifolia*, and the other under the closely allied *E. media*.

After returning to Llandaff about the middle of July, when my summer holidays always end, I wrote to Mr Day, of Minchinhampton, who has done much work of excellent quality for the County Flora, to ask him to send me a gathering of *Epipactis* from the woods near him. He kindly forwarded a good parcel of specimens gathered in Gatcombe Wood. These, on a first examination, proved to include two specimens, and no more, of *E. media*. The rest were all of one type, showing considerable variation in slight matters, but clearly all of one group.

A subsequent and very careful and detailed examination of each specimen enabled me to make notes on flower colour, length of bract, state of label surface (it is necessary to see whether it is smooth, or furrowed and folded), shape and direction of the point of the label. They were then all carefully dried, the specimens turning out very well. Unfortunately, it seems impossible to dry *Epipactis* specimens in such a way as to preserve the critical features : they are pressed out of recognition. This is particularly the case with the colour, and the surface of the label. Hence the preparation of careful notes before drying.

Next, in order to make my results known to such critical botanists as were likely to be able to throw light on them, I sent most of the gathering, under the general and non-committal name of *Helleborine latifolia*, to the Botanical Exchange Club, for distribution among its members. The point of my results was embodied in a general note which accompanied them, and which needs (for our present purpose) two preliminary explanations :—Firstly, that the name *Helleborine* is the current name in use for the genus *Epipactis*, cf., e.g. Lon. Cat. Ed. X. ; and, secondly, that the label surface in segregate *E. latifolia* is smooth, whereas all Mr Day's specimens showed some plication and roughness.

The Exchange Club Report, which appeared in August, embodies my note and several criticisms. It is quoted here *in extenso*.

"*Helleborine latifolia*, Druce. Gatcombe Wood, Minchinhampton, v.c. 34, Aug. 14, 1912, Coll., E. M. Day. These are sent to illustrate the difficulty of fitting our forms to the received descriptions. None of these specimens have the orthodox 'smooth bosses' of the species, though they vary greatly in depth of furrows and amount of roughness. The plants are clearly *H. latifolia*. Much scarcer with us in Gloucestershire is var. *media*, E. S. Marshall, the bosses of which show no essential difference from the type, nor do the flower bracts. H. J. RIDDELSDELL. In *H. latifolia* the bosses are smooth. I believe this to be fine *H. atroviridis*, W. R. Linton. E. S. MARSHALL. The habit, shape, and texture of leaf, smaller flowers, etc., seem to point to var. *media* rather than typical *latifolia*. C. E. SALMON. A mixed gathering. Two samples were *E. latifolia*, All., one was probably *E. atro-rubens*, Hoffm., and several were intermediates. The specimens were, however, not well prepared for accurate determination.—J. CRYER."

The last two criticisms may be dismissed shortly. The specimens (which all showed a short recurved point to the label) were certainly not *E. media* : I had satisfactory specimens of that from Mr Day ; Mr Salmon's suggestion may therefore be ruled out of court. Mr Cryer's criticism may also be neglected. The gathering was not mixed; there was no true segregate *E. latifolia*, and most decidedly no *atrorubens*, and the specimens were as well prepared for accurate determination as the species allows, though that is not saying very much. Mr Cryer's note is correct in saying that there were "intermediates," but that was only saying again what Mr Marshall's note had put clearly, *viz.*, that the gathering is "fine *H. atroviridis* W. R. Linton." This is, no doubt, true, for W. R. Linton's species, which was published as *Epipactis atroviridis*, is intermediate between *H. latifolia* and *H. atrorubens*. I take no small blame to myself for having overlooked the determination. My only excuse is that my usual and best book of reference, Babington's *Manual*, Ed. IX., does not refer to *H. atroviridis*.

The species was created by W. R. Linton in his *Flora of Derbyshire* (1903), where there is a plate, opposite p. 269, which, in spite of its odd appearance, is sufficient to illustrate the critical points which separate the form from its closest allies. The description, on p. 270, is as follows (under the name of *E. atroviridis*):—

"This plant is in some respects intermediate between *E. latifolia* and *E. atrorubens*. It has the broad, rounded leaves of the former but rather more numerous lanceolate leaves between the lower leaves and the flowering spike; the label is furnished with two side hunches and one median linear hunch, descending lower than the side ones; in size and robustness it is like *E. latifolia*, its flowers are not rose-coloured or not so much as in *E. atrorubens*."

Except that the colour of some of Mr Day's specimens was well-marked, and the variability of their hunch-plication was considerable, this description fits very well indeed to the Gloucestershire plants under discussion.

The probability is that we shall find that much of our Gloucestershire aggregate *E. latifolia*, but not all, is this particular segregate of W. R. Linton's, or, at any rate, nearer to it than to any other described form. The greatest probability of all is that there is a pretty complete series of forms running from extreme *E. latifolia* to extreme *E. media*; the latter of which, as found in England, has been declared by Herr Freyn, the German botanist, to be merely a form of

E. latifolia. Plants which I examined in Glamorgan, on the coal measures, some years ago, baffled me completely at the time, for they satisfied the descriptions of neither segregate *E. latifolia* nor *E. media* nor any other form then published. Now it is clear that they belong to *E. atroviridis*, W. R. Linton.

We have thus in Gloucestershire, in this genus, not only *E. latifolia*, All., in all probability, and *E. media*, but also *E. purpurata*, near Stroud, *E. atroviridis*, *E. ovalis* or *atrorubens* in one locality of the Forest of Dean, and *E. palustris* in a bog on the Cotteswolds—a very good record for a single county.

THE GLACIAL BOULDERS AT BOURNVILLE, BIRMINGHAM

BY

Prof. CHARLES LAPWORTH, LL.D., M.Sc., F.R.S.

(*Read May 20th,* 1913)

I was exceedingly pleased a few days ago to receive a kind invitation from my friend and former pupil, Mr Louis Barrow, to come over to Bournville on the present occasion and join him in the very hearty welcome which the firm of Messrs Cadbury Bros. and Mr Barrow himself offer to the members of the Cotteswold Naturalists' Field Club.

I was the more pleased to accept the invitation because the boulders which you have come to see were discovered on the estate of Messrs Cadbury, who have always keenly interested themselves in the advancement of the people at large; also I have myself for nearly half a lifetime been interested in everything that tends to progress in geological discovery, and that prompts any observer to hearty geological work.

Of course geologists are pleased that those who are unfamiliar with the science take occasionally some little interest in their work. But as a rule the ordinary public gives a hearty welcome to advances in geological knowledge, but a very tardy welcome to advances in geological theory.

What the outsider rarely seems to grasp is that geological theories are simply those always-improving mental explanations which appear to the geologist at each successive stage of his advance best to agree with the facts known to him at the time, and serve as tools to aid him in his future work. Whenever an old explanation no longer accommodates itself to the additional facts, which the geologist has in the meanwhile discovered, he improves that explanation, making it more suitable to the new facts, and uses that as a tool until he again finds it necessary to make a further improvement, and so on.

Of course some geologists, familiar with the old explanations, give up their use with great reluctance, and not until the new array of facts forces them to do so. On the other hand, some may be tempted to make too great a change and, as it were, overshoot the mark.

But between these two extremes geology advances year by year—some tools get superseded by others because they no longer fit the facts, and some never come into use at all because the facts will not fit them.

The outsider, however, generally accepts the prevalent geological theory of the moment as if it were the be-all and end-all of everything, both opinion and discovery, and when the science advances to a newer and higher stage, he soon develops what he thinks to be a common-sense horror of all theories, and a contempt for all scientists, especially geologists, who seem to him to be for ever altering their points of view. It is a consummation that pleases him, because it gives him a comforting feeling of superiority, and it pleases the geologist, because the apparent neglect allows of his doing his work in his own quiet time and in his own quiet way.

And what great advances in geological theory have been made within the last hundred years, even in theories connected with boulders like these which we are examining to-day.

I doubt whether the memory of the oldest of us goes back to the time when the dispersion of such boulders was confidently assigned to Noah's Flood, or even to the later time when that view became superseded by the theory of mighty local floods of water of some mysterious and unknown origin. But we can most of us remember how even as late as 1886, the date of the last meeting of the British Association in Birmingham, many geologists still held firmly to the theory that the boulders had been brought on floating icebergs when Britain and all Northern Europe was sunk for a time under a kind of shallow Arctic Ocean.

At the present day the general working theory of the majority of geologists is that many boulders were brought into the Midlands from distant mountainous regions by means of a great ice-sheet, like the present ice-sheets of Greenland and the Antarctic Continent, which great ice-sheet moved mainly from north to south, and buried up in a continuous white mantle the British Islands and the neighbouring seas, moving almost as far south as the valley of the Thames.

Our present knowledge of the wide spread extent of the Midland glacial deposits, boulder clays, gravels, brick clays and the erratic blocks has been of slow growth. It has been accumulated stage by stage, and from time to time by a large number of Midland workers. Many of the earliest and most enthusiastic of them, Mr Mackintosh, Dr Crosskey, and Mr Jerome Harrison are, alas, no longer with us. Mr C. J. Woodward, Mr Fred Martin, Mr Mantle, Dr Matley, and others still remain to us, while fresh workers are quietly advancing our knowledge.

Of geologists working elsewhere, we owe, of course, a debt of gratitude to Professor James Geikie, his brother Sir Archibald Geikie, Professor Bonney, the late Professor Carvill Lewis, Professor Percy Kendall, Dr Marr, Professor Penck, and other authorities on Glaciology in general.

THE GREAT ICE-SHEET

The present trend of collective opinion is to regard it as a well established theory that the great Ice Age was a time of more or less gradually increasing cold, the effects of which led to a greater and greater accumulation of snow and ice. This began in the northern regions and on the higher grounds, and gave origin in the first instance to snowfields and glaciers, which by their growth and coalescence eventually developed into the great Ice-Sheet itself. With the gradual amelioration of the climate towards the close of the Ice Age, the ice sheet as a whole gradually retreated northward, and divided into its component parts, which eventually disappeared. Both in the latter stages of its advance and in the earlier stages of its retreat its outward edge was always fringed by long ice lobes or finger-like glaciers extending far down the deeper valleys.

Fig. 1.—From the Indicator in the Cotteridge Park, showing how this country was affected by Glaciers in the Ice-Age, their extent, and the chief lines of flow. Note the southern limit of the ice-sheet.

It is, of course, somewhat difficult to picture the actual form of the upper surface of the great Ice-Sheet when at its maximum, but that surface probably sloped gently from north to south (somewhat like the surface of a gently inclined plane) down to its southern extremity. The ice-mass was so thick that in Scotland it apparently buried from sight the great ranges of the Sidlaws and the Pentlands. It filled the Irish Sea and the German Ocean to overflowing, and moved thence south-eastwards and south-westwards over the plains and solid lands.

There is evidence to show that the surface of the ice overtopped hills in Scotland 1,800 feet high, in Shropshire came down to somewhat over 1,000 feet, and lay at least more than 800 feet above sea level in the Birmingham district, for boulders brought far from the north-west occur on the hill of Frankley Beeches, which exceeds that level.

On the face of the indicator, so kindly prepared and presented by Mr Barrow, will be found a diagram showing the vast extent overspread by the great continuous Ice-Sheet when it was at its maximum expansion. Of course, this diagram is to a certain extent theoretical, but it generalizes a large majority of the most important facts connected with the present distribution of the erratic blocks and boulders of the Midlands and elsewhere.

Now I am aware that I am speaking in a great part to members of the Cotteswold Naturalists' Field Club, who are quite familiar with the geology of their own district, but whose visits to the Birmingham country are probably few and far between. Perhaps, therefore, one may be permitted by the way to make a few remarks upon the differences between the Cotteswold region and that of Birmingham.

THE ICE-SHEET AND THE MIDLANDS

The district of country of which Cheltenham is the centre, and therefore that in which the Cotteswold geologists and geographers carry on their work, is strikingly contrasted as a whole with that part of England which has Birmingham as its centre, and where Midland geologists and geographers carry on their investigations. The distance between the two towns in a straight line is about forty miles, and a circle of about twenty miles radius from each town may, but merely for our present purpose, be considered to be the outer limits of the Cheltenham and the Birmingham areas respectively.

The main waterparting of the British Islands, dividing at the present day the basins of the rivers whose waters flow on the whole eastwards to the German Ocean from those rivers whose waters flow westward to the arms of the Atlantic, runs through both the Cheltenham and the Birmingham areas. But the course of that waterparting is a very different one in the two regions. In the Cotteswold area the waterparting is not far removed from a direct N.E-S.W. line. In the Birmingham area it has the appearance of staggering across the surface of the country in a most irregular and capricious manner, first from N.W. to S.E., then from north to south, and finally irregularly eastward. But this contrast in the behaviour of the waterparting is merely a consequence of the striking contrast of the two areas, not only in their geological structure but also in their geological history. The structure of the Cheltenham area is one of great geological simplicity. From the long north and south line of the Malvern Hills there follow one after another the successive formations in unbroken order, the great sheets all tilted gently south-eastward, all beautifully dissected by the ancient rains and rivers, but so deeply eroded to the north-east that their widest members have long since been levelled to form the broad spreading plain of the Lower Severn, while the hard limestone formations to the south-east still stand stubbornly resistant of the elements, and their north-eastern edges rise tier after tier in the beautiful scarps of the Cotteswolds.

But matters are wholly different within the limits of the Birmingham area. There all the newer limestone formations with their characteristic N.E. strike, so conspicuous in the Cheltenham area, have long since been wholly swept off, leaving not a wreck behind. Only one of the level or but gently inclined Mesozoic systems is left to us. That system is the Trias, with its lower member the Bunter, and its newer and softer member, the Keuper Marl. Not long ago, geologically speaking, the Trias overspread the whole of the Birmingham area in one vast sheet, almost like a mighty red rock sea. Where the Keuper Marl remains to us, there we have our broad rolling plains like the picturesque Arden country and the broad levels of Worcester and Stafford, and over these softest plains our rivers, the Trent and its branches, the Tame and the Penk, the Lower Severn, and its main tributary, the Avon, take their gently descending way.

But the very heart of the Birmingham country is of a very different constitution and structure. It consists of a long anticlinal form—the so-called South Staffordshire anticlinal—the long and somewhat curved axis of which ranges roughly from south to north for a distance of some thirty miles from north-east of Redditch to east of Stafford. This Midland anticlinal presents in miniature almost all the main physiographic features of the classical anticlinal of the Weald, its streams rising, even at the present day, not far from the median axis, and flowing centrifugally across the more levelled centre parts of the ancient dome, cutting in valleys sometimes gorge-like through that broken ring of high ground, which to-day represents the less denuded parts of the dome, on their way to the surrounding plains, defined by the long north and south synclinal forms, whose axes are parallel to that of the great dome.

In the Birmingham country also, as in the Wealden region, the highest points are now situated on the upland ring, and look out in one direction over the central hollows, and in the opposite direction over the broad surrounding plains.

This complicated structure had a most important bearing upon the movement of the great Ice-Sheet, and the courses of its lobe-like glaciers, both during the advance and retreat of the Ice-Sheet. And not only so, but it in a sense controlled the direction in which boulders could be transported during the advance, and left behind in the retreat. And last, but by no means least, these surface-irregularities determined the places of the as yet undefined ice-dammed lakes, in front of the ice sheet, until the last northern waters possibly overflowed through the lowest grooves in the main watershed, namely the cols of Kingswood and Tettenhall.

The erratics occurring in the Birmingham country (with the doubtful exceptions of certain flints) have all been transported for long distances from the north or the north-west, and, as a rule, the greater the distance from which they have been brought, the greater is their rarity.

There are granites from the South of Scotland, and from Eskdale in the Lake District, granophyres from the Buttermere country; andesites, felsites, rhyolites and ashes from the Lake District generally, andesites, felsites and volcanic ashes from the Arenig mountains of North Wales ; stratified Ordovician and Silurian rocks with fossils from the Berwyn Hills, rhyolites, quartzites, diorites and sandstones from the Wrekin ; dolerites and basalts from the Rowley District in the Black Country, and innumerable boulders and pebbles from the Carboniferous Permian and Triassic formations of the north-western Midlands, and the north-western part of the Birmingham country itself.

Most of the fine boulders collected at Bournville by Mr Barrow are masses of a dark igneous Plutonic rock, usually known as felsite or andesite, identical with the rock which forms a large part of the Arenig mountain range, several miles west of Bala Lake in the basin of the river Dee, North Wales, and fully eighty miles in a straight line from Bournville itself.

THE GLOUCESTER & BERKELEY CANAL

BY

A. J. CULLIS

Engineer to the Sharpness New Docks and Gloucester and Birmingham Navigation Company.

The ship-canal between Gloucester and Sharpness is known as "The Gloucester and Berkeley Canal," for which the first Act of Parliament was obtained in 1793. In the original scheme, it was intended to make the connection with the Severn Estuary at Berkeley Pill, but this idea was abandoned twenty-five years after, and further powers were obtained to vary the line and terminate the canal at Sharpness Point, but no attempt seems to have been made to alter the title.

During this period many financial difficulties had beset the construction of the canal, and many differences of opinion had arisen between the numerous engineers (including the famous Telford), who, from time to time, were engaged upon the works. Thus, it was not until the year 1827 that this important undertaking was finally completed and opened for traffic. But for many years previous to this date the dock basins at Gloucester, and the canal as far as the Hardwicke Bridge (still called the Stank Bridge) had been completed, and the former were used for the discharge of cargoes by vessels which had successfully navigated the tortuous channels of the River Severn, and entered from the river by the Gloucester Lock.

The canal was originally designed to enable vessels of 600 to 700 tons burthen—probably the largest ships of the day—to reach the City of Gloucester, which had been formerly approached only on spring tides by smaller craft making the difficult and dangerous passage by the River Severn. The construction of the canal shortened the distance from the sea by twelve miles, and provided not only a safe route, but one also available at all tides for such vessels.

At the present time, owing to improvements in the canal and in the construction of shipping, steamships carrying as much as 1200 tons regularly navigate the canal to Gloucester.

One of the notable features is the absence of intermediate locks ; the canal is at a considerable height above the River at both ends, the difference of level at Sharpness varying according to the height of the tides, which rise at low neaps and high springs approximately to 13 feet and 31 feet on the entrance cill ; the height of the canal water being $36\frac{1}{2}$ feet above this cill ; while at Gloucester the normal difference in level between the river and canal is 12 feet.

For a few miles near Gloucester the canal is in cutting, but for nearly the remainder of its length, it is retained by embankments, raised in some places the whole depth of the canal above the adjoining lands. Near Sharpness, for a distance of about two miles, it is merely divided from the River Severn by an embankment and sea wall.

Half-way between Gloucester and Sharpness the older Stroudwater Canal is crossed, at a point known as "The Junction," to which the half-day excursion was made by the Cotteswold Club on June 28th, 1913. This waterway dates from 1776, and connects Stroud with the River Severn at Framilode.

The water-supply is obtained from natural sources, principally by means of the River Frome, which is penned up to the necessary height by a weir across it near Whitminster. In dry seasons this is supplemented by pumping from the River Severn, two large centrifugal pumping-engines, capable of delivering 285 tons of water per minute, being installed at Gloucester.

Surplus water from the River Frome is taken under the canal by means of two large culverts each 10 feet in diameter, and there are also a large number of other culverts of various sizes to take the drainage of the lands below the canal-level on the east side.

A considerable extension was made to the canal in 1874 when the Sharpness New Dock was opened, with an entrance 60 feet wide, nearly half-a-mile below Sharpness Point. This was necessitated by the vast developments which had taken place in shipping, and it may be noted that vessels carrying up to 9000 tons are now received at Sharpness. The safe passage of such large vessels, so far up the Severn Estuary, has been made possible by an efficient system of lighting and marking the channel from the Kingroad to Sharpness, where many improvements have also been effected to cope with this increased tonnage: as for instance, the dock gates are now operated by hydraulic machinery, coal is shipped by hydraulic power, and grain is pumped into the warehouses by pneumatic elevating appliances.

THE WATER SUPPLY OF CIRENCESTER, GLOUCESTERSHIRE

BY

T. HIBBERT

Surveyor to the Cirencester Urban District Council

AND

L. RICHARDSON, F.R.S.E., A. Inst. W.E., F.G.S.

(*Read* 11*th November*, 1913)

The greater portion of the town of Cirencester is situated in a depression in the upland of the Cotteswold Hills. The higher ground immediately to the east, north and west, is, for the most part, capped with Forest Marble, beneath which comes the Great Oolite. Below the Great Oolite is the Fullers' Earth.

The reason for the depression is faulting. As will be seen on reference to the map given below (fig. 1), a fault, having a direction approximately from W. by N. to E. by S., is situated to the south of the town.

FIG. 1.—Map of Cirencester and neighbourhood.
(Scale: 1 inch = 1 mile.)

[It has not been found possible to indicate the extent of the Oxfordian and Cornbrash in the neighbourhood of Lewis Lane].

The old portion of the town is built on a gravel-bed that borders the River Churn. Beneath the gravel is clay. The gravel is composed of waterworn pieces of Oolite, and is anything up to 20 to 25 feet in thickness. The clay below holds up the water.

Previous to 1882 Cirencester was supplied with water solely from wells sunk into this gravel-bed. Unfortunately, there are still a large number in everyday use. Gravel, it is true, acts to a certain extent as a natural filter; but, in a thickly-populated district, water in wells in such a deposit is always liable to contamination, and their disuse, therefore, is eminently desirable.

About the year 1870 considerable discussion took place as to the possibility of obtaining a supply of pure water for the town.

The then Earl Bathurst had a boring put down in 1871-72 in a field near The Barton Mill (see map, fig. 1, No. 1) to ascertain if an adequate supply could be obtained there from the Great Oolite. J. H. Taunton was engaged to watch the boring operations, and on July 16th, 1872, reported to the Sanitary Committee of the Cirencester Town Commissioners as follows :—[1]

> "A boring 3½ inches in diameter has been sunk there [near The Barton Mill] for a depth of 148 feet from the ground-surface down to the Fullers' Earth formation. At 91 feet 6 inches, after piercing a bed of marl, the loose rocks of the Great Oolite were found charged with water, which ascended the bore-hole with great force as an artesian spring from January 6th to March 2nd, delivering at one time (during the week ending January 27th [1872]) 29 gallons of water per minute.
>
> "Again, after piercing 8 feet of impervious beds in the Great Oolite at a depth of 109 to 117 feet from the surface, more water was tapped and ascended to the surface.
>
> "The boring was continued until it was found to have been carried into the upper beds of the Fullers' Earth. I have had the advantage of Mr [Prof. James] Buckman's assistance in determining this point.
>
> "The work, although of an experimental character, has been successful in obtaining so large a supply of spring water at the site in question, that, with the gravel-bed supply procurable there, I believe enough water has already been found to meet the general requirements at Cirencester."

1 Copies of this letter are deposited at the Public Library, Gloucester, the Bingham Library, Cirencester, and at the office of the Surveyor to the Cirencester Urban District Council.

A sample of the water was submitted on the 8th January, 1872, to Prof. A. H. Church, M.A., F.C.S., of the Royal Agricultural College, who reported :—

> "This water corresponds in general character and in chemical composition to the best deep well waters of this district. It is quite suitable for drinking purposes and for ordinary domestic uses.
>
> "The hardness of this water is 14·95 degrees, reduced to 4·9 degrees by boiling. One imperial gallon contains 21·42 grains of total residue or saline matter. Of this residue 2 grains are sulphate of lime and 1·49 grains common salt. The colour, odour and taste of this water are quite satisfactory."

Taunton published a coloured vertical section of The-Barton-Mill boring in the "Proceedings" of the Club, and a paragraph in explanation.[1]

For some reason or other the Barton site was not adopted, and the bore-hole has never been utilized. Instead, attention was given to a site, marked by the present pumping-station (2 on the map), in Lewis Lane—in the town.

From 1832 to 1882 the site of the present pumping-station was occupied by Messrs E. Bowly & Son's Brewery, Mr E. Bowly purchasing the Brewery in 1832. Previous to 1880 the Brewery obtained its water from a well 30 feet deep and 3 feet 6 inches in diameter. This well passed through about 7 feet of made ground, about 12 feet of gravel, 2 feet of fine sand, into clay, and was lined with cast-iron cylinders. The water was, of course, derived from the gravel-bed.

In 1880, however, Messrs Bowly required more water, and, therefore, had a 4-inch chisel-boring put down from the bottom of their well to a depth of 100 feet, or 130 feet from the surface.[2] Joseph Lucas, F.G.S., was engaged by Messrs Bowly to advise them.

Lucas at first thought that an adequate supply would be obtained from "the junction of the Stonesfield Slate with the Fullers' Earth,"[3] but after he had been over the ground, came to the conclusion that a sufficient quantity would probably be obtained from the Great Oolite.[4]

1 Vol. ix, pt. 1 (1886), p. 60.

2 This is the well referred to by Harker as "The well at Lewis Lane (Bowly's Well)," Proc. Cotteswold Nat. F.C., vol. x., pt. 2 (1891), p. 185.

3 *In litt.* to Messrs Bowly & Son, 16th April, 1880. 4 *In litt.* 21st April, 1880.

Copies of letters written on April 16th, 21st, 24th, and May 3rd are deposited at the Public Library, Gloucester, the Bingham Library, Cirencester, and at the office of the Surveyor to the Cirencester Urban District Council.

On May 3rd, 1880, Lucas replied to a letter in which he had been told that water had been obtained. He expressed his satisfaction at the news, but doubted if the Great Oolite had really been reached.

In 1882, on the death of Mr E. Bowly, the Brewery, its houses, etc., were sold to Cripps' Brewery (now known as the Cirencester Brewery Co.), and from them—in the same year—the Cirencester Water Works Company acquired the " Brewery well."

In 1882-83, in order to supplement the supply, the Water Works Company had another 4-inch chisel-boring put down from the bottom of the well, at a distance of about 2 feet to 2 feet 6 inches away from the other hole.

This second bore-hole penetrated to a depth of 109 feet from the bottom of the well, or to 139 feet from the ground-level. *The Great Oolite was reached at* 119 *feet from the surface. The boring was continued for* 20 *feet into the Great Oolite and then left off.*

Taunton, who supervised the sinking, published a vertical section of the rocks passed through.[1]

The supply of water from this 30-foot well, with its two 4-inch bore-holes from the bottom (one to a depth of 100 feet and the other to a depth of 109 feet), did not provide a supply adequate to meet the demand. Consequently, in 1890, the Water Works Company decided to sink a new shaft and bore-hole. The Aqueous Works and Diamond Rock Boring Company, of Lambeth, were entrusted with the work, and Mr Taunton watched the operations.

First a shaft 46 feet 3 inches deep and 4 feet 9 inches in diameter was sunk to a depth of 28 feet 5 inches ; then 3 feet 2 inches in diameter for a further depth of 2 feet 2 inches, and 3 feet 9 inches in diameter for the remaining 15 feet 8 inches.

Taunton kept some of the fossils that he had obtained from the clay that had been dug out of this well, and about June, 1890, showed them to Professor Allen Harker, of the

1 Proc. Cotteswold Nat. F.C., vol. ix., pt. 1 (1886), table facing p. 60

Royal Agricultural College. Harker was surprised to see that they were specimens indicative of Oxford Clay[1] At his request Taunton sent them to Jermyn Street, where they were examined by Messrs Sharman and H. B. Woodward, who confirmed his (Harker's) conclusions.[2]

Harker naturally became interested, and when, in July, 1890, a 9-inch diamond-boring[3] was commenced from the bottom of the new shaft, kept a very close watch.

The Great Oolite was proved in this bore-hole—according to Harker—at between 128 *and* 130 *feet from the surface. The boring was continued into the Great Oolite for close upon* 50 *feet, and was then abandoned at a depth of* 177½ *feet from the surface.*[4]

The cores that were drawn were placed at Harker's disposal for detailed examination.[5] Harker published a vertical section of the beds that were passed through.[6]

From the well and bore-hole sunk in 1890, a sufficient quantity of water was obtained to meet the needs of the time.

In 1898 the Works of the Water Company were purchased by the Cirencester Urban District Council.

More water was soon required. Consequently, it was contemplated putting down an 18-inch bore-hole between the two 4-inch holes at the bottom of the "Brewery Well." It was found, however, that the two 4-inch holes had not been bored true: they were out of the vertical and converged. Also, it was discovered that the greater quantity of water supplying this well was not coming from a deep-seated source, but from the gravel-bed. Apparently, the two bore-holes had not proved satisfactory in the matter of obtaining water, so seven holes had been drilled through the side of the well to admit of water from the gravel-bed!

1 Proc. Cotteswold Nat. F.C., vol. x. pt. 2 (1891), p. 186.

2 *Id.*, p. 187: see also H. B. Woodward "The Jurassic Rocks of Britain –vol. v. (1895), The Middle and Upper Oolitic Rocks of England (Yorkshire excepted)," p. 36. Mem. Geol. Surv.

3 Harker says 8½ inches.

4 This bore-hole was left unlined by the Water Company and was tubed by the Cirencester Urban District Council when they took over the Works in 1898.

5 Proc. Cotteswold Nat. F.C., vol. x., pt. 2 (1891), p. 188. A portion is now at the Royal Agricultural College, Cirencester. It is hoped that at some future time it will be possible to examine it in detail. The Kellaways Rock is unmistakable.

6 Proc. Cotteswold Nat. F.C., vol. x., pt. 2 (1891), table facing p. 190.

On the 16th March, 1901, in reply to a request from one of us (T.H.) the Aqueous Works Co. supplied particulars of the strata passed through in the boring. Harker's record is so much more detailed that the information given by the Company is not published, but copies have been deposited at the Gloucester Public Library, the Bingham Library, and at the office of the Surveyor.

In 1904 this well was very wisely filled up, and a new bore-hole put down by Messrs Thomas Tilley & Sons, of London. This new bore-hole was intended to be 18 inches finished diameter, but it was found necessary to line it to a greater depth by a second lining 16½ inches diameter, as mentioned below.

On page 183 will be found details of the rocks passed through, but these will be discussed shortly (page 183).

When a depth of 181 feet below the present engine-room floor was reached (and the end of the bore-hole was still in the Great Oolite), a temporary pump was put down to test the yield of water. It was found that it was not equal to 1,000 gallons per hour. Consequently, it was decided to put down a small 1-inch diamond-boring to a further depth of 50 to 60 feet from the bottom of the bore-hole. The experiment proved satisfactory, so the boring was continued to a depth of 267 feet, but this time with a 6-inch-size calyx-borer, so that cores were drawn.

The bottom of the Great Oolite limestone was reached at 260 *feet below the engine-room floor* (102 *feet above O.D.*)

Representative pieces of these cores have been kept (see page 183).

Afterwards the bore-hole was enlarged by percussion-boring with chisels. From 6 feet down to 135 feet it was lined with cast-iron pipes having an internal diameter of 18 inches. Through these pipes were thrust wrought-iron pipes (with an internal diameter of 16½ inches) to a depth of 195 feet 2 inches. From 195 feet 2 inches to 259 feet the bore-hole was enlarged to 12 inches and left unlined, or " open ; " while the 6-inch bore-hole from 259 to 267 feet was left uninterfered with and unlined.

In 1905 the building of the present pumping-station was completed.

The yield of the 1904 bore-hole is 16,700 gallons per hour, and of the 1890 bore-hole 10,000 gallons per hour.

STATEMENT OF REST LEVELS OF WATER IN WELL AND BOREHOLE AT THE PUMPING STATION, LEWIS LANE.

The depths recorded are the depths below Engine-room floor.*

1906 LEVEL

Date	Ft.	in.
Sept. 2	22	6
Oct. 3	22	9
,, 29	22	2
Nov. 16	18	6
,, 21	14	0
,, 28	13	6
Dec. 5	13	6

1907 LEVEL

Date	Ft.	in.
Jan. 4	14	3
,, 8	13	10
,, 22	13	0
Feb. 14	14	5
March 8	14	3
April 3	15	3
June 14	16	0
,, 27	16	1
July 4	16	9
,, 13	17	0
Aug. 2	16	4
Sept. 5	17	10
Oct. 12	19	9
,, 25	15	0
,, 31	13	0
Nov. 1	12	0
,, 5	11	3
,, 14	12	0
,, 21	13	0
,, 28	11	6
Dec. 6	8	8
,, 11	6	6
,, 12	6	3
,, 13	6	0
,, 14	5	11½
,, 17	6	0
,, 19	6	5

1908 LEVEL

Date	Ft.	in.
Jan. 10	11	0
Feb. 7	13	3
,, 28	15	10
March 5	14	6
April 1	12	0
May 7	10	6
,, 29	13	9
June 5	14	9
,, 12	15	3
,, 19	15	10
,, 26	16	6
July 3	17	0
,, 10	18	0
,, 24	17	6
,, 31	17	8
Aug. 6	18	4
Sept. 18	19	3
Oct. 20	20	0
,, 16	20	7
Nov. 6	20	5
Dec. 4	19	10
,, 10	18	9
,, 18	18	0
,, 31	14	0

1909 LEVEL

Date	Ft.	in.
Jan. 1	14	0
,, 22	11	10
Feb. 17	15	0
,, 26	16	0
March 4	16	2
,, 19	12	10
,, 23	12	3
,, 26	11	2
April 16	11	11
,, 30	13	9
May 20	15	3
June 2	16	2
,, 23	17	0
Aug. 27	18	7
Sept. 9	19	0
,, 19	19	6
Oct. 22	10	0
,, 29	8	0
Nov. 5	9	7
Dec. 14	10	0
,, 24	7	2

1910 LEVEL

Date	Ft.	in.
Jan. 1	7	8
,, 21	10	1
Feb. 4	10	3
,, 25	7	0
March 4	7	4
,, 18	11	5
May 6	14	8
June 2	16	4
July 20	16	3
Aug. 12	16	6
,, 27	16	4
Sept. 16	17	6
Oct. 21	15	0
Nov. 25	10	3
Dec. 2	9	6
,, 20	5	8

1911 LEVEL

Date	Ft.	in.
Jan. 7	10	7
Feb. 1	12	2
March 2	13	6
,, 10	12	3
,, 17	11	4
,, 21	13	6
,, 24	12	6
,, 28	11	9
April 27	15	2
May 26	17	4
June 2	17	10
,, 30	18	9
July 25	20	6
Aug. 2	20	2
,, 15	21	9
Sept. 4	22	0
,, 25	22	6
Oct. 2	23	0
,, 17	24	0
Nov. 2	24	0
,, 28	20	8
Dec. 6	20	0
,, 11	16	0
,, 20	9	0
,, 21	7	9
,, 22	6	3
,, 23	5	9
,, 26	6	6
,, 29	7	0

1912 LEVEL

Date	Ft.	in.
Jan. 2	8	0
,, 10	7	0
,, 17	7	6
,, 18	6	6
,, 20	6	3
,, 22	5	6
,, 26	5	4
,, 30	6	0
Feb. 1	6	5
,, 5	7	0
,, 8	10	0
,, 14	11	0
,, 19	10	0
,, 22	10	6

* The level of Engine-Room floor is 362 feet above O.D.

The water from the "1890 well" is lifted by an "Ashley" patent double-acting bucket and plunger pump, worked by a steam-engine (condensing), while that from the "1904 well" is lifted by the same type of pump—but with a larger capacity—driven by a gas-engine working with suction gas.

The water is pumped to a reservoir in the Park (3 on the map), which has a capacity of 204,000 gallons. From the reservoir the water gravitates back through another main, to which the houses are directly connected.

The water is analysed regularly by Prof. E. Kinch, of the Royal Agricultural College, and the following is an analysis of a typical sample :—

Analysis of a Sample of Water from the Cirencester Waterworks
obtained from the larger pump at the Pumping Station on December 17th, 1913.

"The water was clear and bright; the residue left on evaporation was white and scarcely changed on heating.

"On analysis it yielded:

Total solid residue at 100° C. ..	21·28 grains per gallon
Loss on heating	1·12 ,, ,,
Chloride, expressed as common salt	1·37 ,, ,,
Oxygen, from potassium permanganate, consumed by organic matter in three hours	trace only
Nitrogen as Ammonia	trace only
Nitrogen as Albuminoid Ammonia	0·02 per million
Nitrogen as Nitrates	2·69 per million
Temporary Hardness 15·5° / Permanent Hardness 2·3°	On Clark's Scale *i.e.* grains of Carbonate of Lime per gallon

"This sample was of accustomed good quality and purity.

"The samples examined throughout the year have all been clear and bright and in good condition.

"The total solids have varied between 21·28 and 22·33 grains per gallon. The Chloride from 1·31 to 1·43 grains per gallon. The Free Ammonia from none to trace. The Albuminoid Ammonia from 0·01 to 0·05 per million, and the Nitrogen as Nitrates from 2·5 to 2·78 per million."

With regard to the deposits penetrated by the 1904 borehole, such details as could be noted at the time by one of us (T.H.) are set out on page 183. Down to 181 feet from the surface a chisel-borer was used, and, therefore, no cores were drawn. At the best, only small fragments of rock were obtained. From 181 feet down to 267 feet, however, a calyx-borer was employed, and therefore cores were drawn. Representative specimens of these were saved, and have been examined by one of us (L.R.).

Rocks Penetrated by the 1904-Bore-Hole at the Lewis Lane Pumping Station, Cirencester

Remarks		Nature of Rocks	Thickness of rocks	Depths from surface	Remarks
Engine-room floor, 362′ above O.D.		– Made ground	12′	12′	
[Highest known rest-level–356′ 8″ above O.D., or 5′ 4″ down [1]]	[Superficial Deposits.]	1 Yellow gravel	3′ 6″	15′ 6″	Bore-hole lined with 16½-inch wrought-iron pipes from 6 ft. down to 195 ft. 2 ins. (from 6 ft. to 135 ft. being inside the 18-inch pipes). Bore-hole from 6 ft. down to 135 ft. lined with 18-inch cast-iron pipes.
		2 Clay	6″	16′	
		3 Yellow gravel	5′	21′	
	[Great Oolite, Forest Marble, Cornbrash and Oxfordian.]	4 Blue clay	26′ 6″	47′ 6″	
		5 Hard loamy clay	1′	48′ 6″	
		6 Blue clay	2′ 6″	51′	
		7 Hard blue clay	7′	58′	
		8 Blue stone with shells ..	5′	63′	
		9 Hard blue stone with white vein	4′	67′	
		10 Rotten clay with a band of stone	2′ 6″	69′ 6″	
		11 Hard clay with a band of stone	5′	74′ 6″	
		12 Grey gault with stone ..	17′ 6″	92′	
		13 Very hard grey marble stone	7′ 6″	99′ 6″	
		14 Light blue clay and stone ..	17′	116′ 6″	
		15 Hard blue clay and stone ..	6′	122′ 6″	
		16 Hard light clay and flint ..	5′	127′ 6″	
		17 Hard light stone bed ..	8′	135′ 6″	
		18 Dark marl and bed of light stone	3′ 1″	138′ 7″	
		19 Light marl	14′ 1″	152′ 8″	
		20 Hard light stone	19′ 4″	172′	
		21 Light marl	9′	181′	
		22 Hard light stone	28′	209′	12-inch open boring from 195 ft. 2 ins. to 259 ft.
		23 Oolite, hard	7′	216′	
i.–*Specimen from about 231 ft.* [1]		24 Very hard light stone ..	14′	230′	
ii.–*Specimen from about 262 ft.* [2]		25 Great Oolite (very broken) ..	30′	260′	
iii.–*Specimens from between 264 and 267 feet.* [3]	[Passage Beds into Fullers' Earth.]	26 Stonesfield Slate [cf. bed 2 of the Kemble boring] ..	4′	264′	6-inch open boring from 259 to 267 ft.
		27 Fullers' Earth [cf. bed 4 of the Kemble boring]	3′	267′	

1 This occurred on three successive dates, namely, January 25th, 26th, and 27th, 1912.—T.H.

1–3 These Specimens are preserved in the Council Chamber of the Cirencester Urban District Council, and duplicates of ii. and iii. have been deposited at the Cheltenham Town Museum.

The rock between 264 and 267 feet down (called " Fullers' Earth " in the section) is identical with that which was proved in a boring put down at Kemble in 1911 at from 105 feet 6 inches to 106 feet down.[1] It is largely composed of shell-fragments (principally of *Ostrea* and *Pseudomonotis*[2]), in places

1 Specimens 6 and 7, p. 189. Specimen 6 from Kemble is identical in appearance with the rock (Specimen iii.) from between 264 and 267 feet down here.

2 It also contains *Chlamys vagans* (Sow.) and *Rhynchonella* sp.

compacted into a limestone, contains irregularly-shaped little bodies similar to those in its equivalent at Kemble, and has for its matrix the ordinary Fullers'-Earth clay.

The rock called " Stonesfield Slate " in the section (specimen ii.) reminds one of that constituting the bed between 60 and 70 feet down (specimen 1) in the Kemble Boring. It is, however, much more oolitic.

A sample of the limestone from about 231 feet down has been preserved, and is typical Great Oolite limestone. Unfortunately, it is not at all clear where the Great Oolite ends and the Forest Marble begins. Even in open sections in the neighbourhood, that is, quarries and cuttings, the question as to where precisely the line of demarcation between these two formations comes is not an easy one to settle : there are certain beds that have been called " Kemble Beds " which are " Passage Beds " between the two. Harker states that in the 1890 bore-hole " the fine cream-coloured freestones of the Great Oolite " were reached at a depth of 128-130 feet from the surface.

We hesitate to suggest the division-line in the section between the Forest Marble and Cornbrash, or between the latter and the Kellaway's Rock. From a geological standpoint it is very interesting to know that Kellaway's Rock and Oxford Clay are really there.

A DEEP BORING AT KEMBLE

BY

L. RICHARDSON

In 1911 a deep boring was put down from the bottom of the old well immediately to the south of the pumping-station at Kemble Junction.

Great-Oolite limestone, 60 feet thick; beds best described as "Passage-Beds," 48 feet thick; Fullers' Earth, 73 feet thick; the whole of the Inferior Oolite (as here developed) were penetrated, and the boring was continued into the Cotteswold Sands to a depth of 54 feet 6 inches.

GREAT OOLITE.—For the first 60 feet the bore-hole passed through pale-yellow oolite of fairly homogeneous structure. A representative piece had a porosity of 16·1 per cent. of its volume in addition to the capacity of the fissures in the rock.

PASSAGE BEDS.—The deposits between 60 and 181 ft. down were characterized by a prevalent grey tint. Upon closer inspection, however, it was found that they comprised the beds described in the record given on page 188. They were all practically impervious, and the more calcareous portions were very close-grained. The porosity of a representative sample of the hard rock was only 2·5 per cent. of its volume; while that of the beds as a whole would be much less, owing to the layers of clay between the stone.

From a geological standpoint it seems desirable to separate the deposit between 60 and 181 feet down into two portions, and to tentatively denominate the upper 48 feet of deposit "Passage-Beds," that is, Passage Beds between the underlying and unmistakable Fullers' Earth, and the overlying true Great-Oolite limestone.

The grey, fine-grained sandstones, in part fissile, which constitute bed 3, suggest a Stonesfield-Slate horizon. From similar "Passage Beds," discovered in the sinking of certain of the shafts for the Sodbury Tunnel, Prof. S. H. Reynolds and Dr A. Vaughan obtained the ammonite *Perisphinctes gracilis* (J. Buckman).[1] The same species was noticed by Witchell in the equivalent beds at Stroud Hill.[2] This ammonite is characteristic of the true Stonesfield Slate of Puckham (near Cheltenham), of Eyeford and Stonesfield, Oxon.

Fullers' Earth.—The thickness assigned to the Fullers' Earth at Sodbury by Reynolds and Vaughan, is 90 feet.[3] In the Great Western Railway Tunnels at Sapperton it has been noted as between 80 and 90 feet thick.[4] While the upper limit of the Fullers' Earth is not readily fixed, the lower limit is very obvious: the greenish-grey Fullers'-Earth marls, with their noticeable conchoidal fracture, rest directly upon the Rubbly Beds of the Inferior Oolite.

Inferior Oolite.—No rock corresponding to Witchell's White Oolite, as developed at Stroud Hill (according to that author's record), was observed; but the Rubbly Beds were unmistakable. Although, owing to non-exposure to atmospheric conditions, they were of a bluish colour, it was easy to see that they would soon weather so as to assume the aspect of their equivalents in such sections as that on Stinchcombe Hill.[5]

The White Oolite, as developed in the Horton-Rectory Quarry in the South Cotteswolds,[6] followed below the Rubbly Beds and was 15 feet thick. It also was, as a rule, of a bluish colour.

The *Clypeus*-Grit and Upper *Trigonia*-Grit, except in the matter of their colour, were quite typical; but there was no

1 Quart. Journ. Geol. Soc., vol. lviii. (1902), p. 741.
2 Proc. Cotteswold Nat. F.C., vol. vii., pt. 2 (for 1879-80), p. 124.
3 Quart. Journ. Geol. Soc., vol. lviii. (1902), p. 741.
4 Proc. Cotteswold Nat. F.C., vol. v., pt. 3 for 1870 (1871), [Plate] B.
5 Proc. Cotteswold Nat. F.C., vol. xvii., pt. 1. (1910), p. 96.
6 *Ibid.*, pp. 110 and 112.

Upper Coral-Bed, or representative of the Dundry Freestone in between them.

The Upper *Trigonia*-Grit here rests directly upon the Lower Freestone, the top-stratum of which was noticeably bored. The fact that the "Grit" rests directly upon the Lower Freestone, is important in connection with the representation of the results of the Bajocian Denudation.[1] The Lower Freestone is 43 feet 6 inches thick, well oolitic and pale-yellow. It rests upon the Pea-Grit, which is 35 feet 6 inches thick, but of bluish-grey tint. An important fact, from a geological standpoint, was next observed, namely, that the Pea-Grit here rests directly upon the yellowish-brown, iron-shot Cephalopod-Bed, without the intervention of any Lower Limestone or *Scissum*-Beds.

UPPER LIAS.—There was no mistaking the Cephalopod-Bed. Its rich yellowish-brown colour and irony-grains had led the workmen to call it "the ironstone." It was not possible to determine the precise hemeræ to which the deposits composing this 6-foot Cephalopod-Bed belonged; but the hard "cap" or *Opaliniforme*-Bed did not appear to be represented.

The line of demarcation between the Cephalopod-Bed and Cotteswold Sands was very sharp. The Sands, when dry, were grey in colour, but a pretty green when freshly brought up to the surface, and therefore moist. Compared with the Sands on the Cotteswold edge, these sands from the Kemble bore-hole contained a large amount of argillaceous material; but the explanation doubtless is that percolating waters have washed out most of it from the deposit where it occurs near the edge of the hills.

1 *Vide* Quart. Journ. Geol. Soc., vol. lvii. (1901), plate vi.

DESCRIPTION OF THE ROCKS PASSED THROUGH BY THE BORE-HOLE AT KEMBLE

(Bore-hole, 353 feet deep).

Line-Level.—356 feet above ordnance-datum.
Well (through embankment), 27ft. 6 ins. deep.
Top of bore-hole.—328 ft. 6 ins. above ordnance-datum.

	No.	Description	Thickness of rocks. Ft.	Ins.	Depth from top of bore-hole. Ft.	Ins.
Great Oolite	1.	Pale yellow oolitic limestone with a few shell-fragments and small gastropods	60	0	60	0
"Passage-Beds"*	2.	Limestone, hard, blue-black (with sporadically-distributed yellow oolite-granules) separated by layers of somewhat sandy rock	10	0	70	0
	3.	Sandstone, grey, fine-grained, micaceous, calcareous, compact in some places, fissile in others	12	0	82	0
	4.	Marls, grey, sandy in places, with very shelly layers; *Rhynchonella*, *Chlamys vagans* (Sow.), *Pseudomonotis*, *Volsella imbricata* (Sow.), etc.	26	0	108	0
Fullers' Earth†	5.	Marls, similar in many respects to those composing bed 4. The upper part is sandy and indurated, the lower more marly, and when dry from exposure, breaks up with a conchoidal fracture into irregular pieces. Some very shelly layers occur, being crowded with crinoid-ossicles and specimens of *Ostrea acuminata* (Sow.)	73	0	181	0
Inferior Oolite	6.	*Rubbly Beds.* Ragstone, rubbly, shelly, bluish; *Terebratula globata* auctt. (common) *Rhynchonella*, *Syncyclonema*, etc.	4	6	185	6
	7.	*White Oolite.* Limestone, bluish, oolitic	15	0	200	6
	8.	*Clypeus-Grit.* Ragstone, rubbly, shelly; usual fossils	7	0	207	6
		Non-sequence. Upper Coral-Bed and Dundry Freestone wanting.				
	9.	*Upper Trigonia-Grit.* Ragstone; usual fossils	6	0	213	6
		Non-sequence. All the beds of the hemeræ *niortensis* to *bradfordensis* (incl.) wanting				
	10.	*Lower Freestone.* Top-bed well bored by annelids	43	6	257	0
	11.	*Pea-Grit.* Limestone, bluish, pisolitic ..	35	6	292	6
		Non-sequence. Lower Limestone, *Scissum-* and *Opaliniforme-*Beds, wanting.				
Upper Lias	12.	*Cephalopod-Bed.* Yellowish-brown, ironshot, marly limestone	6	0	298	6
	13.	*Cotteswold Sands.* The upper 17 feet are greyer and more compact than the lower deposits; penetrated	54	6	353	0

Bottom of bore-hole.—24 ft. 6 ins. below ordnance-datum.

* Rock-specimens

(1). from 62 feet down. *Cf.* specimen ii. from Lewis Lane, [Cirencester (page 183).
(2). ,, 75 feet ,,
(3). ,, 82 feet ,,
(4). ,, 91 feet ,,
(5). ,, 97½ feet ,,
(6). ,, 105½ feet ,, *Cf.* specimen iii. from Lewis Lane, [Cirencester (page 183).
(7). ,, 106 feet ,,

† and

(8). ,, 134½ feet ,,

have been labelled as to the depths from which they were obtained and placed in the Cheltenham Town Museum.

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[*The Editor of the Proceedings of the Cotteswold Naturalists' Field Club is directed to make it known to the Public that the Authors alone are responsible for the facts and opinions contained in their respective Papers.*]

VOL. XVIII. PART III.

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OF THE

Cotteswold Naturalists'

FIELD CLUB

FOR

1914

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[With Plates illustrating Reports of Field Meetings]

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1913	Martin, J. Middleton, B.A., M.D., B.C., D.P.H.	The Chestnuts, Stroud
1867	Marling, Sir William H., Bart., J.P. D.L.	Stanley Park, Stroud
1888	Marling, W. J. Paley, J.P... ..	Stanley Park, Stroud
1887	Marling, S. S., J.P.	Stanley Park, Stroud
1901	Mitchinson, Right Rev. J., D.C.L., D.D.	College Gardens, Gloucester
1911	Montgomrey, A. S., J.P.	19 Royal Parade, Cheltenham
1912	Mylius, F. J.	Winchcombe, Gloucester
1878	Moreton, Lord	Sarsden, Chipping Norton, Oxon.
1902	Newton, Surgeon-Major Isaac, I.M.S.	Broadlands, The Park, Cheltenham
1899	Norris, H. E.	Cirencester
✠1891	Paine, Alfred E. W...	The Poplars, Welford-on-Avon
1913	Palin, P. Nevinc, J.P.	Aylesmere Court, St. Briavels, Glos.
✠1906	Paris, E. Talbot, B.Sc., F.C.S. ..	15 Montpellier Villas, Cheltenham
1909	Pearce, F. T...	Lorraine House, Gloucester
1898	Phillips, J. G.	Barnwood Avenue, near Gloucester
✠1905	Prevost, E. W., M.A., Ph.D., F.R.S.E. ..	Weston, Ross
1908	Price, M. P., J.P.	Tibberton Court, Gloucester
1909	Price, W. R., B. A., F.L.S. ..	Pen Moel, Chepstow
✠1900	Richardson, L., F.R.S.E., F.G.S.	10 Oxford Parade, Cheltenham
1908	Rixon, W. A., J.P., C.C.	Turkdean Manor, Northleach, Glos.
✠1891	Sawyer, John, J.P., Ald. C.C. ..	Battledown, Cheltenham
✠1883	Scobell, Ven. Archdeacon E. C., M.A.	7 College Green, Gloucester
1878	Sewell, E. C.	The Beeches, Cirencester
1910	Sinclair, The Ven. Archdeacon ..	The Greenway, near Cheltenham

1913	Skillicorne, W. N., J.P.	9 Queen's Parade, Cheltenham
1903	Skinner, J. W.	The Edge, Stroud
1905	Slater, A., J.P.	Garron Dene, Gloucester
1882	Smith, A. E.	The Hollies, Nailsworth
1914	Smith, F. W., F.G.S.	Duart, Cheltenham Road, Gloucester
1913	Smith, G. H. Pavey	High Beeches, Nailsworth
1909	Smithin, James A.	Lloyds Bank, Gloucester
1908	Stanton, A. W.	69 Oxford Terrace, London, W.
1906	Stephens, A. J.	Clovelly, Denmark Road, Gloucester
1887	Taynton, H. J.	8 Clarence Street, Gloucester
1914	Thomas, J. H.	2 Wedderburn House, Wedderburn Road, Hampstead, London, N.W.
✠1896	Thompson, W.	Lansdown, Stroud
✠1889	Upton, Charles	Rooksmoor, Tuffley Avenue, Glouces- [ter
1889	Waller, F. W.	Horton Road, Gloucester
1894	Washbourn, William	Blackfriars, Gloucester
1911	Watkinson, A.	Mickleton, Campden, Glos.
1889	Watson, Dept. Surgeon-Gen. G. A.	Hendre, Cheltenham
1910	Weaver, Henry J., M.I.C.E.I. M.I.M.E., F.G.S.	Churchdown, nr. Gloucester
1905	Wenden, Major J. G., V.D.	The Chantry, Dursley
✠1880	Wethered, E. B., J.P., F.G.S.	The Uplands, Cheltenham
1914	Wilkin, L., M.A., B.C.	46 London Road, Gloucester
1912	Wilson, E. T., M.B., F.R.C.P.	Westal, Cheltenham
✠1884	Winnington-Ingram, Rev. A. R.	Lassington Rectory, Gloucester
✠1876	Winwood, Rev. H. H., M.A., F.G.S.	11 Cavendish Crescent, Bath
✠1896	Witchell, E. Northam	Lansdown, Stroud
1885	Wood, Walter B.	Barnwood, Gloucester

A cross signifies those who have contributed papers printed in the "Proceedings" of the Club.

(*Any corrections in this List should be notified to the Hon. Secretary*)

LIST OF SOCIETIES, INSTITUTIONS, &c.,

To whom Copies of the Club's Publications are presented.

An asterisk denotes those from whom publications are received in exchange. All publications sent in exchange should be addressed to the Librarian, Cotteswold Club, Public Library, Gloucester.

* The American Museum of Natural History, Central Park, 77th Street and 8th Avenue, New York City, U.S. America, c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

†Birmingham Nat. Hist. & Phil. Society, c/o The Librarian, Avebury House, 55 Newhall Street, Birmingham.

The Bodleian Library, Bodley's Librarian, Oxford.

*†Bournemouth Natural Science Society, c/o Hon. Secretary, "San Remo," Boscombe, Bournemouth.

*†The Bristol and Gloucestershire Archæological Society, The Librarian, Public Library, Gloucester.

*†The Bristol Naturalists' Society, c/o C. King Rudge, L.R.C.P., 145 White Ladies Road, Redland, Bristol.

The British Museum (Natural History), The Librarian, Cromwell Road, London, W.

The British Museum (Copyright Office), London, W.C.

The British Association, The Secretary, Burlington House, London, W.

The Cambridge University Library, c/o The Librarian, Cambridge.

*†The Cardiff Naturalists' Society, c/o The Hon. Librarian, 98 Bute Street, Cardiff.

The Derbyshire Archæological and Natural History Society, c/o P. H. Currey, Market Place, Derby.

The Geological Magazine, The Editor of, 13 Arundel Gardens, Notting Hill, W.

The Geological Society, c/o The Librarian, Burlington House, Piccadilly, London, W.

* The Geological Survey, c/o The Librarian, The School of Mines, Jermyn Street, London, S.W.

*†The Geologists' Association, c/o The Librarian, University College, Gower Street, London, W.C.

* The Glasgow Geological Society, c/o The Librarian, 207 Bath Street, Glasgow.

The Gloucester Municipal Library, Brunswick Road, Gloucester.

The Library, County Education Office, Shire Hall, Gloucester.

Nature, The Editor of, c/o Messrs Macmillan & Co., St. Martin's Street, London, W.C.

*†The North Staffordshire Field Club, c/o W. Wells-Bladen, Stone, Staffordshire

The Royal Society, c/o The Librarian, Burlington House, Piccadilly, W.

The Smithsonian Institution (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

* The U.S. Geological Survey (Washington, D.C., U.S. America), c/o Messrs Wesley & Son, 28 Essex Street, Strand, London, W.C.

*†The Warwickshire Naturalists' and Archæologists' Field Club, The Museum, Warwick.

*†The Wiltshire Archæological and Natural History Society, The Museum, Devizes.

*†The Woolhope Naturalists' Field Club, c/o Hon. Librarian, Woolhope Club, Free Library, Hereford.

†The Presidents and Secretaries of these Societies are considered as Ex-officio Members of the Club, and are cordially invited to the Meetings; Programmes of Meetings to be sent to them as invitations.

INCOME AND EXPENDITURE FOR THE YEAR ENDING DECEMBER 31st, 1914

INCOME

	£	s	d	£	s	d
To Balance from 1913	4	2	11			
,, 4 Subscriptions for 1914 @ 15/-	3	0	0			
,, 103 do. 1914 @ 15/-	77	5	0			
,, 1 do. 1914 @ 10/-		10	0			
,, 10 Entrance Fees 1914 @ £1	10	0	0			
,, 1 Entrance Fee and Subscription in advance for 1915	1	15	0			
				96	12	11
,, Sale of Proceedings, &c.				2	2	3
				£98	15	2

Cash Assets—

	£	s	d
Balance as on other side ..	£2	15	11
Subscriptions in arrear ..	7	10	0
	£10	15	11

J. H. JONES, *Hon. Treasurer.*
Gloucester, 19th January, 1915.

EXPENDITURE

	£	s	d	£	s	d
By Hon. Secretary's Expenses..	9	19	0			
,, Treasurer's do.		15	0			
,, Librarian's do.		5	1			
,, Public Library Rent and Insurance ..	1	3	6			
,, Pitcher—Lantern		9	0			
,, Bellows—Printing "Proceedings," &c. ..	49	3	0			
,, Hire of Blocks and Photographs, &c., for "Proceedings"	0	14	7			
,, Bellows—Printing, Stationery, etc. ..	1	9	6			
,, Norman, Sawyer & Co.—Printing.. ..	10	6	9			
,, Ordnance Survey Office Maps	12	0	0			
,, L. A. Smart—Binding, &c.		12	0			
,, Bristol and Gloucestershire Archæological Society—Rent to 31st December, 1914..	4	0	0			
,, Ditto one-third Share, Custodian (Cleaning and Fires) from 31st December, 1912 to 31st March, 1914	2	4	10			
,, Gloucester Technical Schools — Rent of Room, Season 1913-1914	2	2	0			
,, Ditto Custodian—preparing rooms, &c. ..		15	0			
				95	19	3
Balance in hands of Hon. Treasurer ..				2	15	11
				£98	15	2

Audited and found correct,
F. HANNAM-CLARK.
25th January, 1915.

RULES OF THE CLUB

1.—The Objects of the Club are to study the Natural History and Antiquities of the County and the adjacent districts.

2.—The Club shall use its influence to obtain the record of all details of geological interest, to promote the preservation of all antiquities, and to prevent, as far as possible, the removal of scarce plants and the extermination of rare species of the flora or fauna.

3.—The Club shall consist of a President, Vice-Presidents (not exceeding seven in number), an Honorary Secretary, Honorary Assistant Secretary (when required), an Honorary Treasurer, an Honorary Librarian, and Honorary, Ordinary and *Ex-officio* Members.

4.—Before anyone can be elected a Member, he must be duly proposed and seconded on a printed form provided for that purpose, and supplied by the Honorary Secretary upon application. His name will be placed on the circular and will come up for election at the next meeting of the Club; one dissentient in ten to disqualify.

5.—The Entrance Fee shall be £1. The Annual Subscription of Ordinary Members shall be Fifteen Shillings, due in advance on the first day of January. For Members elected after September, the Subscription for that year shall be Ten Shillings.

6.—Any Member in arrear with his Subscription for the year is liable to removal from the list of Members.

7.—No Member shall be entitled to a copy of the Proceedings whose Subscription is one year in arrear.

8.—The Club may admit a limited number of Honorary Members (See Rule 3), whose scientific work entitles them to the distinction, and who must be elected at the Annual Meeting.

9.—The Executive Council for the Management of the Club shall consist of the Officers of the Club, namely, the President, Vice-Presidents, the Honorary Secretary, the Honorary Treasurer and Honorary Librarian, and four Members, all of whom shall retire at the Annual Meeting, but are eligible for re-election (by ballot); but the President shall not hold his office for more than two consecutive years.

10.—The Annual Meeting shall be held in January, at which Meeting the President's Address shall be read, the Financial Statement of the Honorary Treasurer shall be presented, and the Officers and other Members forming the Council shall be elected, and the dates and places of the Field Meetings be fixed; but the arrangements for the Winter Meetings shall be left to the Council.

11.—The Club shall usually hold yearly four Field Meetings, and also four Winter Meetings for the reading and discussion of Papers. At the Field Meetings any Member may introduce one Visitor, and at the Winter Meetings more than one; and at the Winter Meetings the term "Visitor" may include ladies. Members must give due notice to the Honorary Secretary of their intention to be present at any Field Meeting, and should any Member, having given such notice, fail to attend, he will be liable for his share of the expenses.

12.—All papers communicated to the Club shall be submitted to a Publication Committee, which shall consist of the President, Honorary Treasurer, Honorary Secretary, and two other Members appointed at the Annual Meeting. The decision of the Publication Committee shall be final. Any gentleman who favours the Club with Lectures on any subject shall be invited to furnish an abstract of the lecture for publication in the Proceedings of the Club.

13.—The Council may at any time call a Special General Meeting of the Members. Upon the requisition of any eight Members being sent to the Honorary Secretary, a Special General Meeting shall be convened; and any proposition to be submitted shall be stated in the Notice. Not less than seven days' notice of any such General Meeting shall be given.

COTTESWOLD NATURALISTS' FIELD CLUB

Transactions and Proceedings of the following Societies are in the Club's Library :—

Anthropological Institute. Journal, 1871-1900.

Bath Natural History and Antiquarian Field Club. Proceedings, 1890-1909. (Club dissolved.)

Birmingham Natural History and Philosophical Society. Annual Reports, from 1909. *In progress.*

Bournemouth Natural Science Society. Proceedings, from vol. I., 1908-9. *In progress.*

Bristol and Gloucestershire Archæological Society. Transactions, from vol. I. *In progress.*

Bristol Naturalists' Society. Proceedings, from 1874. *In progress.*

Cardiff Naturalists' Society. Transactions, from 1911. *In progress.*

Derbyshire Archæological and Natural History Society. Journal, from 1909. *In progress.*

Geologists' Association. Proceedings, from vol. I, 1859. *In progress.*

Glasgow Geological Society. Transactions, from 1863. *In progress.*

Northamptonshire Natural History Society and Field Club. Journal, from 1884. *In progress.*

Staffordshire (North) Naturalists' Field Club and Archæological Society. Annual Reports, from 1878. *In progress.*

Warwickshire Naturalists' and Archæologists' Field Club. Proceedings, from 1867. *In progress.*

Wiltshire Archæological and Natural History Society. Magazine, from 1904. *In progress.*

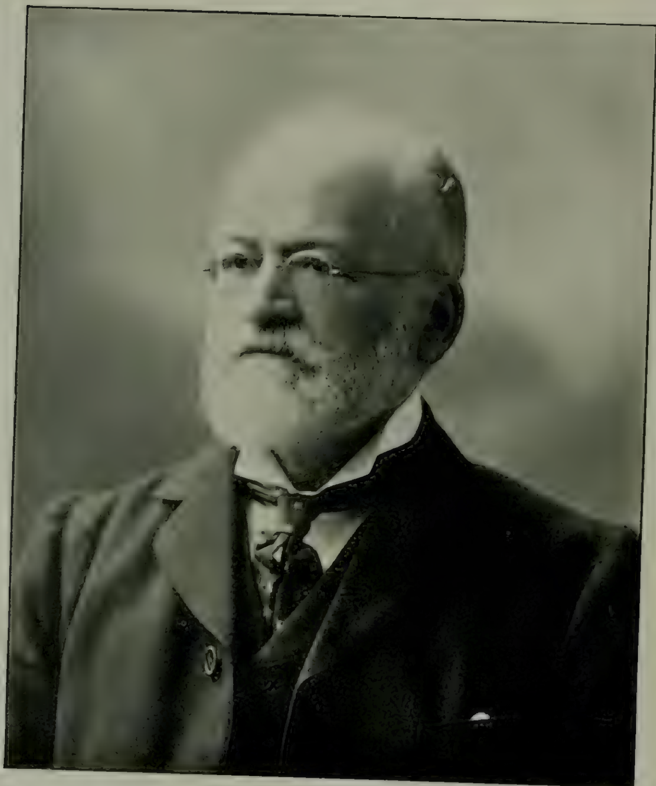
Woolhope Naturalists' Field Club. Transactions, 1856-1864, and from 1872. *In progress.*

Worcestershire Naturalists' Club. Transactions, from 1847. *In progress.*

BRISTOL AND GLOUCESTERSHIRE ARCHÆOLOGICAL SOCIETY

The Bristol and Gloucestershire Archæological Society has agreed to permit members of the Cotteswold Naturalists' Field Club to borrow Transactions and Proceedings which it receives in exchange from the following Societies :—

Society of Antiquaries of London.
Society of Antiquaries of Scotland.
Royal Society of Antiquaries (Ireland).
Royal Archæological Institute of Great Britain and Ireland.
British Archæological Association.
British School at Rome.
Birmingham and Midland Institute.
Bureau of Ethnology, Smithsonian Institute.
Cambrian Archæological Society.
Cambridge Antiquarian Society.
Chester and North Wales Archæological Society.
Royal Institution of Cornwall.
Cumberland and Westmorland Antiquarian Society.
Derbyshire Archæological and Natural History Society.
Dorset Natural History and Antiquarian Field Club.
Essex Archæological Society.
Exeter Diocesan Architectural and Archæological Society.
Kent Archæological Society.
Society of Antiquaries of Newcastle-upon-Tyne.
London and Middlesex Archæological Society.
Norfolk and Norwich Archæological Society.
Powys Land Club : Montgomeryshire Records.
William Salt Archæological Society.
Somerset Archæological and Natural History Society.
Shropshire Archæological and Natural History Society.
Suffolk Institute of Archæology and Natural History.
Surrey Archæological Society.
Sussex Archæological Society.
Thoresby Society of Leeds.
Thoroton Society of Nottingham.
Wiltshire Archæological and Natural History Society.
Worcestershire Architectural Society.
Yorkshire Archæological and Topographical Association.



C. CALLAWAY, M.A., D.Sc., F.G.S.

President, 1902-1904.

PROCEEDINGS

OF THE

COTTESWOLD NATURALISTS' FIELD CLUB

AT THE

ANNUAL GENERAL MEETING

20th JANUARY, 1914.

The Minutes of the last Annual Meeting were read, confirmed, and signed by the President, the Rev. Walter Butt.

Mr Butt exhibited two long clay pipes which he had brought from Tidenham Chase for inspection, and, if possible, to obtain information as to their probable age. The required information was not forthcoming, but as the pipes are to be placed in Gloucester Museum, it is hoped that when Members of the County Archæological Society have inspected them a more satisfactory result will be obtained. Mr Butt explained that the pipes were discovered and taken up when a water-supply to Madgetts Farm, near Chepstow, was being carried out. Iron pipes of a more recent date were also discovered, and in a letter to Mr Butt, Mr A. W. George, the Estate Agent at Sedbury Park, states that about a century ago Madgetts, Beech Farm, and Sheepscott Farms were occupied by a first-class farmer, and it was then probably that a water-supply was laid on. The small iron pipes were laid at a later date. When Mr George made an inspection in 1892 the existence of a water-main was unknown to the tenants. Canon Bazeley was asked to state whether he considered the red pipes on view to be of Roman make, and he said he thought they were probably medieval. The President drew attention to the peculiar shape of the pipes, particularly near the joints, and Canon Bazeley suggested that the plan on which they had been made might have been copied from Roman pipes.

Mr J. H. Jones, the Hon. Treasurer, presented his Financial Statement, which was approved.

The President then delivered his

ANNUAL ADDRESS.

He reminded the Members that this was the sixth occasion on which he had been called to address them when retiring from the Chair. He compared himself to a hardy perennial, but claimed that it was only under a strong sense of duty that he had so often accepted office. He felt that he had stepped into the gap when others had stood aside, and therein lay the only merit of the service he had rendered. Mr Butt said that the Club was in a prosperous condition, but during the year they had had to deplore the loss by death of six Members, namely, Dr. Oscar Clark, Sir E. M. H. Fulton, Mr B. G. Geidt, Mr G. W. Keeling, Mr W. J. Stanton, and Canon F. E. Broome Witts. He had also heard with sorrow that only the previous day their old Member, Mr Charles Stanton, had passed away. The Hon. Librarian, Mr J. G. Phillips, was resigning office, because he was removing from Gloucestershire ; and Mr E. T. Paris, Hon. Assistant Secretary, was also resigning, but happily this only applied to office, as he would continue a Member of the Club. The membership now stood at 116, and several of those recently elected were workers eminent and well-known. Reference was made to Mr Roland Austin's services, including the compiling of the Index. A tribute was also paid to Mr L. Richardson, Hon. Secretary, for his zeal and energy, and the admirable way in which he edits the Club's Proceedings. The Flora of the County was making satisfactory headway, and next year the speaker hoped to see the proposed preliminary list of plants in the printer's hands. He was happy to say that in June, Mr Riddelsdell, the General Editor of the Flora, would become Rector of Wigginton, near Chipping Norton. This would give him more leisure, and he would also be able to work scientifically and systematically that part of the County which now stood most in need of a trained botanist's attention. Mr H. H. Knight had almost completed a list of the mosses found in the County, and was now at work on the liverworts. It was possible that Mr C. G. Clutterbuck and Mr Butt, junior, might attempt a revision of the list of Lepidoptera for the County. Such a revised list was needed, but what was much more needed was a list of the moths—a considerably bigger piece of work. Dr. D. E. Finlay was spending his leisure hours in accumulating information about the zoology of the County, and Dr. E. T. Wilson had done and was doing valuable work in investigating the remains of Neolithic man. The name of Mr J. W. Gray might also be mentioned in connection with his work on the origin of the Cotteswold flints. A reference was then made to Mr St. Clair Baddeley's new book on the "Place-names of Gloucestershire," and the good work done by Mr Hanson in the Forest of Dean. In conclusion, Mr. Butt thanked the Members for the clemency they had extended to his deficiencies, and assured them that no succeeding President would surpass him in the affection he bore to the Club, nor in the endeavour to foster its growth and promote its efficiency.

The chair being vacated, the Rev. H. H. Winwood, as senior Vice-President, proposed the election of Professor J. R. Ainsworth-Davis, Principal of the Royal Agricultural College, as President for the ensuing year. This was seconded by Mr Butt, who said that the choice of the Club had fallen on a most capable Member, for Prof. Ainsworth-Davis was a man of great scientific knowledge and attainments. The proposition having been heartily carried—

The President-Elect said they would not expect a second Presidential address, but he must say that he regarded it as a great compliment to the College at Cirencester for its Principal to be chosen President of that Club, and more particularly because the College had much to do with the foundation of the Club. He was a busy man, and it would have been impossible for him to accept the office unless he had known that when he was unable to attend their meetings his place would be filled by his predecessor in office.

Mr J. H. Jones was re-elected Hon. Treasurer, Mr. Roland Austin, Hon. Librarian, Mr L. Richardson, Hon. Secretary, and the Council *en bloc*. In accepting re-election, Mr Richardson said this was the tenth time the honour had been conferred on him.

The summer meetings were then fixed as follows: May 19th, a visit to the School of Forestry, in the Forest of Dean, and the Roman road in the same neighbourhood; May 28th, half-day excursion to Stroud; June 9th, Beverston, Tetbury, and Westonbirt; June 20th, half-day excursion to Cirencester College, by invitation of the President; July 14-16th, Weymouth, Dorchester, etc.; September 17th, North Cotteswolds, including Stanway, Hailes Abbey, and Stanton.

ORDINARY WINTER MEETINGS, 1914.

TUESDAY, MARCH 17th, 1914.

Rev. WALTER BUTT, M.A., Vice-President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

Mr Roland Austin exhibited a copy of the first printed map of the County drawn by Christopher Saxton in 1577 and published in his "Atlas of England and Wales," 1579. The map is in colour. On it "St. Tecla's Island" is given as "Sct Treacle."

Mr Butt drew attention to, and exhibited a specimen of, a foreign plant (*Cyperus*) found in Gloucestershire, and to a handsome flowering plant from Mr W. R. Price's fine collection of 13,000 plants brought from Formosa. The latter was new to science, and had been given the name of *Tricyrtis stolonifera*. One of the genus, *Tricyrtis hirta*, is grown in English gardens and is commonly known as the Toad Lily. The *Cyperus* found in Gloucestershire was first sent to a newspaper editor, who passed it on to Mr Hollingworth, the County Council Organiser of Agriculture. He submitted it to Mr Butt, who recognised it as a *Cyperus*, but found it necessary to send it to Kew for identification. The Director gave the name as *Cyperus albostriatus*, Schrad., and said it was a native of South Africa. Apparently it had rarely, if ever before, been found in England, as the Director asked to be supplied with a specimen for the Kew Herbarium.

Mr H. H. Knight read a carefully prepared paper on "The Mosses of Gloucestershire," in the course of which he acknowledged the work done by Bryologists in various parts of the County, including the Rev. Father Reader, formerly of Woodchester, Mr George Holmes, Mr E. J. Elliott, and Miss Gingle, of Stroud. He said that 298 species of mosses were to be found in Gloucestershire, out of a total of 620 distributed over the British Isles.

Mr W. Thompson said he was pleased to hear Mr Knight refer to the late Mr George Holmes's collection of mosses, now placed in Stroud Museum, which unfortunately was not a public Museum, but since entering that room he had been pleased to hear that there was now some chance of the Museum being opened at an early date, and he hoped this might be in time for Members of the Club to inspect its contents when they visited Stroud in the coming Spring.

Mr Butt re-echoed this hope, and said he had been putting in a word on behalf of the Stroud Museum, and as the Club had interested itself in the question, it was gratifying to know that the outlook was more promising.

In the absence of the Rev. H. J. Riddelsdell, the author of some "Notes on Helosciadium," Mr Butt read his valuable contribution to botanical research, and rightly emphasised the service which his son-in-law had rendered not only to the Club, but to all botanists. First Mr Butt dealt with the correct pronunication of a somewhat awkward word, and then said the underlying meaning was an umbelliferous plant living in marshes. It is closely allied to the common celery, and is sometimes confused with watercress, though the taste is not the same. The species most met with in the South is *H. nodiflorum*, which resolves itself into a variety of forms. These were clearly indicated by a number of excellently mounted plants. The plant not only varies in size but in structural characteristics, and to adopt Mr Riddelsdell's words, the forms available for the field botanist are legion. These variations may be attributed to soil, water-supply, and other surrounding circumstances. It is only by an examination of the fruit that a distinction can be drawn between *H. repens* and *H. nodiflorum*. The former is found at Skipworth. In Gloucestershire there is a small slender aquatic plant found in ponds and canals, and sometimes on dry mud. It has been found near Sapperton Tunnel and Tidenham Chase, and Mr Riddelsdell identifies it as *H. fluitans*. Then there is a third form which he makes out to be a hybrid of *H. Moorei*, which is abundantly distributed in Ireland, and less abundantly in England. Mr Riddelsdell gives valid reasons for considering it a hybrid, among others its vegetative method of propagation.

Mr Bailey spoke in high terms of praise of Mr Riddelsdell's paper, and with Mr Coley expressed the hope that it might be printed in the Club's Proceedings.

The third contribution to the meeting's edification and enjoyment was made by Mr Butt, and was entitled "Notes on Tecla's Island." For Mr Butt such an island does not exist. There is an island at the mouth of the River Wye which has enjoyed that name for a considerable time, but Mr Butt stoutly denies its right to be associated with the martyred saint who owed her conversion to St. Paul and whose memory is preserved in the Acts of the Apostles. Far be it from him to say there was no St. Tecla. As a matter of fact seventeen such had been canonised by the Church, but it did not follow that the name of either of these Saints had been given to this island. Miss Ormerod sketched the island in 1860 and took measurements. Since then it has diminished in size, and great damage has been done to the shrine. Down to 1770 the island was called Treacle Island, but with the arrival of the ordnance map it became St. Tecla's Island. Mr Butt threw out several suggestions for the origin of the word "Treacle." Suffice it to say that Chepstow, the mouth of the Wye, rapid and winding water were severally referred to, and the whole paper showed that the writer had constructed a strong case for his main contention and one which other antiquaries may be inclined to take into consideration.

Mr F. J. Cullis exhibited some human bones taken from the island, and in commenting upon what he described as a "revolutionary paper," remarked that the island undoubtedly contained a burying ground. With the wasting of the island bones were exposed, and naturally in time the place would waste away.

Mr J. W. Haines, of Hucclecote, was elected a Member.

TUESDAY, OCTOBER 27th, 1914.

PROF J. R. AINSWORTH-DAVIS, M.A., in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

The Rev. Walter Butt exhibited (1) some apples called "the ten commandments apples," because they have ten fibro-vascular bundles, and (2) the flower of *Tricyrtis*. Mr John Sawyer exhibited a Romano-British jar from Bafford, Charlton Kings.

The President announced that the Council had appointed Mr W. Butt Hon. Assistant Secretary.

The following paper—illustrated with lantern-slides—was then read:—"Troublesome Vegetable Growths in the Waters of Lakes and Reservoirs, and some Attempts at their Prevention," by J. H. Garrett, M.D., D.P.H., F.L.S., Medical Officer of Health for Cheltenham.

Mr John Frith was elected a Member.

TUESDAY, NOVEMBER 24th, 1914.

PROF. J. R. AINSWORTH-DAVIS, M.A., President, in the Chair.

The Minutes of the last Meeting were read, confirmed, and signed by the Chairman.

It was announced that Mr John Sawyer was to have communicated a paper that day, but owing to illness was unable to do so.

The Hon. Secretary therefore made some remarks—illustrated by lantern-views—on "The Weymouth District," "The Forest of Dean District," and "The Stroud District," all of which the Club had visited during the summer of 1914.

In the discussion, the President, Dr T. S. Ellis, Mr W. R. Carles, and the Rev. Walter Butt spoke.

The President remarked that the shortage of potassic manures caused by the War—Germany being the chief source of supply—was to be met to some extent by falling back on the old method of using ashes from wood and other vegetable substances. The potash in these is largely in the form of the carbonate, so the ashes must be protected from the weather until actually required for use. The Advisory Agricultural Council for the Province (Glos., Somerset, Wilts, Hereford and Worcs.) has been promoting an ordered series of manurial demonstrations at various centres, and at his suggestion wood-ashes were being employed in some of these as potassic manure. The idea had been taken up by the Board of Agriculture, partly with the idea of establishing a minor Forestry industry. It might also be added that the Board had recently issued a leaflet (which might be had for the asking on application to the Secretary, Board of Agriculture, Whitehall Place, S.W.) on the use of hedge-clippings, weeds, etc., as a source of potash.

FORESTRY AT THE ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

The President said that Mr Richardson having given some details of what was being done in the Forest of Dean in the matter of Forestry, he would like to remind them that the Royal Agricultural College also possessed a well-organised department of Forestry, in charge of a Professor who was assisted by a lecturer. The subject was taken by candidates for the Diploma (Estate Management Branch); while candidates for the B.Sc. in Forestry of the University of Bristol spent their two final years at Cirencester. Through the kindness of Earl Bathurst his well-managed woodlands (3,000 acres) were available for instruction, and a Forest Garden of 19 acres was under the charge of the Professor. There were also two Forest Nurseries and a small Forestry Museum. The College was the Advisory Centre in Forestry for the West and South-West of England (Cornwall, Devon, Somerset, Wilts, Glos., Mon., Glam., Hereford and Worcs.), and applications for advice had to be made to the Technical Adviser in Forestry, Professor H. A. Pritchard.

Mr F. W. Fyffe was elected a Member.

EXCURSIONS

1914

EXCURSION TO THE FOREST OF DEAN.

TUESDAY, MAY 19th, 1914.

Director: C. O. HANSON.

(*Reported by* C. O. HANSON, T. NEWCOMEN, JOHN SAWYER and W. THOMPSON.)

The First Field Meeting for the year 1914 was held in the Forest of Dean.

Those present included the Rev. Walter Butt (Vice-President), Mr L. Richardson (Hon. Secretary), Rev. A. R. Winnington-Ingram, Rev. S. R. Robertson, Dep. Surg.-Gen. G. A. Watson, Surg.-Major Isaac Newton, Dr J. N. Middleton Martin, Messrs. St. Clair Baddeley, Walter Butt, H. T. Bruton, H. W. Bruton, S. J. Coley, J. D. Crewdson, A. J. Cullis, F.G.S., J. M. Collett, F.C.S., G. M. Currie, T. S. Ellis, Herbert Haigh, H. Knowles, J. N. Hobbs, J. H. Hume-Rothery, F. Hannam-Clark, A. E. Hurry, C. O. Hanson, H. H. Knight, E. Lawrence, John Sawyer, E. C. Sewell, W. Thompson, Charles Upton, Dr E. W. Prevost, Dr Cunningham Affleck, R. Austin and R. Anderson.

The Members left the G.W.R. Station, Gloucester, at 10.45 a.m. and motored *via* Minsterworth, Westbury-on-Severn and Flaxley to Pleasant Stile (Little Dean), which was reached about 11.45 a.m. [W.T.]

FORESTRY IN THE FOREST OF DEAN.

The Forest of Dean is situated on the western extremity of the County of Gloucester, and lies between the Rivers Severn and Wye. It contains 15,184 acres of woodland, of which 9,630 acres are enclosed, and the balance is unenclosed. The Crown have a right to enclose 11,000 acres, and this limit will shortly be reached and will eventually form the timber estate. The "open woods" cannot be properly worked over for timber, as no re-planting could be done if the present crop is cut, owing to unrestricted sheep grazing in the open areas. Besides the above, the Highmeadow Woods of 3,349 acres, Abbotswood of 618 acres, and Clearwell Woods of 298 acres are under the same management as the Dean. These are all enclosed, and, with the four estates, there will thus be, when the 11,000 acres of Dean are fully enclosed, a wooded estate of 15,265 acres. Practically the whole of this area is actually under timber or young plantations at the present moment.

The management of the Forest is carried out by the Deputy Surveyor, who is assisted by a Head Forester, two Assistant Foresters, and fifteen woodmen, each of whom is in charge of a definite district. There are also about 130 permanent workmen, and an office staff consisting of a Surveyor, an Accountant, and Clerk.

As a side branch, there is a School of Forestry under the instructor, who is solely responsible for the educational work and who has no say in the management of the Forest. At the school young working-men are trained to be foresters, and there are at present twenty-three students. Up to date, 64 students have been through the school, and many of them are now holding excellent positions both at home and in the Colonies.

In a forest which has been perfectly managed for a considerable time there should be a definite area of each age class, from the youngest to the oldest wood. Thus, dealing only with the enclosures of 11,000 acres, there should be, assuming that oak may be considered ripe for the axe at 140 years, 1,571 acres aged 0 to 20, 1,571 aged 21 to 40, and so on to 1,571 acres aged 121 to 140 years. When this stage of perfection is reached one can go on cutting 1,571 acres of mature oak-wood during each 20-year period. The existing crop in the Dean is far from this state. The 11,000 acres are at present stocked as follows:—

Blanks	70 acres
Woods: 0–20 years	2,429 ,,
21–40 ,, ...	Nil
41–60 ,, ...	1,000 ,,
61–80 ,, ...	1,353 ,,
81–100 ,, ...	1,864 ,,
101–120 ,, ...	4,135 ,,
121–140 ,, ...	149 ,,
	11,000

There is thus an excess of the 101 to 120 year woods, and, this being so, the present scheme of management lays down that about 160 acres of the oldest and most badly growing woods are to be cut each year, and these are planted up chiefly with conifers, larch, Douglas fir and spruce preponderating.

This scheme of management will shortly be revised. The best soils will be set aside for oak, which will perhaps be grown on a rotation of 140 years, and the balance will be conifers probably on a 70 or 80 year rotation. It is estimated that only about 4,000 acres are really suitable for oak.

It is an accepted axiom of forestry that good oak cannot be grown without beech. Beech growing below and amongst oak gives a spendid humus, which improves the soil in many ways, to the benefit of the oak. As it grows it kills off side branches of the oak, and hence fine tall clean timber of great value is obtained. The present crop of oak in the Dean is poor (see Plate XIX., fig. 1) because of the absence of beech, but in the Highmeadow Woods some very fine oak mixed with beech is to be seen (see Plate XIX., fig. 2).

For the above reason all the younger oak woods are now being underplanted with beech as fast as it can be obtained. Beech is best introduced under oak at about the fortieth year, and all the 40 to 60 year old woods are being underplanted at present.

A considerable amount of planting is done each year in the four estates. Last year 167 acres in Dean, 65 in Highmeadow, and 22 acres in Abbotswood were planted, a total of 1,103,000 plants being used. To supply this large number of young trees there are 11 nurseries, with a total area of 20 acres. Practically the whole of the plants are raised from seed sown in these nurseries, very few being bought.

The bulk of the Forest, made up of its central, western and southern parts, overlies the Coal Measures, and the soil is for the most part a yellow loam, rendered stiff in parts by clay, and occasionally a band of clay takes the place of the loam, or is near the surface. Immediately underlying the loam is a very much broken up rubble sandstone, and under that beds of grey and blue sandstone (Forest of Dean stone) of excellent quality for building purposes. Towards the north are found traces of the Millstone Grit, with its coarse pure sand. Outcrops of Carboniferous Limestone occur running more or less north and south from Wigpool Common to Staple Edge enclosure, and north and east of this formation comes the Old Red Sandstone with its deep fresh sandy loam. On the extreme east is found some marl.

The soil is generally good, and in some parts it is exceptionally fertile for a forest soil. In many places, however, it has deteriorated considerably owing to the open nature of the woods, and it is one of the objects of the management to improve the fertility by reintroducing beech into the woods. It is recorded that in 1787 the Forest carried a mixed crop of oak and beech in the proportion of two beeches to one oak, and this clearly indicates the conditions under which the fine oaks, for which the Forest was renowned, were produced. The last of this fine old crop was felled in 1852 and 1853. A record shows that 1,241 trees yielded 191,825 cubic feet, or an average of 154 cubic feet per tree.

The Abbotswood estate was next visited. This estate was formerly part of Dean Forest, but was granted to the monks of Flaxley Abbey in 1258 by Henry II. in exchange for a right to take two oaks weekly from the forest. Eventually the estate passed into private hands, and was purchased by the Crown in 1899. At that time a large proportion of the area was waste land, and a considerable amount of planting has been done.

A large beech was here cut in the presence of the Members by the method known as "key-cutting." When a large heavy tree is standing on a steep slope it is very apt to split when cut in the ordinary way. Key-cutting consists in first cutting a hole through a buttress of the tree, inserting the saw into this and sawing through the tree in the direction away from the small uncut portion, or "key." This key holds up the tree until the sawing is finished, and it is then cut through with an axe and the tree falls.

The experimental plots were next visited. These plots have an area of 20 acres, and are situated at an elevation of from 380 to 450 feet, on a south or south-east aspect. The soil is a good sandy loam derived from the Old Red Sandstone. The plots were started in 1904 to illustrate the growth of several species, both pure and mixed, dense and open. Up to date, the only measurements taken are those of height-growth, and the following are some of the results, the figures being obtained by the measurement of over 1,000 trees in each plot. The age of all species was ten years at the date on which they were measured, except the Lawson's cypress, which was nine years old.

Tree	Average height of all trees	Average height of the tallest 50	Highest tree
Spruce (pure, 3′×3′) ..	4′ 11″	8′ 0″	11′ 5″
,, (with Scotch pine, 4′×4′) ..	4′ 8″	7′ 0″	8′ 9″
Scotch pine (pure, 3′×3′) ..	7′ 6″	11′ 5″	13′ 3″
,, (with Douglas fir, 4′×4′) ..	8′ 5″	10′ 10″	13′ 6″
,, (pure, 5′×5′) ..	4′ 8″	6′ 9″	8′ 6″
Pacific Douglas fir (pure, 3′×3′)	6′ 11″	13′ 3″	16′ 0″
Colorado Douglas fir (pure, 3′×3′)	2′ 2″	4′ 8″	7′ 6″
Larch (with Pacific Douglas fir (4′×4′)	11′ 6″	14′ 10″	17′ 6″
Lawson's Cypress (pure) ..	6′ 11″	8′ 3″	9′ 6″

As a rule close planting gives far better results than open planting, and trees should ordinarily not be planted further apart than 4 feet by 4 feet, they then soon form a thicket, in which stage *natural* pruning takes place, the branches die off and clean timber results—a very important point to the modern forester.

It is also to be noted that the Pacific variety of the Douglas Fir is a much faster grower than the Colorado variety. The latter hardly appears to be worth growing, at any rate under the conditions found in Dean Forest.

These plots will be of great value when older for experiments in thinning the various species.

Entering the motor-cars, a short drive brought the party to Bradley Hill Wood, where a light lunch was taken. When this had been disposed of, and a welcome drink of water taken from a forest stream, the wood was inspected. It consists of 59 acres of pure oak, 42 years old (Plate XVIII., fig. 2). The elevation is 250 to 500 feet, and aspect south-east. The soil is very stony, but is a good loam over Old Red Sandstone. The wood was originally planted with oak and larch in alternate lines four feet apart. The larch was cut out in thinnings made in 1887, 1891, 1897 and 1900. This work is often left too late, with the result that the oaks get suppressed. In Bradley Hill, however, the larch were removed at the right time, and the oaks are now very fine for their age. Sample plots were measured in 1910 with the following results per acre. Number of oak = 248; average height = 47 feet; average volume, 1162 cubic feet. A few selected trees were measured in March, 1912, and were then 60 feet high and with girth up to 2′ 10½″. Six of these selected trees were again measured on 7th July, 1914, and gave an average increase in height in the two and a half years of 2 feet 10 inches, and an increase in girth at 5 feet of 1⅛ inches.

The total revenue to date for this wood is £1,678, and expenditure £1,071—not a bad result for so young a wood. In the future the revenue will be large and expenditure small.

Below the oak much natural regeneration of beech has appeared, and where this was absent, beech was underplanted below the oak in 1913-14.

Climbing up the hill to Blakeney Lodge at an elevation of 550 feet, the Members obtained a good view over a large portion of the Forest. Blakeney Hill Wood itself is a very fine example of natural regeneration of oak, which extends over some 370 acres, and is the finest example in England of naturally-sown oak (Plate XVIII., fig. 1). The soil is a splendid sandy loam over Old Red Sandstone. The area was enclosed against sheep in 1900, the crop being then pure oak 92 years old. In 1900 there was a good acorn year, and about half the crop was cut. The removal of the timber wounded the soil and buried the acorns, and the whole area became covered with seedling oak. When well established the remaining old oaks were cut, to give more light to the young crop, and there is now a really fine thicket. On 7th July, 1914, the oaks on a 25 square yard patch were counted and gave 12,580 per acre, and are from 14 to 18 feet high. As time goes on thinnings will be made, and eventually beech will be introduced under the oak and there should be a fine stand of timber here in 100 years' time. [C.O.H.]

From Blakeney Hill to Blackpool Bridge the walk was much enjoyed, for in this part of the Forest the natural beauties are exceptionally varied and romantic. If close at hand the art of man has interfered with the primeval grandeur of the Forest, in the distance masses of oak trees clothe the undulating ground, and so maintain a fairly even balance between nature and scientific experiment. Passing down the steep hill, the Members found themselves by a stretch of paved road (Plate XX.), which Mr John Sawyer and Mr St. Clair Baddeley had no hesitation in attributing to Roman artificers. The former pointed out that it differs from the great Roman roads in one or two important respects. Unlike such roads as the Fossway, the paving-stones rest on the original soil. It had sometimes been spoken of as a road connecting Gloucester with the legionary camps at Caerwent and Caerleon, but there seemed no evidence for such a belief. Mr Sawyer said he believed that almost the only contemporary information of the Roman roads of this country was contained in the well-known Itinerary of Antonine, of the second or third century. In the 14th Iter, mention was made of the road from Gloucester to Caerleon as passing through Ariconium (near Ross), Monmouth, and Usk. In the latter part of the 18th century, the Deputy-Surveyor of the Forest of Dean said, a great sum of money was spent on the roads between Mitcheldean and Coleford and Littledean to Coleford. These were the principal roads from Gloucester to South Wales. In the "Gloucester Journal" of September, 1796, a Mitcheldean publican advertised that the road from Coleford to Monmouth had been greatly improved and "in a short time would be equal to any in this part of the country." He added that he had laid in a stock of admirable port and other wines, and his carriages were driven by sober drivers! Modern evidence confirmed the description of the route. Recent editions of the ordnance maps described the South-Wales road as having here and there traces of Roman pavement, although difficult to find. If the Romans had required a more direct route, the most favourable would have been through Newnham and Lydney. These considerations were sufficient to dispose of the theory that the paved road which they were now examining was a great arterial roadway. Some mention had been made of Telford and his work of road-making, but this road was evidently made long before his time, and the width might also be taken as a proof of its Roman origin. For what purpose then was it made? It was probably a bye-road for the transport of iron to the ports. There were other trackways in the Forest in the vicinity of mines, some connected with arterial roads. Mr Sawyer concluded by saying that much of the stone with which the road at Blackpool Bridge was made had been removed by Foresters for building purposes. The Forester was but a human being, and when he found stone ready worked to his hand he was not likely to put himself to the trouble of going to the quarry. Still, though the road was shorn of much of its ancient glory, it remained as a permanent witness to the period when Roman rule was felt as strongly in the Forest of Dean as in the Capital of the Cæsars. [J.S.]

Mr St. Clair Baddeley having been invited by Mr Butt to address the Members, said he thought there was sufficient reason for saying the road was undoubtedly made by the Romans. The width was strong corroboration, but it does not appear to have been much used, and it was probably in use only at the end of the Roman occupation. Could they have seen it in the middle of the second or beginning of the third century they would have found it much smoother and better adapted for use. He did not think it had any connection with Gloucester. It might have been used as a connecting link (or bye-way) between the camps at Yorkley and Soudley. The occupation on that side of the Severn was complete during the last two and a half centuries of the occupation, and there would be no further need of such a road for military purposes. It might have been a convenience for the people who were dealing in minerals, but the surface does not evidence heavy traffic. All the minerals at that time belonged to the empire and were weighed and stamped with the imperial stamp. The road had nothing to do with the great legionary camps. The only military knowledge they had about Gloucester was that it was given over in the reign of Nerva (c. A.D. 97) to an officer as a reward for services rendered, but the city of first-rate importance in that part of the West was Corinium (Cirencester), absolute proof of which was supplied not merely by the great roads, but by the wonderful stone discovered there, with the inscription showing that the Emperor Diocletian invested Cirencester with an importance to which no other neighbouring city could lay claim. The speaker then dealt with the real reason for walling cities, Gloucester included, the contention being that when the people saw a time of retribution approaching, then it was that engineers were set to work to defend the cities. [W.T.]

Entering the motor cars the Members drove to the Wood-distillation Works near Speech House Road Station.

These works, erected in 1912 and 1913 from plans by Mr E. Maples Linton, of Newport, instructed by Mr F. H. Meyer, of Hannover Hainholz, consist of a retort of large capacity for the carbonisation of the wood, and the necessary plant for producing and working up charcoal, grey acetate of lime, miscible naphtha, and wood tar.

The Cordwood used is brought in from the Crown Forest, in the centre of which the Works are situated, by hauliers, and is stored in large stacks. A stock of 1,500 to 2,000 cords[1] is kept.

The retort is built of iron plates, and is about 56 feet in length and 7½ feet in diameter. It is fired from a fireplace on the left side, and is set in flues, which effectually enable the wood to be carbonised. The wood is stacked into cylindrical shaped trucks, each holding about 2 cords or 256 cubic feet, and 5 trucks form one charge for the retort. When ready the iron door of the retort is lifted, and the trucks of wood are drawn in by an electric motor. The door is then securely closed and heat is applied from 330 to 350 degrees Centigrade. Distillation usually commences in about two hours and continues for from 20 to 22 hours.

After the process is completed the door at the other end of the retort is raised, and the trucks, which now contain charcoal, are quickly drawn by the motor into an iron cooling chamber, and, the doors at each end being made secure, it is irrigated by water to expedite cooling. From here the trucks of charcoal are, on the following day, removed to the charcoal shed, where they are emptied and the charcoal put into bags ready for dispatch.

During the process of distillation about 70 per cent. of the weight of the wood is given off as vapours or gases, these pass out of the top of the retort through two copper pipes into a tar separator, where the tar in them is condensed and flows into a tank. It is then run into a Montejus and lifted by the compressor into the tar still, where it is freed from the acid, oils and water remaining in it. It is run direct from the still into casks, and is now ready to dispatch.

The gases and vapours, freed from tar, pass out of the top of the separator, and into a tubular condenser : here the naphtha and acid vapors are condensed and run into large storage-vats. The "pyroligneous liquor," as it is called, is left in the vats 3 or 4 days to free it from any tar that remains suspended in it, and is then ready for further treatment.

The incondensible gases leave the condenser cooled, and pass into a gas-washer, into which a small quantity of water is trickling, where they are freed from any naphtha or acid which may be left in them, and are then conveyed by a pipe to the furnace, where they are utilised in the process of carbonisation.

The "pyroligneous liquor," freed from tar, is pumped from the storage-tanks across the yard to the vat in the acid-room, where it is mixed with lime, which has been prepared in the lime-mixing tank outside until all the acid is neutralized. It is stirred continuously by the mechanical stirrer, until the mixing and neutralization is complete. From thence it is pumped into "settling-tanks" at the top of the building, then into the "sludge-tanks" on the first floor, and thence into the "storage-tanks" in the acid room—further impurities being removed in the sludge tanks.

It is now pumped into the small "clear-liquor tank" on the top-floor, and from thence it runs into the iron column of the "continuous apparatus."

This consists of a wrought-iron base or still, containing a copper coil, surmounted by a series of cast-iron plates, which have the effect of completely separating the neutralized acid liquor from the naphtha, the neutralized liquor

1 One "cord" = 128 cubic feet

being run off continuously from the still into a tank below, and while still hot, pumped into the evaporating pan. It is there boiled down to a strength of about 10 degrees Baume, and when this point is reached, is run into the pan of the rotary dryer.

This is a large wrought-iron horizontally-arranged drum, heated internally with live steam, which, slowly revolving in a shallow tank, picks up a coating of the liquid. The water is driven off, and about 70 per cent. of the original liquid remains in the form of dry grey acetate of lime. This is removed by a series of scrapers.

The acetate, which is now in a pasty condition, is then spread upon the floor, under which pass the gases from the retort to the chimney stack. After being dried for several hours, it is filled into sacks. It now contains about from 84 to 85 per cent. of true acetate of lime.

The naphtha, which runs from the top of the iron still and column, after being freed from the acetate of lime liquor as previously described, and also from some of the heavy oils, is passed through a copper wash column, into which a weak solution of sulphuric acid trickles, and is here further purified. From thence it goes into a second column, where it is treated with a weak solution of caustic soda, and more oils are separated here. After passing through a small condenser the purified methyl alcohol is run into a storage-tank below, and from thence into drums for dispatch.

Power is provided by a 27′ × 7′ 6″ boiler (made by Messrs. E. Danks & Co. Ltd., of Oldbury), which supplies steam to the 35-H.P. single-cylinder non-condensing engine (made by Messrs. Marshall, Sons & Co. Ltd., of Gainsborough), the Worthington steam-pump for the cooling water, the fan engine, the condenser engine, the evaporating pan, the heating of the rotary dryer, the continuous apparatus, the tar still, the tar condenser and the boiler feed-pump.

The main engine drives, by shafting, the dynamo which, in addition to lighting the Works, provides power for the motors for charging and discharging; also the acid pump, the neutralized liquor pump, the clear liquor pump, the evaporator pump, the lime stirrer and the rotary dryer.

[T. Newcomen.]

AT SPEECH HOUSE

The Members were now ready for tea, and on arrival at the Speech House the provision made for their entertainment was taken full advantage of.

A. J. Lumbert, photo.] The Speech House.

(*Block kindly lent by the publishers of "A Week's Holiday in the Forest of Dean."*)

The building of The Speech House appears to have commenced shortly after 1668, in which year an Act was passed for the preservation and improvement of the Forest, but was not completed until 1682. It was intended for the use of the ancient court of "The Speech."

The fine Court Room—which between the Court meetings is used as a general dining and coffee-room—is 25 feet long, 23 feet broad, and of good height, and has a raised gallery along the southern wall. The walls are decorated with the antlered heads of twenty-one Fallow Deer and one Red Deer.

After tea, Mr St Clair Baddeley, in the name of the Club, thanked Mr Hanson for his great kindness in conducting the Members, and Mr Hanson replied. Unfortunately, the Rev. Walter Butt, who was acting for the President (Professor Ainsworth-Davis), was indisposed, and could not take advantage of the rambles before and after lunch.

The ride home by way of Cinderford, Mitcheldean, Huntley and Highnam proved scarcely less enjoyable than the outward journey, for the wide-spread carpets of blue hyacinths were still illuminated by the sun, and the hawthorn trees in the Forest, no less than those in the roadside gardens, were marvels of beauty and sweetness.

Among many other interesting facts Mr Hanson mentioned that after making diligent search in the Forest only fifteen mistletoe plants have been found, eight of which were on poplar trees and none on oak. This tends to confirm the belief that the connection between the oak and mistletoe in druidical times is more mythical than real.

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EXCURSION TO STROUD.

THURSDAY, MAY 28th, 1914.

Directors: L. RICHARDSON AND E. NORTHAM WITCHELL.

(*Report by* L. RICHARDSON AND W. THOMPSON.)

Those present included Prof. J. R. Ainsworth-Davis (President), the Rev. Walter Butt, Mr L. Richardson (Hon. Secretary), Lieut.-Col. J. C. Duke, Dr. J. H. Garrett, Messrs. A. J. Morton Ball, J. M. Collett, F.C.S., T. S. Ellis, F. Hannam-Clark, C. I. Gardiner, F.G.S., J. H. Jones, E. P. Little, H.H. Knight, E. Lawrence, F. J. Mylius, A. E. Smith, J. A. Smithin, W. Thompson, E. Northam Witchell, etc.

The Members met at the G.W.R. Station, Stroud, at 3 p.m., and drove to Mr F. Harper's gravel-pit at Gannicox (Plate XXI., fig. 1).

Mr Richardson said that the main object of their visit to Stroud was to see these gravels. In the pit beloingng to Mr H. Blanch, near the Cainscross Brewery, there was a deeper face of gravel exposed, and as the rain now falling was not very pleasant for open-air speaking, perhaps it would be more satisfactory if the Members visited the Senior Council School at Downfield, and

Fig. 1.—Natural regeneration of oak at Blakeney Hill, Dean Forest, when 8 years old. Number of oaks per acre in best patches—about 13,000.

Fig. 2.—Bradley-Hill Wood, Dean Forest. Oak when 37 years old, with natural beech underwood. Average height, 47 feet: number of oaks per acre, 248: volume, 1162 cubic feet per acre.

(Blocks from "Forestry for Woodmen," by C. O. Hanson, kindly lent by The Clarendon Press, Oxford.)

Fig. 1.—Typical overthinned oak in Dean Forest, aged 95 years; height, 40 to 45 feet.

Fig. 2.—Oak and larch with coppiced beech in Highmeadow Wood. Oak aged about 120 years, 70 to 80 feet high.

(Blocks from "Forestry for Woodmen," by C. O. Hanson, kindly lent by The Clarendon Press, Oxford.)

The Roman Road at Blackpool Bridge, Forest of Dean.

Fig. 1.—Gannicox Gravel-pit, Stroud.

W. E. Butland, photo.

Fig. 2.—Cainscross Gravel-pit, near Stroud: depth, about 20 feet.

W. E. Butland, photo.

then proceeded to Cainscross. This suggestion was acted upon, and when the gravel pit at Cainscross was reached (Plate XXI., fig. 2), the rain had ceased. Here Mr Henry Blanch and his son welcomed the party, and directed attention to mammalian remains taken from the gravel. Then Mr Richardson resuming his remarks, said similar gravel extends with one or two interruptions all the way from Stroud to Stonehouse along the north bank of the Frome, and at Stonehouse expands, forming a wide spread. It was absent from the south side of the valley until they arrived at Stanley Downton, between which place and Frocester was an outlier of similar gravel. No doubt the deposit had been more extensive in the valley but had been removed by the Frome, which had excavated a hollow though the gravel (where it had been deposited) into the Lower-Lias clay and had margined itself with alluvium which gave rise to the level pastures over which they would shortly obtain a view.

The gravels[1] are of local origin. They are composed of well-rolled pieces of limestone from the Great Oolite, Inferior Oolite and Lias of the neighbourhood. Intercalated in the coarser gravel is finer material, and irregular layers of tough clay. Some portions of the gravel are black, owing to the occurrence of carbonaceous matter around the pebbles; while in the finer material and clay-bands land and fresh-water shells had been found by a former esteemed colleague, Edwin Witchell, F.G.S., and a present Member, Mr Charles Upton. Witchell wrote (Trans. Stroud Nat. Hist. and Phil. Soc. pt. 1 for 1876-7-8, p. 23): "The following shells have been found at Gannicox, and some of them are abundant: *Ancylus fluviatilis, Limnæus auricularius, Limnæus pereger, Limnæus truncatulus, Helix nemoralis, Helix rotundata, Helix umbilicata, Helix pulchella, Pupa umbilicata, Pupa muscorum, Zua lubrica, Zonites excavatus, Pisidium pusillum.*"

Mr Richardson continued that numerous remains of mammalia had been, and still are, found here. Witchell had recorded (*loc. cit. supra*) remains of mammoth, rhinoceros, reindeer, horse and bison. A portion of a tooth of a mammoth, a horse tooth, and several teeth of *Bos* were shown to the Members. Mr Richardson said that W. C. Lucy as long ago as 1869 (Proc. Cotteswold Nat. F.C., vol. v., p. 90) deplored the fact that while many mammalian remains had been discovered here few had been preserved. Unfortunately, he had to reiterate the complaint. However, they were going to try to amend matters and collect and deposit in the Stroud Museum a typical series. He asked those Members who possessed specimens, or knew of people who had any, to bear the museum in mind.

Having described the gravel and told them what had been found in it in the way of land and fresh-water shells and mammalian remains the next matter to think over was how the deposit had got there: what were the conditions under which it was accumulated. He feared he could not tell them for certain. He reminded them, however, that during the Glacial Period, whilst the greater part of the Midlands and the North were covered with the ice-sheet, there must have been a great deal of ice and snow on the Cotteswold uplands and in the combs. In closing Glacial times the detached pieces of rock would be borne valewards by the waters derived from the melting snow and ice and deposited on the lower ground. Edwin Witchell regarded the deposit as a "river-laid gravel" (Proc. Cotteswold Nat. F.C., vol. viii., p.94). Some, he believed, thought that the vale was flooded in closing Glacial times; that there was a lake, and that these gravels were arranged around portions of its margin in the same way as gravel occurs on the shores of Lake Bala at the present day. He personally felt that more work was necessary before any suggestion of value could be made; but one thing was certain—the gravels were not of marine origin.

The President said he was inclined to favour the lacustrine theory.

[L.R.]

1 The gravel is principally used for drives and paths, for concrete work, and the finer material for cement.

As previously remarked, from Gannicox pit the Members went to the Senior Council School at Downfield, where they were received by Mr W. Thompson, one of the Managers, and Mr H. Roberts, the Head Master.

Various questions were asked touching the financial conditions under which the School is worked and the method adopted in selecting boys from the Elementary Schools. Mr. Thompson referred to the visit paid the School by Mr Ashbee, of Chipping Campden, the well-known experimentalist in art handicraft, and the warm tribute of commendation offered by him on the tuition imparted at the School, and the results so far achieved. Then the Members saw the class-rooms, rooms for metalwork and woodwork, and the loom-rooms (Textile School). It was explained that the School was the first of its kind in the county. It was intended for the brighter boys from the Elementary Schools of the district, who go there for a three years' training, in which hand-work played an important part. The aim is not to produce boys for any particular calling, but to give them a sound training, awakening their interest by practical work of general utility. Much of the necessary English, arithmetic and drawing is linked up with the work done by them in the workshops. Unfortunately, the necessity or anxiety for wage-earning took away many of the boys before their general education was complete, at their most important and susceptible age (14 to 16), and often not for the vocations for which they showed most aptitude.

Interest was displayed at the provision made at the adjoining Textile School for helping those who are engaged in the textile industry and wish to become more expert and gain additional technical knowledge.

Re-joining the brakes the Members drove to Mr Northam Witchell's residence "The Upper Birches," to see his fine collection of flint-implements from the Stroud district and some mammoth teeth collected by his father from Gannicox and Cainscross.

Afterwards Mr A. J. Morton Ball very kindly entertained the Members at tea at "The Green," and exhibited his fine collection of tusks and teeth taken from the gravel at Cainscross. Subsequently he invited his guests to join him on his spacious and picturesque lawn, where a varied collection of handsome trees was much admired. Before separating Professor Ainsworth-Davis, in the name of the Club, thanked Mr. Morton Ball and Mrs Jack Ball for their generous hospitality, and in reply Mr Ball expressed the hope that when next the Club favoured Stroud with a visit he might enjoy the company of Members for a longer time, and that they would also be able to inspect the Stroud Museum, which, he was pleased to say, was now being arranged.

[W.T.]

EXCURSION TO BEVERSTON, TETBURY AND WESTONBIRT.

TUESDAY, JUNE 9th, 1914.

Directors : THE REV. J. N. BROMEHEAD and MESSRS L. RICHARDSON, RATTRAY, ARTHUR CHAPMAN and ALEXANDER.

(*Report by* L. RICHARDSON AND W. THOMPSON.)

Twice within a fortnight the Members of the Club foregathered at Stroud G.W.R. Station, the first Excursion being confined almost within the limits of the Urban District area, and the second taking them on to the breezy uplands in the neighbourhood of Beverston, Tetbury, and far-famed Westonbirt. From Gloucester Members of that city and those from Cheltenham were conveyed to Stroud in a motor char-a-banc, and in addition there were several private motors. The passing of the horse so far as these excursions are concerned is regretted by none, for not only is the Hon. Secretary able to arrange far more extended trips, but the day's time table is carried out more smoothly. There was a slight delay in starting on Tuesday, but as rain was descending rather freely, Stroud and Cirencester Members did not object to the shelter provided at the G.W.R. Station. Fortunately, the weather improved in less than an hour after the motors travelled down Rowcroft and through the Nailsworth valley. Indeed, with Horsley left behind—for the outward journey lay through Tiltups End and the picturesque country leading to Calcot Barn[1] and Beverston—the rain had ceased, and for the remainder of the day the conditions were delightful. This was all the more satisfactory because the programme included a stoppage of nearly three hours in the magnificent grounds at Westonbirt House. [W.T.]

BEVERSTON CASTLE.

Here the Rev. J. N. Bromehead, the Rector of Beverston, was in readiness to act as conductor, as he had been only a few days before for the Bristol and Gloucestershire Archæological Society. He is well-qualified to undertake this duty, for he has published a well-written guide of this district;[2] and when playing the part of cicerone he discourses fluently and pleasantly upon a subject which he has made his own. First, he drew attention to the farmhouse inhabited by Mr E. Garlick, which was erected about 1791 on the site of the castle banqueting hall, the outer wall of which remains. The roof of this hall was pitched much higher than that of the present long farmhouse, as may be seen by the east side of the tower against which it rested. Entering the guard-room of the tower at the south-west corner (fig. 1), the party were

South West Tower, Beverston Castle.
(*Block lent by the Bristol & Glos. Arch. Soc.*)

1 See Proc. Cotteswold Nat. F.C., vol. vi., pt. 1 (for 1871), pp. 15–16; and *id.*, vol. ix., pt. 1 (for 1885-86), pp. 6–7.

2 "Beverston: its Church and its Castle" (1905). Phillimore & Co., London.

An excellent account of Beverston Castle, by a former rector of Beverston, the late Rev. J. H. Blunt, will be found in his "Dursley and its Neighbourhood," pp. 97-147. Views of the Castle, as it appeared in the 18th century, are given in Buck's "Antiquities," vol. i., plate 98 (dated 1732); Grose's "Antiquities" (New Ed.), vol. ii., p. 73; and Bigland's "Collections," vol. i., p. 175. See also Trans. B. and G.A.S., vol. ii., pp. 205–207.

asked to observe the vaulting, and the Rector informed them that this was characteristic of the domestic offices of the farmhouse, although there had been two fires and much damage. From this room the Members climbed to the garrison chapel, where Mr Bromehead, ascending the piscina, said he would constitute that his pulpit, and from this he delivered a short address.

He said some kind of stronghold existed on the site of the castle more than a thousand years ago, and by 1051 it was well known, for the three Earls, Godwin, Harold and Sweyn, lodged at Beverston. Probably no trace of that fortress was left, but they knew that it was besieged by the Empress Matilda in 1145. The next castle was built by Maurice de Gaunt in 1225, and it was held by him for 100 years..

The castle was re-built and enlarged by Thomas, Lord Berkeley, sometimes known as the great Lord Berkeley, c. 1356-1361. He obtained the money from the ransom received for French prisoners taken at Poitiers and incarcerated at Beverston. The castle remained in the hands of the Berkeleys until the reign of Elizabeth, when the representative of the junior branch of the family sold it and emigrated to Virginia, where he was murdered. It was owned by the Hicks-Beach family until 1842, when it passed to Mr Holford, of Westonbirt. When Sir Michael Hicks-Beach was made a peer he was desirous to take his title from Beverston, and for that purpose endeavoured to purchase the castle, but owing to the entail he was unable to do so. The castle was besieged in 1644 by Colonel Massey in the Parliamentary wars—or rather it was stormed for twelve hours. It remained in the King's hands for four or five months, and then it only fell in consequence of strategy. With a twinkle in his eye the Rector reminded his hearers that they had all been in love, and it was because Col. Oglethorpe, the commanding officer in defence of the castle, neglected his duty by going into the village to court a maid at a farm that the Parliamentary forces were able to outwit an incompetent lieutenant, and put themselves in possession of the castle.

At the present time there remain a large tower, which would have formed the south-west angle, 34 feet long by 30 feet wide, and 60 feet high ; another tower set diagonally at the north-west angle, 24 feet square ; a curtain or wall connecting these towers, containing various rooms and galleries, about 65 feet long ; and a barbican commanding the entrance. What remains of the moat on the west and south sides shows us what was its original shape and extent. The whole area within it has been calculated by Mr Blunt to have been 2,255 square yards.

Reference was made to a salt-cellar which was sold at the Ashburnham sale and realised £5,600. It belonged to the Berkeleys and had been in use at Beverston.

From the garrison chapel the party ascended the tower, where a fine view of the surrounding country was obtained, and incidentally Mr Bromehead was able to point out the original dimensions of the castle. [W.T.]

THE GEOLOGY OF THE DISTRICT.

From Beverston the Members motored to Veizey's Quarry, in the bottom-beds of the Forest Marble and the top-beds of the Great Oolite. Here Mr Richardson reminded the Members that they were well up on the Cotteswold upland and amid typical Cotteswold scenery. If a boring were put down some 600 feet at Tetbury this upland mass would be found to be composed of the following geological formations :—

Forest Marble.—Beds of blue shelly limestone, clay and sand.

Great Oolite.—Wedge-bedded and massive-bedded limestone ; about 106 feet.

Fullers' Earth.—Clays with shelly layers in the upper portion ; about 128 feet.

Inferior Oolite.—Ragstones and limestones, (below Kemble) 111½ feet.

Upper Lias.—Cephalopoda-Bed (? about 6 feet), "Cotteswold Sands" (? about 185 feet) resting on clay (? about 15 feet) ; about 206 feet.

The upland around and between Tetbury and Cirencester is best described as in the main level but slightly inclined to the south-east and diversified with many frequently "dry" valleys. In a south-easterly direction, therefore, the rocks that succeed the Forest Marble must be looked for, and such are the Cornbrash and wide-spreading Oxford Clay.

The country where the limestones predominate is partly downland and partly under the plough. The former is divided up and the latter enclosed by dry stone walls, and this country is therefore in marked contrast to the hedge-enclosed pastures on the Oxford Clay.

To the north-west headward-growing tributaries of the Severn, namely, the Frome and its tributaries with their affluents, have incised the Cotteswold upland and have excavated deep valleys and combs.

In their drive from Woodchester Station to Beverston the Members passed over the Upper-Lias clay and limestone, Cotteswold Sands, Inferior Oolite, Fullers' Earth and Great Oolite, and arrived upon the Forest-Marble beds. Several deep borings had been put down in the district, so that the exact thickness of the Great Oolite and Fullers' Earth was known. This information was most valuable from a water-supply standpoint.

Mr Richardson said that the Forest-Marble beds were of particular interest in this district. They comprised, according to their late Honorary and respected Member, Mr H. B. Woodward :—

(a) Clays with thin bands of gritty Limestone : 10 to 15 feet.
(b) Sands and calcareous sandstone : 5 to 10 feet.
(c) Oolitic and sandy limestones, passing down into more shelly limestones and clays : 20 to 30 feet.
(d) Bradford Clay : 2 to 6 feet.

The clay-beds (a) held up the water, and most of the cottages in the district obtained their water-supply from comparatively shallow wells sunk in the Forest-Marble series. He understood that the water from the Forest-Marble beds was harder than that from the Great Oolite.

The sand and calcareous sandstone are well-developed on the Westonbirt Estate, where their detailed succession is :—

(a) Clay.
(b) Tilestone (fissile sandstone) and sand : 5 to 10 feet.
(c) Oolite and sandy limestone.

After some discussion on the probable origin of many of the "dry" valleys of the Cotteswold—such as that in which the Members were stood—and water-supply, the Members went on to Tetbury.

TETBURY.

"The quaint little town of Tetbury lies just within the County of Gloucestershire, close to the Wiltshire border. It was probably a military station of the Britons, and of the Romans. Roman coins have been found here, and the remains of a Roman camp existed till the middle of the 18th century, when they were removed to make room for 'improvements.' 'Tetebûrie, in Langestrewes Hundred,' appears in the Domesday Survey. Fighting took place here in the Civil War of the 12th century, between Stephen and the Earl of Gloucester in person. A monastery, of which no trace remains, existed here in Saxon times. A Cistercian monastery was founded here which had a somewhat chequered history. The monks of Kingswood[1], an off-shoot from Tintern, divided, and 'swarmed,' one half removing to Hasildene, near to Tetbury, after the wars of Stephen and Maud. But owing to want of water, they obtained a grant of land at Tetbury, where was a good spring, and removed there. Kingswood was thus eventually left as merely a grange of Tetbury, much heart-burning being the result. Again the monks of Tetbury became dissatisfied, owing now to want of fuel, which they were obliged to fetch from Kingswood. They accordingly determined to return; but the buildings there not being sufficient for their accommodation, Bernard de S. Walerick, the founder of Tetbury Church, obtained a grant of 40 acres at Mireford, from Roger de Berkele, and there erected, about 1170, a new abbey, and transferred the monks of Tetbury thither. After this Tetbury became in its turn a grange of Kingswood. The scanty remains of the monastery are still to be seen in the Chipping.

"Charles I. visited Tetbury in 1643, and there was fighting here during the Civil War of the 17th century. Charles II. and Queen Katherine were here in 1663, and James II. in 1687.

"A town hall, on three rows of pillars, was erected in the centre of the town in 1655; it was, unfortunately, altered and enlarged in 1817.

"A church is said to have been founded at Tetbury in 1160, but nothing of this remains. The present tower and spire were probably erected about 1400, but were taken down and rebuilt in 1893. The dedication was of St. Mary Magdalene, and the old church had a south aisle and porch and two north aisles to the nave, with north and south aisles to the chancel, and vestry and chantry chapels. In the 18th century this church fell into serious disrepair, and a society was formed to raise funds for pulling it down and building another on its site. This work was commenced in 1777, and the present flower of 18th century Gothic was opened for divine service in 1781. The arrangement of a cloister on each side is probably unique.

"Tetbury, though without any buildings of great historic or architectural importance, has a number of old houses of considerable interest, and presents a delightful picture of an old-fashioned little country town[2]."

Lunch was served at the White Hart, Tetbury.

The following candidates were nominated for membership:—F. W. Smith, F.G.S., Gloucester; and L. Wilkin, M.A., B.C., Gloucester.

The Rev. Walter Butt, who as ex-President was acting for Professor Ainsworth-Davis, who was unavoidably prevented from being present, mentioned that a very rare fern, *Hymenophyllum Tunbridgense*, had recently been discovered at Symonds Yat during a visit of the Mycological Society.

WESTONBIRT.

After lunch a move was made for Westonbirt, where, through the kindness of Lieut.-Col. Sir George Holford, the party was not only permitted to wander through the Arboretum, gardens, and orchid houses, but also to inspect the interior of the mansion.

Before entering the house, however, the party were met near the Arboretum by Mr Rattray, the Forester, and under his leadership saw a portion of the arboreal wonders for which this estate is famous.

1 Near Wotton-under-Edge. See Proc. Cotteswold Nat. F.C., vol. xviii., pt. 2 (1913), p. 117.

2 These notes, put together by Mr J. L. Osborne for a meeting of the Bristol and Gloucestershire Arch. Soc. in 1914, are mainly derived from the Rev. A. T. Lee's "History of Tetbury," published in 1857.

Mr Richardson first mentioned that the sand-deposits in the Forest-Marble series to which he had already referred had rendered possible the successful growing of rhododendrons at Westonbirt. Rhododendrons dislike lime. It was the occurrence of this sand at Westonbirt which had been responsible for their visit to that part of the county that day. Sir George Holford had told Earl Ducie of its occurrence. Earl Ducie knew that the Geological Survey map represented the rock there as Forest Marble, and that that series generally comprised limestone and clay, and had therefore enquired of him as to the age of the sand. He (Mr Richardson) was not cognisant at the time of an abundance of sand in the Forest-Marble series, and therefore had visited Westonbirt, and had been shown very carefully over the ground by Sir George.

Members would gladly have remained longer among the rhododendrons, pines, spruces, thujas, maples, and other fine trees, for Mr C. O. Hanson, from the Dean Forest School of Forestry, was present, and he and the Rev. Walter Butt supplemented the efforts of the Forester, and most of those present were in the mood for acquiring information. The maples, no less than the Douglas pine and rhododendrons, dislike lime.

Westonbirt House was next visited. It is one of the finest and largest residences in the county. It is, according to Kelly's Directory, "a structure in the Jacobean style, erected from the designs of the late Mr Vulliamy, architect, of London, at a cost of about £200,000, and completed in 1878; it consists of a centre and two wings, the former being surmounted by a lofty tower, terminating in a cupola; the entire building has a frontage of about 360 feet, the general height being about 70 feet. . . . , . ."

The house contains many priceless treasures, including tapestry, pictures and vases, and these were much admired.

If the Arboretum had been found enjoyable, the gardens under the direction of Mr Chapman were positively enchanting. Here art has achieved the acme of success in tree-grouping, the idea being to secure perfection of colouring at all seasons of the year. It is pleasing to reflect that Sir George Holford willingly permits the public to visit his grounds, and it is to be hoped that nothing will occur to interfere with the privilege so long enjoyed and so highly prized.

The visit was not well timed for seeing the orchid houses at their best, but Mr Alexander was able to interest and instruct. There are half a million of orchids at Westonbirt, and, as is well-known, there is no other exhibitor to compare with Sir George Holford at the great shows. He has to fight for his laurels, but he wins them. As a closing tit-bit to a memorable visit some of the party were taken by Mr Chapman to his store beds for bulbs, shrubs, etc. Then, with farewells made, the excursionists started on the homeward journey, the alternative route of Avening and Longfords being selected.

Those present were:—The Rev. Walter Butt and Mr W. R. Carles, C.M.G. (vice-presidents), Mr L. Richardson (Hon. Secretary), Dr. F. C. Carter, Dr. R. Cunningham Affleck, Surgeon-Major I. Newton, Messrs. Walter Butt, J. M. Collett, A. J. Cullis, O. H. Fowler, J. C. Frith, C. O. Hanson, E. Lawrence, E. P. Little, W. Margetson, E. C. Sewell, J. W. Skinner, W. Nash Skillicorne, F. W. Smith, A. W. Stanton, A. J. Stephens, W. Thompson, etc.

EXCURSION TO CIRENCESTER.

SATURDAY, JUNE 20th, 1914.

Directors: E. C. Sewell and W. St. Clair Baddeley.

(*Report* by W. THOMPSON & E. D. SEWELL.)

Those present at this Excursion were: Professor J. R. Ainsworth-Davis (President), Mr L. Richardson (Hon. Secretary), Dr. R. Cunningham-Affleck, Dr. J. H. Garrett, Messrs St. Clair Baddeley, Prof. Blundell, W. Bellows, Christopher Bowly, F. H. Bretherton, O. A. Brown, H. W. Bruton, Collett, G. M. Currie, J. M. Dixon, T. S. Ellis, R. G. Foster, C. I. Gardiner, C. O. Hanson, E. Hartland, Professor Kinch, E. Lawrence, E. P. Little, W. Margetson, H. E. Norris, John Sawyer, E. C. Sewell, A. E. Smith, G. H. Pavey-Smith, A. W. Stanton, J. H. Thomas, W. Thompson, etc.

Meeting outside the King's Head Hotel, the party, led by Mr Sewell, crossed the Market Place to the fine old Church. Comfortably seated in the nave (fig. 1), the Members listened to a short but illuminating address on the

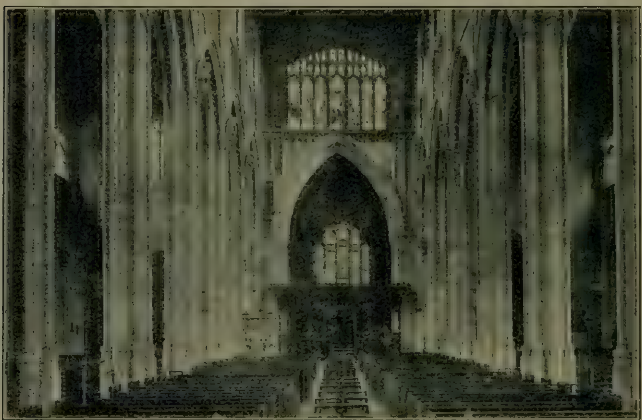


Fig. 1.—Nave of the Parish Church, Cirencester. 1

main historical and architectural features of the building (Plate XXII.) A Saxon Church, said Mr Sewell, stood somewhere on the east side, and that was succeeded by a Norman Church, with massive round pillars similar to those at Gloucester and Tewkesbury. Later an Early English roof was placed on the Norman pillars, and in the fifteenth century the Church was practically rebuilt. Then it was that the perpendicular tower and tall graceful shafting for sustaining the roof came into existence, and the speaker reminded his hearers that the heavy outlay was borne by the wealthy wool-staplers of the district. It was claimed that no other church in Gloucestershire surpassed that of Cirencester in symmetry and beauty, and attention was drawn to the clerestory extending round the whole of the building, this being a testimony

1 The Club is indebted to the Cirencester Tradesmen's Association for the Blocks used for Plate XXII. and figs. 1, 2, 3 and 4.

Cirencester Church and Market Place.

(Block kindly lent by the Cirencester Tradesmen's Association)

to the bold and artistic ideas of those entrusted with the work. A plan of the foundations of the Abbey Church that existed until the dissolution of the Monastery in 1535 was shown, disclosing the interesting fact that side by side with the Parish Church once stood a Norman Abbey Church like Tewkesbury, in length equal to Bristol Cathedral, with a lofty central Tower. At the capture of the Town by Prince Rupert in 1642 he put his prisoners into the Church, and then it was that the valuable glass windows were broken by friends of the prisoners in order to convey food and water to them.

Next the party walked to the adjacent Abbey grounds, where a fine capital of a Roman pillar was seen. Mr Bowly was invited to say something about this example of Roman sculpture, but had to confess that nothing was known, and as Mr St. Clair Baddeley did not essay to recreate the column in its pristine grandeur and give it a local habitation and a name, Members had to be content with what they saw.—[W.T.]

Mr Sewell had prepared a paper upon the Abbey which he read as follows :—

In 577, at the battle of Dyrham, the Saxons defeated the three British Kings, and their three cities of Gloucester, Cirencester and Bath were taken, and the defeated British were driven into Wales. Almost simultaneously with this (A.D. 597) Augustine with a band of monks arrived from Rome, and commenced, with the protection of King Ethelbert, King of Kent, to propagate the Christian faith. About 680, Ethelred is said to have founded at Worcester a College of secular canons, and to have constituted it as a Cathedral of a Diocese comprising the district within the modern counties of Worcester, Warwick and Gloucester. These secular canons generally lived, for the sake of protection, under the same roof as the Bishop or head of their college ; unlike the Monks, they were frequently married men, and were not subject to the monastic life. Besides the Cathedral Church at Worcester the following important religious houses were founded in Saxon times within the diocese of Worcester : The College of Secular Canons, afterwards a Benedictine Monastery, at Gloucester ; the Benedictine Monastery at Tewkesbury ; the like at Winchcombe ; and lastly, in the reign of King Egbert (828-836), the Collegiate College of Secular Canons at Cirencester by Alwyn. It would be most likely in the Chapter House of the Collegiate Church that King Ethelred held the Synodal Council (A.D. 991-92) which dispossessed Alfric, the son of the Duke of Mercia, of his estates, and banished him his realm ; and in the same building that Canute, at Easter, 1020, held the Witenagemote which outlawed Ethelward and Edwy. The importance of Cirencester College is indicated by the appointment by Edward the Confessor of Reimbold as its Dean about 1050, and by his continuance in the office until after the compilation of the Domesday Book 36 years later. Henry I. ascended the Throne in the last year (1100) of the century that had witnessed the Conquest of England by his father, and reigned during more than one third of the century succeeding. By him and his successors or under their auspices several Augustinian Monasteries were founded, and in some cases, as in that of Cirencester, upon the foundation of a Collegiate Church of Secular Canons, whose churches, lands and charters were presented to the new institution, respect, of course, being paid to the then existing life interests of the prebends. In 1117 Henry I. commenced to restore and enlarge on an extensive scale the church and conventual buildings of the Secular Canons, and upon completion of the work fourteen years later, dissolved the ancient collegiate institution and conferred its charters and possessions with many other additional lands and privileges upon the regular Canons of St. Augustine. The new Monastery was opened by the King in person, and Serlo, the fourth Dean of Sarum, was appointed the first Abbot. The Abbey was dedicated in November, 1176, in the presence of Henry II., the grandson of the founder, who confirmed the charter of his grandfather. In the first year of Henry IV., the townsmen of Cirencester, who had just distinguished themselves in their fidelity to this Monarch, in the assistance they had rendered in suppressing the insurrection of the Earls of Kent and Salisbury, appealed to the King for a strict inquisition to be issued against the Abbot for the usurpation of certain rights in the Town and Seven Hundreds. In the reign succeeding that of Henry V. the Monks grew more and more disliked by the laity, and this eventually culminated in the Reformation in the reign of Henry VIII. The Abbey of Cirencester was surrendered to the King's Commissioners 29th December, 1539, and was at that time one of the richest religious houses in the kingdom. By letters patent dated 11th May, 32 Henry VIII., the King, granted to Robert Bassinge, Esq., the site of the late dissolved Monastery of Cirencester conditional upon all edifices within the site being pulled down and carted away. The Hospital or Spital Gate in Grove Lane (fig. 2) is the only portion of the Conventual buildings that remains.

Fig. 2.—The Hospital Gate of the Abbey of St. Mary, Cirencester.

To this gateway the Members travelled, and Mr Sewell mentioned an interesting picture sold by Sotheran's, of London, in the form of an eighteenth century picture of the gateway. This depicts a building which in site agreed with where the Abbey barn was believed to have stood. All the farm buildings had been swept away, and with the exception of the gateway not a scrap of the original Abbey remained.

Mr Baddeley said that originally there were two gateways. The one that had been removed stood some 50 or 60 yards further in the grounds. It would be interesting to know whether the old picture to which reference had been made contained any evidence of the existence of a second gateway. The moulding of the gateway arches practically gave them the date of erection.

There had been an extensive settlement of the stonework, and this may have been due to the fact that originally the gateway was 20 or 30 feet higher, and the weight resting on the arch would have been considerable. It dated back to late Henry II., the whole character of the erection pointing to the end of the 12th century.

A short walk brought the party to all that remains of St. John's Hospital (fig. 3). According to Leland it was founded by Henry I., and endowed by

Fig. 3.—St. John's Hospital, Cirencester

him with one-third of the tithes of his demesne in Cirencester. The surviving arches were utilised for the erection of cottages, one of which remains, but three arches have been restored to their original state, and this involved the removal of the tunnel-like passage known as the "paen," along which the boys of Cirencester, Mr Sewell included, were in the habit of running. [E.C.S.]

In Gloucester Street attention was drawn to some model cottages erected by Earl Bathurst in lieu of pre-existing slums, and which he endeavoured to make conform to the best type of Cotteswold cottage extant. The general effect is pleasing, and it was acknowledged that the Earl had been happy in his selection of architect and builder.

A short walk along the bank of the river Churn, under the branches of noble limes and with the scent of hay borne on the breeze, brought the Members to Barton Mill, and then to Mr Anderson's house, where the finest of Roman pavements in the immediate neighbourhood of Cirencester was inspected. The discovery was due to the removal of a walnut tree. Mr Sewell pointed out the design of the pavement—Orpheus charming animals and birds by the power of his lute—and then Mr Baddeley said that the steps taken to preserve this Roman relic had been characterised by skill. He mentioned that the remains of a full-length man had been discovered beneath the pavement, and the curious thing about the discovery was that the man belonged to the Saxon period. This was proved by the large iron boss which was found resting on the centre of the remains. It was just such a boss as the Anglo-Saxons placed on their shields. There were also fourteen small iron studs, which no doubt surrounded the leather covering of the shield. The shield rested on the man's stomach, but now all that remained was the iron boss. The skeleton was complete with the exception that the patella of the left knee-cap was wanting. It was now to be seen in the museum. Three Roman coins were found, the best and most complete of which was a small bronze coin of Electus. With regard to the date of the pavement, the smallness of the tesseræ pointed to an early date, possibly to that of Antonius Pius, which was somewhat later than Hadrian, during whose reign the Villa at Woodchester was made. Mr Baddeley said it was curious that the legend of Orpheus should so persistently be adopted by the Greeks and Romans. He called attention to the excellent design and workmanship exhibited in this pavement, and said that as time advanced a guild of mosaic workers was formed, and the members went round the country working to order, there being a great demand for such work.

From the pavement the party walked *via* the Cecily Hill Gates and Barracks (fig. 4) to Earl Bathurst's House, where, by permission, a view of the pictures was obtained. These include numerous portraits of the Bathurst family by Hoppner, Romney, Lawrence, Reynolds and Gainsborough. A

Fig. 4.—Cecily Hill Gates and the Barracks, Cirencester.

portrait of the poet Pope served to remind the party of his intimate association with the Bathurst family in the reign of Queen Anne. There are also some unique prints, and valuable porcelain, including a Berlin Service presented by William IV. of Prussia to the 3rd Earl. The chief object of interest in the garden is the Yew Rotunda, planted in the early part of the 18th century, now of a height of over 30 feet.

Leaving the House, the next walk lay through the gardens and the shady path, with its wealth of timber and shrubs, to the ornamental sheet of water, which is not the least among the glories of this beautiful domain. Leaving the Park, the walk was continued to the Agricultural College, where tea was served in a marquee by the President and his daughter, to the enjoyment of men somewhat wearied by a protracted pilgrimage. Then Professor Ainsworth-Davis conducted his friends through the gardens and grounds, pointing out the experimental beds for the raising of grasses, flowers and

Fig. 5.—The Broad Drive, Cirencester Park.

other plants, and proudly drawing attention to a fine specimen of *Paulownia imperialis*, the national tree of Japan, which this year has bloomed well. Some of the flower beds are devoted to British natives, others to foreign plants, and thus botanists as well as archæologists recognised that the day's programme was both full and varied.

Nor did this complete the pleasures, for after thanking the President for his generosity Members were driven to the Museum which the Rajah of Sarawak has created not only for his own enjoyment, but for that of his neighbours, who are scarcely likely to see the territory which he and his family not only rule but possess. The Museum is situated at Chesterton, opposite the Rajah's residence, and in the Museum grounds on Saturday this distinguished British subject and ruler was entertaining the inmates of the local Union Workhouse to tea, games, band music, and his own kindly presence. Thus the Cotteswoldians found themselves in the midst of a happy throng of people of all ages, and from those upon whom devolved the pleasing task of assisting the Rajah in this annual treat they learnt that the supreme desire of his life seems to be to make other people happy, a by no means unworthy example for an octogenarian to set. The interesting curios in his Museum, including so much that is representative of life in Sarawak, were inspected, together with the living parrots and other eastern birds in the aviary close by, and then the party dispersed, some to travel by the M. and S.W.R. and G.W.R., and others to find their homes by means of private motors and bicycles. [W.T.]

EXCURSION TO WEYMOUTH, PORTLAND, WOOL, WAREHAM, CORFE, LULWORTH AND DORCHESTER.

JULY 14th-16th, 1914.

Directors: DR. W. T. ORD, F.G.S., AND L. RICHARDSON.

(*Report by* L. RICHARDSON AND THE REV. H. J. RIDDELSDELL, M.A.)

On this Excursion, Weymouth, Portland, Wool, Wareham, Corfe and Lulworth were visited. As on previous Long Excursions some Members of the party arrived in advance of the others and did some useful botanical work.

Thus on Monday, 13th July, an advance party consisting of the Rev. W. Butt, Messrs. A. J. Stephens and H. H. Knight, and the Rev. H. J. Riddelsdell, motored to Portland. Mr W. Bowles Barratt, of Weymouth, kindly went with them in order to render the search for local species more profitable; for he knows the flora of Weymouth and Portland well, and has indeed made considerable contributions to the literature of the subject in the "Proceedings" of the Dorset Field Club. The party were greatly indebted to him for his kindness. The general features of the Flora of the Chesil Beach need no description or attention here, as they were investigated by the Club at the Bridport meeting in 1912[1]. But one or two special points were noteworthy, particularly the disappearance of *Asparagus officinalis* from the neighbourhood at a very recent date owing to the extension of the Torpedo Works, and the presence of a small quantity of *Polycarpon* in a reduced form. This rare plant was discovered here in 1845 or thereabouts by Wm. Borrer, and re-discovered by Mr. Barratt. It is known only in a very few of the south-western counties of England, although it is common in the Channel Islands. *Koeleria albescens*, discovered here in 1907, was on this occasion untraceable, owing to railway-side fires, and the lateness of the season. *Raphanus maritimus*, however, was seen in fine quantity and condition, and a small patch of *Stellaria Boræana* was found, as well as a nice piece of *Cuscuta europæa*. The Yellow horned Poppy and the Sea Holly, at any rate where they are in a flourishing condition, always convey the impression of a nice clean unspoilt beach, as was the case now at Smallmouth Sands. The Sea Pea, *Lathyrus maritimus*, we did not find. Other interesting plants seen in profusion were *Linum angustifolium, Arenaria peploides, Cochlearia danica, Senebiera procumbens, Trifolium scabrum, Carduus tenuiflorus*, with smaller quantities of the beautiful seaside *Convolvulus, Calystegia Soldanella, Suæda fruticosa, Atriplex portulacoides, Carex arenaria, Festuca rottbœlliodes, F. uniglumis, Agropyron pungens* and the like. All this botanising was done on the sands and shingle between the mainland and the island. Portland itself was visited both on the Monday afternoon and again on Tuesday after the arrival of the main party. Even around the quarries on the top of the island there is some interesting botany to be done. *Artemisia Absinthium, Rumex pulcher*, and *Lactuca virosa* may be specially mentioned. The chief interest, however, lies in the resemblance of the remains of the native flora, in its dominant constituents, to that of the Cotteswolds, e.g., *Inula squamosa, Rhamnus catharticus, Conium;* while we were glad to find *Brassica nigra* a very common native plant all about Weymouth and Portland; *Lathyrus Aphaca* was discovered on Portland on Tuesday afternoon, after a vain search for it near Monte Video in the morning rain. *Hydrocotyle* was seen on one spot in Portland; *Smyrnium* abounded everywhere, the Danewort, *Sambucus ebulus*, was in great quantities in several parts of the island; *Crithmum* and *Inula crithmoides* were gathered on the cliffs; the Oxtongue, *Picris echioides*, dominates

1 Proc. Cotteswold Nat. F.C., vol. xviii., pt. 1 (1912), pp. 31-38.

Fig. 1.—View from Portland, looking northwards, showing Portland Town, Chesil Bank and Portland Harbour.

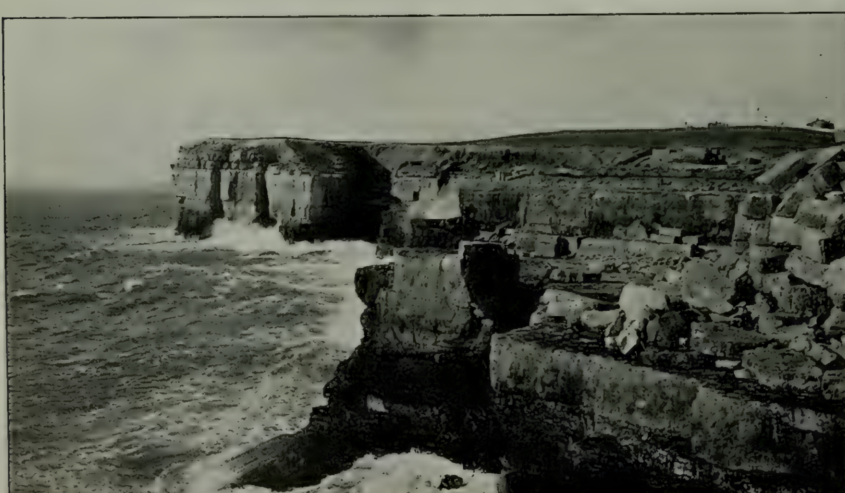


Fig. 2.—Cliffs and "Raised Beach" near Portland Bill.

the situation everywhere. The local *Hieracium platyphyllum*, found in 1907, was one of the important things missed now, and we could not trace *Valerianella eriocarpa*. But Mr Barratt kindly directed us to a spot where we found both *Limonium occidentale*, and *L. recurvum*. The latter is a form of Sea Lavender confined to Portland, and even there is very scarce. It is known from no other locality in the world. It may be doubted whether its characters —greater stoutness, compactness of inflorescence, recurved spikes, bract characters and so on—are of specific value, but the plant, in good condition, is quite easy to distinguish from *L. occidentale*, and makes at least a good variety. It was a great pleasure to see it, and to know that it is in no danger of extinction, so long as botanists treat it with respect. Of other Portland plants we need only mention *Diplotaxis muralis* var. *Babingtonii*, *Medicago maculata*, *M. denticulata*, *Carum segetum*, *Fœniculum* (? escaped), *Rubia*, *Galium tricorne*, the rayed form of *Centaurea nigra*, *Matricaria inodora* var. *Salina*, *Salvia Verbenaca*, *Lithospermum arvense*, *Echium vulgare*, *Euphorbia portlandica*, *Mercurialis annua*, *Iris fœtidissima*, *Allium vineale*, (a tiresome weed), *Scirpus Tabernœmontani*, and the ubiquitous *Brachypodium pinnatum*: while in some parts the whole of the cliff top turf was composed of *Lepturus*. The local *Hordeum maritimum* was also found before the ascent of the island.

On Tuesday morning, the same party of four visited the ground near Monte Video on the north side of the Fleet. Their special purpose was to find *Lathyrus Aphaca* which was seen in quantity in a field there, seven years ago. It was now sought for in vain, but *Ranunculus sardous* throve in a muddy clayey lane, the haunt of brickbats, empty tins and *Lotus tenuis*. Some *Senecio sylvaticus*, at one point, suggested the presence of heathy ground, and a pond produced the pretty grass *Catabrosa*, fine specimens of *Alisima ranunculoides*, *Potomogeton pusillus*, *Ranunculus Baudotii*, etc. *Œnanthe pimpinelloides*, usually a rare plant, and in Gloucestershire local only, was common on dry road sides and meadows—as in most of Dorset—while close by in wet places would be found *Œnanthe Lachenalii*. On returning to Weymouth, near Sandsfoot Castle we failed to find *Trifolium subterraneum*, recently discovered at Lancaut, near Chepstow, but on the cliffs and at their foot quantities of the rare vetch, *Vicia lutea*, were seen, in a form with very pale flowers, hardly yellow at all; in Cornwall and elsewhere the flowers are a decided yellow. An interesting form of *V. angustifolia* is found there. It has very dark, almost black, flowers, and was in quantity in 1907; this year it was scarce and was already in fruit, no flowers being seen. The only other noticable features were the large quantities of native Celery growing on the cliff face; the presence of such introduced species as *Hippophaë*, the Sea Buckthorn, *Heracleum giganteum*, etc., and the occurrenceof the local Sea Clover, *Trifolium maritimum* and the great *Festuca arundinacea*. It was too late for the grass-leaved Vetchling. [H.J.R.]

PORTLAND.

The official party arrived at Weymouth about 2 p.m. on the Tuesday. At 3 p.m. the Members left the Hotel Burdon, which was headquarters, for Portland. On the way they were reminded of Weymouth's halcyon days of 1779-1805, when George III.—or "Farmer Jarge" as the quaint Wessex folk of those days used to call him—visited the town, by an ungainly statue erected to that monarch in 1809. Passing through Wyke Regis the Members soon arrived at the Torpedo Works, and obtained a good view of Portland Harbour and the Chesil Bank.

Portland Harbour is a fine natural harbour excavated by the sea out of the Kimmeridge Clay (Plate XXIII., fig. 1). It is protected on the west by the Chesil Bank and on the east by a breakwater. This breakwater took twenty-three years to construct. "The first stone was laid by Prince Consort on the 25th July, 1849, and the last stone by the King (Edward VII.) then

Prince of Wales, in August, 1872. The breakwater and other harbour works cost £1,033,600, but this is exclusive of a very large amount of free convict labour in preparing the stone and bringing the same to the water's edge. At each end of the breakwater is a circular fort. In design and construction, as well as in armaments, these forts are as powerful as money and British ingenuity can make them[1]."

On the land, at the northern extremity of the harbour, is the Nothe Fort, and at the southern end—crowning the Portland cliffs—the Verne Citadel.

Henry VIII. also fortified Portland Harbour. On the north side he had built, in 1539, Sandsfort Castle, and on the south side a castle that is still in splendid repair and is used as quarters for the senior married officer of the Verne Citadel. Sandsfort Castle, however, has been reduced to a very small ruin. It was captured and re-captured on several occasions during the Civil Wars, but about 1700 fell into complete disuse.

Passing through Chesilton or Portland, the Members motored up the steep ascent to the high ground and obtained a fine view over Weymouth Bay and Portland Harbour (which were crowded with warships assembling previous to going to Spithead for the great review by the King on July 18th) to the hills beyond, and of the Chesil Bank (Plate XXIII., fig. 1).

The pebbles comprising the Bank get larger and larger from West Bay, Bridport, to Portland. It is locally said that the fishermen landing on the Bank at night can tell their whereabouts by the size of the pebbles.

A stop was made at the Portland Stone Quarries of Mr F. J. Barnes, and the Members were conducted over the Steam Saw-Mills, Masonry and Turning Works by Mr E. Allen. The stone is cut with either (1) horizontal corrugated steel saws aided with sand and water (which cut at the rate of 6 inches per hour), or (2) a circular diamond (black) saw (which cuts at the rate of 6 inches per minute). Steam-driven moulding-machines were seen at work, and in an adjoining shed a large number of masons. Beautifully-dressed blocks for the Corfield monument were pointed out and much admired.

From the Works the Members went into the quarry Here Dr. W. Theophilus Ord, F.G.S., of Bournemouth, made some general remarks upon the geology of the district, pointing out that the Island of Portland was formed of Lower Purbeck Beds, overlaying Portland Stone; this, Portland Sand, and the last named, the Kimmeridge Clay—all the beds being inclined to the south. Mr Allen gave some particulars regarding the beds, and it was understood that the excellent weathering properties of Portland Stone were due to the presence in it of a considerable amount of siliceous matter.

The motor drive was then resumed southwards as far as the road permitted. A short walk brought the members to "The Bill."

The curious obelisk on "The Bill" is called "The Sign." It was put up in 1844 by the Trinity House Corporation (hence the "T.H." on it), so that seafarers could determine their whereabouts, and distinguishes this promontory from that of Start Point and St. Aldhelm's Head.

Two lighthouses were erected in 1879 on Portland, but their use was given up on the completion of the present magnificent lighthouse in 1905. This structure measures 139 feet from the base to the vane.

After tea at the lighthouse, Dr. Ord showed the Members the very interesting "raised beach" for which Portland Bill is celebrated amongst geologists (Plate XXIII., fig. 2).

The Wireless Station was noticed, and on the way back the stone buildings of the Convict Prison, and—fastened to the side of a house in Fortune's Well

1 Ward, Lock & Co.'s "Guide to Weymouth," p. 35.

G. B. Usher, Furzebrook, photo.

Fig. 1.—The Manor House, Wool
(Immortalised by THOMAS HARDY in "Tess.")

Leonard Elmes, Wareham, photo.

Fig. 2.—A portion of the western earthworks ("Bloody Bank"), Wareham.

(*Blocks lent by J. W. Tribbett, Wareham.*

(a part of Chesilton)—a very fine fossil tree from the Lower Purbeck of the Island.

Rain came on as the Members were passing through Chesilton and continued to fall heavily all the evening.

WOOL, WAREHAM, CORFE, AND LULWORTH.

The next morning it had cleared up, and the Members left the hotel at 9.30 a.m. Between the coast and Preston, Roman remains have been discovered—in particular a Roman pavement found in 1852. To the north of Preston, formed by removing the turf and revealing the white chalk, is a figure mounted upon a horse. No doubt a form of horse was cut there in very early times, but the figure on it is said to have been added in more modern times by a party of soldiers. The loyal inhabitants of Weymouth prefer to believe that it represents George III. !

A very pleasant run amid undulating country brought the Members to Wool. A stop was made at the old red Jacobean Manor, now used as a farmhouse, but once the manor house (" Wellbridge ") of the D'Urberville family immortalised in Thomas Hardy's tragic novel " Tess." An invitation to see over the house was readily accepted (Plate XXIV., fig. 1).

The journey of five miles between Wool and Wareham was soon accomplished. At the western entrance to Wareham (the Anglebury of Hardy's novels) the Members got out and walked along the earthwork to the northwestern corner. Here the Honorary Secretary gave a brief account of the geology of the district.

Next, the history of Wareham was dealt with. It is a place of considerable antiquity. It is situated on a tongue of relatively elevated ground which extends from west to east. In very early times the sea came up to Wareham, but it has retreated, and now the River Piddle or Trent flows to the north of the town and the Frome to the south—both emptying into Poole Harbour, which is situated a little over half a mile to the east.

The fact that the site was a good one to fortify was early appreciated, the natural slopes were suitably steepened, earthworks constructed, and an area of about 100 acres then enclosed. The chief entrances were two gateways—one near St. Martin's Church in the district still called " Northport " and the other (by which the Members entered) on the west, which is still known as " Westport."

When the Romans came, probably in Vespasian's time, the ramparts already existing were completed and extended (Plate XXIV., fig. 2). The evidences for Roman occupation are meagre. They are : (1) that the streets are laid out at right angles, (2) that a number of Roman coins (some of the early Emperors) have been found, and (3) fragments of Roman pottery, Samian ware, etc.[1] In Saxon times Wareham was a place of considerable importance, and is said to have been the best fortified town in the Kingdom of Wessex. A most interesting Saxon Church (St. Martin's) still remains. The town is first mentioned in the time of Alfred the Great, about 876, when the Danes besieged it and destroyed a castle—which was in existence then—and a nunnery. The castle—which was situated near the bridge over the Frome—was rebuilt by William I. and destroyed by Stephen in 1142. The history of Wareham in later times, and up to the days of the Civil War, is obscure. In the early part of the conflict between Charles I. and his parliament it was first of all garrisoned by the latter. It then fell into the hands of the Royalists, then, in 1643, into those of the Parliamentarians, was retaken

1 See also John Bellows, " Roman Wareham and the Claudian Invasion." Proc. Dorset Nat Hist. and Antiqu. F.C., vol. xiii. (1892), pp. 115-130.

by the Royalists in 1644 and by the Parliamentarians again in 1645. On July 25th two-thirds of the place was burnt down.

A few of the inhabitants participated in Monmouth's Rebellion, and six of them were tried by Judge Jefferies at Dorchester, brought to Wareham and executed on the part of the walls still called "Bloody Bank." Since then little of historic interest has occurred.

The Members then returned to the motors and went through the town to the Saxon Church (Plate XXV., fig. 1).

This Church is forty-five feet long, and is supposed to have been erected about the year 700 by Aldhelm, Bishop of Sherborne, who died 705, and was the builder also of the sister church at Bradford-on-Avon. It may possibly have been the first burial place of Bertric, King of the West Saxons, who died in 800, and whose body was buried somewhere in Wareham, and afterwards removed to Tewkesbury. The church has been lengthened westwards, and the north side is of more recent date than the nave. The old beams supporting the roof are still doing duty. When the walls were partially cleaned in 1887, frescoes and inscriptions were discovered. Time did not permit of a visit to St. Mary's Church—a patchwork building, containing some very ancient and interesting work. The original building, which was a small chapel attached to the Priory (at the present time a private house), is now used as a vestry. As King Edward the Martyr, who was stabbed at Corfe Castle in 978, is said to have been buried here, it is generally called "King Edward's Chapel." His marble coffin may be seen near the old font of the church. A few years after its burial in Wareham the body was removed to Shaftesbury.

A short run brought the Members to Corfe, which figures conspicuously in Hardy's "The Hand of Ethelberta." Some of the Members, however, who had seen Corfe before, got off the car about half-way, and spent the time until the main party returned doing botanical work.

Corfe Castle (Plate XXV., fig. 2) is situated on a remarkable knoll of chalk in a gap in the Purbeck Hills, and dominates the little old-world village of Corfe. In Alfred's days the knoll was fortified with earth-works, but it is generally supposed that Edgar (959–975) built the first stronghold. It was here—in 978—that Edgar's wife murdered her step-son Edward while the boy was drinking a stirrup-cup. He was dragged by his horse along the road, where he was found dead on the following day. He was buried at Wareham, and subsequently reinterred at Shaftesbury. Stephen attempted to destroy Corfe Castle as he had done Wareham, but was unable to do so. King John used the castle as a royal residence, and kept his regalia here for safety. In Edward II.'s reign the castle was strengthened and in parts re-built. Successive sovereigns resided here, and Henry VIII. added to the fortifications. Queen Elizabeth granted the castle to Sir Christopher Hatton. After his death it was sold (1635) to Attorney-General Sir John Bankes. Lady Bankes, in the absence of her husband, defended Corfe Castle against various attacks by the Parliamentarians, although the garrison consisted of a few retainers and servants, until Prince Maurice brought help. Later on Sir Walter Erle, with a strong force, attempted to rush the castle with a simultaneous attack on all sides. Then it was that the careful labour of centuries aided the defenders, and the attack utterly failed. In 1646 Corfe was again besieged. The attacking force obtained by treachery what they could not take by storm. An officer named Pitman secretly admitted the enemy and the famous pile fell into the hands of the destroyers, who exploded hundreds of barrels of gunpowder in overthrowing the twelve-feet-thick walls.

At 1 p.m., after a light lunch, the journey was resumed. The main party motored to Lulworth Cove *via* Wool, but two took the road *via* Creech Grange, along the summit of the Purbeck Hills (655 feet) and so to East Lulworth. Here the main party was caught up.

'eonard Elmes, Wareham, photo.

Fig. 1.—St Martin's Church (exterior), Wareham.

. Churchill, Wareham, photo

Fig. 2.—Corfe Castle. (from the south).

Block lent by J. W. Tribbett, Wareham.)

Laurence W. Pike, Furzebrook, photo.

Fig. 1.—Creech Barrow Hill

637 feet. The wood is known as the "Black Hills." The long white line in the foreground represents the spoil-heaps of old workings in the "pipe" or "ball" clay.

S. Yeo, Dorking, photo.

Fig. 2.—The Cove, West Lulworth.

(Blocks lent by J. W. Tribbett, Wareham.

At Lulworth Cove (Plate XXVI., fig. 2), about forty Members of the Bournemouth Natural History Society joined the Club. The combined parties crossed the little cove in boats and proceeded, under the guidance of Dr. Ord, to study the "fossil forest" in the Purbeck Beds in the cliff a little to the east.

After tea at the Cove Hotel, the Members did what they chose, some botanized, others geologized.

At 6 p.m. the return journey was commenced, and it was agreed that more pleasant weather could not have been desired.

As regards the botanical work done on Wednesday, the ground examined was very different from that of Portland and Weymouth; notably the heathland between Wareham and Corfe, and the chalk at Lulworth. At Wool, the river Piddle and its margins produced luxuriant masses of *Œnanthe fluviatilis*, *fistulosa* and *crocata*; and the roadsides, the American invader *Matricaria suaveolens*. The ramparts at Wareham had *Salvia Verbenaca*, *Plantago Coronopus*, *Jasione*, *Trifolium striatum*, *Inula squarrosa*, *Hypochæris radicata* in a lax prostrate form, *Chenopodium Bonus-Henricus*, *Rumex pulcher*, and *Mercurialis annua*. As we were hurried along the roads, we picked out the Wayfaring-tree, plenty of the lovely Chicory, and *Jasione*. Two or three of us were left by the main party to spend an hour on a bog half way between Wareham and Corfe: a very spongy *sphagnum*-bog with plenty of *Drosera*, both *D. rotundifolia* and *D. longifolia*, *Potentilla palustris*, *Pinguicula lusitanica*, *Narthecium*, *Anagallis tenella*, *Scutellaria minor*, *Schoenus nigricans*, *Eleocharis multicaulis*, *Scirpus fluitans*, *cæspitosus* and *setaceus*, *Rynchospora alba*, *Myrica Gale*, *Molinia*, etc; all the characteristic constituents, in fact, of a Western bog-flora. *Lycopodium inundatum*, however, was sought in vain: so was *Malaxis*, which has been found there. *Viola lactea* grew among the heather; *Ulex nanus* was mixed up with *U. Gallii*, *Rosa spinosissima* fringed the roadsides, and *Verbena* grew near houses. Later on by the roadside in suitable places, we found *Butomus umbellatus*, *Iris fœtidissima* and the like.

At Lulworth, on the chalk and near the sea, many of the more familar and beautiful things were seen: the Horned Poppy climbed to the top of the cliffs, with the Wall-flower, common Mullein, Houndstongue, and Viper's Bugloss. In the village we saw *Ranunculus Drouetii*, a very long-leaved form of *Parietaria*, robust plants of *Apium nodiflorum*, var. *vulgare*, and *Mercurialis annua*. On the grassy slopes of the hills were *Thesium* of a yellower hue than usual, *Spergularia rupestris*, and the like. It was interesting, as we climbed Bindon Hill, to note the reduced form of *Campanula glomerata*, less than an inch in total height in the most exposed ground; though, where it was protected by *Brachypodium primatum*—a grass which apparently no animal will eat—the species grew to a height of six or seven inches. We could not find *Senecio campestris* on the hill-top; July is too late for it. But the flora of the bare wind-blown chalk ridge has a peculiar interest; among other things it produces *Hypericum pulchrum* in some quantities, a considerable hollow was filled by a flourishing gooseberry bush, and the stoniest parts near the very summit were occupied by large quantities of *Mercurialis perennis*. The species here was rather dwarfed, and the foliage tough, thick and leathery, no doubt owing to exposure, and of course its presence indicates a wood once there, now vanished. *Viola hirta* was also present in quantities, and a flowerless *Sedum*, which, from its taste, appeared to be *Sedum anglicum*; some *Bryonia*, but not much; some *Inula squarrosa*; the Carline Thistle; quantities of Cowslip and *Teucrium Scorodonia*; and the Bee Orchid. [H.J.H.]

MAIDEN CASTLE AND DORCHESTER.

On the Thursday morning the Members left Weymouth by the 9.20 a.m. for Dorchester; here a brake was in readiness to convey the party to Maiden Castle—the greatest pre-historic hill-camp in Britain.

On the outward journey Poundbury Camp (Plate XXVIII., fig. 2) was pointed out. It is doubtful by whom it was thrown up—whether by Romans, Saxons or Danes.

A short drive over well-cultivated country and chalk downs—close cropped by large flocks of sheep—Dorset "horns" and "downs"—brought the Members to the ancient hill-camp called "Maiden Castle." The camp is an irregular oval in shape, being about 900 yards long and 400 yards at the broadest place. A triple line of ramparts and ditches defend the north front, with an extra line on the south, while the flanks are protected by a maze of bastions and half-moon earthworks, through which the approaches wind. The ditches vary in depth from 60 to 90 feet and the sides of the ramparts are steep. The total area within the outer lip of the outermost ditch is 115 acres. It was doubtless constructed in Neolithic times, and is probably the Dunium of Ptolemy—the hill-fort of the Durotriges (Plate XXVII. figs. 1 & 2).

In the spring of 1913 Maiden Castle was acquired by the Duchy of Cornwall, who already owned Maumbury Rings and Poundbury, and placed under the care of the Commissioners of Works.

Tumuli cover the chalk downs to the south of Maiden Castle.

Maumbury Rings were next visited (Plate XXVIII., fig. 1).[1] They constituted the amphitheatre of the Romano-British Durnovaria, and were constructed probably about or during the time of Agricola. The name is connected by some with the Latin "momus," the Greek "mimos" and the English "mummer" and "mummery," and is said to indicate the theatrical exhibitions probably held here. General notice was first drawn to it by Sir Christopher Wren, once M.P. for Weymouth. It is the finest relic of its kind in the kingdom, and although differing from the amphitheatres of Italy, it resembles, although it surpasses, the amphitheatres at Cirencester, Richborough and Silchester. It is an oval or elliptical earthwork, the long diameter being north-east to south-west, and was formed by excavating the chalk and banking it up to a height of about 35 feet. There was an entrance to the east and another opposite, but the opening has been filled in, probably in the great Civil War, when the Roundhead garrison converted it into a fort to withstand the advance of the Royalists from Weymouth under Lord Carnarvon. The dimensions were: long diameter, 345 feet; shorter diameter, 340 feet. The terrace on the top of the bank was 12 feet wide, and the original dimensions of the area were about 220 feet by 140 feet. In 1706 the accommodation of the amphitheatre was tested to its utmost capacity, for when Mary Channing, the girl-wife of a Dorchester tradesman, was strangled and burnt for the alleged murder of her husband, ten thousand people are said to have thronged the place to gaze on the ghastly spectacle!

In Roman times Dorchester ("Durnovaria") was a large and important town. It stood on the great Via Iceniana, and roads radiated from it to Weymouth (Clavinio), to Ilchester, and to Badbury Rings. The town is on the usual Roman plan and was contained by a vallum with a thick stone wall on the top. Unfortunately, practically all the wall has been pulled down and cleared away; but the members saw a piece in the West Walk—a small portion of the core: grouted flint, rock chalk, and unshapen stone, rudely arranged in courses of herringbone formation. Several handsome Roman pavements have been found and the best removed and relaid in cement in

1 H. St. John Gray, "Interim Report on the Excavations at Maumbury Rings. Dorchester. Proc. Dorset Nat. Hist. and Antiqu. F.C., vol. xxx. (1909), pp. 215–235.

Fig. 1.—Maiden Castle, near Dorchester.

Fig. 2.—A portion of the ramparts of Maiden Castle.

Reproduced by kind permission of W. Pouncy, Dorchester.

Fig. 1.—Maumbury Rings, Dorchester—a Roman amphitheatre.

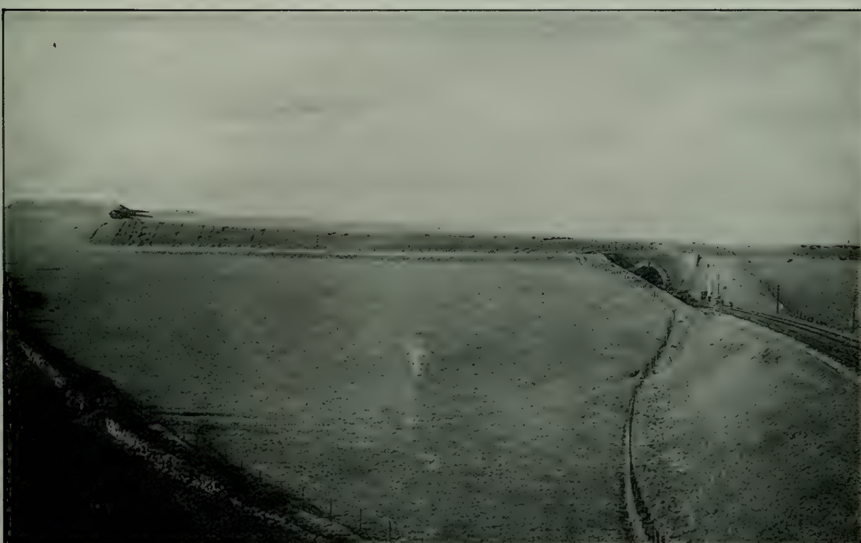


Fig. 2.—Poundbury Camp, near Dorchester.

(*Reproduced by permission of W. Pouncy, Dorchester*.

the County Museum. Nearly opposite the Museum is the large Tudor house that was occupied by the celebrated Judge Jeffreys in 1685 when he was holding the Bloody Assize.

Thomas Hardy, the well-known author of "The Mayor of Casterbridge" and numerous other novels dealing with Wessex, lives at "Max Gate" on the Wareham road.

At 12 o'clock the Members dispersed—some visited the excellent Museum; three started on their return journey, by motors, home.

EXCURSION TO THE NORTH COTTESWOLDS.

THURSDAY, SEPTEMBER 17th, 1914.

This Excursion was cancelled owing to the European War.

THE COURT OF ATTACHMENTS, FOREST OF DEAN, AND THE OFFICE OF VERDERER

BY

M. W. COLCHESTER-WEMYSS, J.P., D.L.

The ancient Court which is still held at the Speech House every forty days is called the "Court of Attachments," and its members "Verderers."

The Verderers owe their first institution to the oldest known Charta de Foresta, proclaimed by King Canute at a meeting held at Winchester in 1016. By this old Charter, King Canute appointed (with the advice "*primariorum hominum meorum*") four men in each of his Royal Forests, who were to have regal powers ("*regalem protestatem*") save when the King himself was present, in matters relating to vert and venison, "as well over the Danes as over the Angles." Each Verderer was to receive annually for his services two horses, one with, one without a saddle, one sword, five spears, one javelin, one shield, and 200 shillings in silver. In order to sustain their authority it was decreed that, if any man offered force to a primarius, he was, if a freeman, to lose his liberty and his goods, if he were villein he was to lose his right hand; and for a second offence the penalty was death.

This old Charter is quoted by Manwood as being "very barbarously translated out of the Danish tongue into Latin," but, he adds, in a note, that "my Lord Coke bids us beware how we give credit to it."

After this there were several Charters issued by the Norman Kings, but the chief appears to have been one issued in the ninth year of King Henry the 3rd, and this Charter for long regulated the Royal Forests. This Charta de Foresta summarises the preceding Charters, describes all the officials connected with the Forest, and their several duties; it clearly defines the then existing Forest laws, the Courts of the Forest, and the many quaint rights, privileges, and onerous restrictions connected with the King's and also private Forests.

There were four Verderers for every Royal Forest, and they were elected then as now, by the votes of all the Freeholders in the County within which the Forest lies. Every Freeholder in the whole County can vote, and the Sheriff must, in case of a contest, keep open the poll as long as he thinks reasonable.

There is a great similarity between the form of appointment of a Coroner and that of a Verderer, the former having to hold an inquest when any of the King's subjects has met his death by violence or mischance, and the Verderer having to investigate the circumstances if one of the King's deer was found " killed or sore wounded." If the deer was killed by an arrow, the Verderer was allowed to retain the arrow as his perquisite.

A Verderer is described as "A judicial officer of the King's Forest, chosen by the King's Writ in the county in which the Forest is, men of good account, ability and living, wise and discreet men, well learned in the laws of the Forest."

Their duties were to have charge of the vert and venison, as to which Manwood says, " Every Forest hath two ornaments which doth grace and decorate the same, and which are, as it were, the only beauty of a Forest, and the want of either of them doth in short time not only deface or blemish a Forest, but doth make a Forest to be no Forest at all. The first of which ornaments is called *vert*, and the second is called *venison*." He then wanders off into a lengthy disquisition as to the relative importance of vert and venison, and proves to his own complete satisfaction that the former is the more important, because vert can thrive and flourish without venison, but venison is dependent upon vert for its very existence ; a superiority which is also indicated by the fact that a Verderer's symbol was an axe.

" Vert " apparently consisted of everything green that in any way contributed to the sustenance of venison ; and " venison " included the five beasts of venery—the Hart, the Hind, the Hare, the Boar and the Wolf, and also the five beasts of the chase—the Buck, the Doe, the Fox, the Martron, and the Roe. Beasts and fowl of warren were apparently not included.

The ancient Courts of the Forest were three in number: (1) the Court of Attachments; (2) the Swanimote Court; (3) the Court of the Chief Justice in Eyre. The last of these has since 1824 ceased to exist altogether, and the second court has been merged in the first. This, the Court of Attachments, was always held every forty days. At it the Verderers attended and entered on their rolls all presentments made by the Foresters, Regarders, and other Forest officials. The Swanimote Court was held three times a year, "15 days before Michaelmas; about the Feast of St. Martin; and 15 days before the Feast of St. John the Baptist." Manwood says all the Freeholders within the Forest owed "suit and service" to this Court, and that it was so called "because this word, mote, in Norman speech is properly called a Court, and this word Swaine in the Saxon's speech, is a Bookeland-man, which at this day is taken for a Charterer, or a Freeholder." At this Court the Verderers were the judges, but they could inflict no penalty where the damage done exceeded 4d. In other cases they heard the charge, and if they held that the charge was proved they presented the offender to the third Court, the Court of the Chief Justice in Eyre, which was a High Judicial Court, assembled within the Forest once every three years, by Order of the Lord Chancellor. At this Court all offenders presented by the Swanimote Court were sentenced, and many other matters relating to the Forest were enquired into and adjudicated upon by the Lord Chief Justice in Eyre, who was said to be "commonly a man of greater dignity than knowledge in the Laws of the Forest," and there were therefore associated with him Assessors as the King might appoint.

Manwood, who wrote in 1665, says quaintly enough, "If any man chance to be bidden to his friend's house to eat his part of fat venison, let him remember this old verse:—

> "It is not to be enquired whence venison cometh,
> For if by chance it stolen be,
> A good belief sufficeth thee."

Thus, in his day, the Forest laws had lost most of their stringency, and the only Court that is still held, the only link with a very picturesque, but very barbarous part of English

Mediæval life, is the Court of Attachments[1]. This is still held at the Speech House by the Verderers, every 40 days, but they rarely have other duties to perform than to adjourn the Court for 40 days—although cases with regard to encroachments on the Forest can be brought to them, and the signature of two of their number is necessary on the Conveyances of small pieces of accommodation land—and they no longer receive the ancient emoluments of horses, swords and spears, nor even the 200 shillings.

1 The Court now (1914) consists of M. W. Colchester-Wemyss, Charles Bathurst, W. C. Nigel Jones, and Sir Francis Brain—*Verderers; The Deputy-Surveyor of the Forest;* and J. W Guise—*Steward*

NOTES ON HELOSCIADIUM

BY

Rev. H. J. RIDDELSDELL, M.A.

Helosciadium is a genus of umbelliferous plants, very closely allied to *Apium*, the common Celery, and often included in one genus with it. It is represented in the British Isles by four species only, of which one has but doubtful claims to specific rank, as it is (in all probability) a hybrid between two other species. Like the Celery, all our *Helosciadiums* are normally waterside or water-plants, *though they are often to be found in spots temporarily dried up ;* this last fact has an important bearing upon the contents of this paper.

Botanically, the group is characterised, among the *Umbelliferæ*, by having the sutural side of the seed flat (*i.e.*, the side by which one half of the complete fruit is united to the other half) ; by having compound umbels, each consisting of a number of rays or umbellules, the number of which is in *Helosciadium* sometimes of critical importance ; its carpels (or half-fruits) have only five true ridges on the surface, and their sutural sides are about as large as each of the other four sides. As often happens in *Umbelliferæ*, the flowers are very small, with practically no calyx, and with tiny round white or cream coloured petals with an acute point.

H. nodiflorum, Water-parsnep or Marshwort, is the species of this group which is most familiar to us down South : and, no doubt, in Britain as a whole it supplies a far larger number of individual plants, as well as localities, than does *H. inundatum*. But the distribution is peculiar : it thins out Northward very much, being of limited occurrence in Scotland. *H. inundatum* thus actually occurs in more counties (in the proportion of about 6 to 5) than the commoner species, for it is the more widespread of the two.

A lengthy technical description is unnecessary, for *H. nodiflorum* is familiar as a ditch plant. It is often mistaken for watercress. There is at some stages a certain resemblance in foliage between the two plants, but none, I should think, in the taste. Syme says that both are harmless.

The points in *H. nodiflorum* which will form the basis of my remarks here, are two:—1st, the variety of its habitats, 2nd, the extreme variability of its forms.

Habitat.—It is always a plant of watery places, though its foliage and inflorescence are almost always raised above the surface of the water. Its favourite spot is some deepish rather shaded ditch, which normally has several inches to a foot of water; but almost any fresh-watery spot will do; rough, swampy ground, either shaded or occupied by a good deal of varied low-growing vegetation; muddy margins of ponds; parts of grassy or heathy hillsides which are wet in winter and dry in summer; the damper parts of the flat sandy ground which usually backs sand dunes, and which completely dries up in an ordinary summer, however damp it may be in winter. Its roots are probably always within easy reach of water, even if the surface of the ground is dry.

The forms of this species are numerous and puzzling. In 1906 Mr E. G. Baker and I wrote a paper on those which occur in Great Britain, confining ourselves to those which have been actually described and named as varieties. There is the large common ditch-form, named var. *vulgare* F. Schultz, running to a yard or more in height, robust, with large pinnate leaves, largest where they spring in tufts from the root, and with nearly sessile umbels of many rays; the fruit is longer than broad, and very dark brown, almost black, in colour. Next comes var. *ochreatum* of de Candolle, which has a stem rooting more freely at the joints, rather narrower leaflets, and rather longer stalks to the umbels; it is a smaller and slenderer plant. Var. *pseudo-repens* of H. C. Watson is a very small slender plant, which roots *freely* at the nodes, has longer-stalked umbels, and few small roundish bluntly-toothed leaflets. Var. *longipedunculatum* F. Schultz is a long slender weak plant, rooting a good deal at the nodes, and having unusually long internodes. More will be said of this variety later on. (See *Journal of Botany*, 1906, p. 185.)

Since this paper was published, I have examined many hundreds of herbarium specimens, and, what is more important, studied the species frequently in the field. Certain conclusions have slowly formed in my mind as a result of this study. The first is that the varieties already mentioned represent *only a few out of numerous forms, all equally capable of description*, which the species assumes. The varieties named happen to have been pitched on by collectors in past years, *and described:* and so they have got into our handbooks. They represent, in fact, certain stages, or steps, or extremes, of variation in a few directions, but leave the student uninformed of the large variety of directions and degrees in which the species varies. The number of characters in which variation occurs is, of course, great; *e.g.*, size of plant, vigour, compactness, production of roots or rootlets at the nodes, direction of stems or branches (*i.e.*, prostrate, ascending, etc.), shape and number of leaflets, length of peduncle, presence and number of involucre-bracts, number of rays in umbel, and so on. The degree of variation in each of these characters, again, differs considerably. Now it is a fact that a large number of the possible combinations of these variations of character may be found in a long series of specimens; and if you were to describe and name every distinct form, you would not exhaust your opportunities for making and naming new varieties, and adding your name as author, under a very large number. The forms of the plant, in fact, are "legion."

A second conclusion is this: that you can often find *upon one plant, springing from one root, more than one of these distinct forms*. Here are some of the facts which bear out this statement. Take such a character as that of "rooting at the nodes." *H. nodiflorum* normally consists of a root from which a more or less upright flowering stem proceeds; and there are numerous nearly prostrate side stems or branches from the root, each of which may both flower and root. Such a plant was one I gathered last year in a wet spot on shingly ground at the foot of the cliffs at Beachley. The rooting character may be present in all the side stems, of course, at the nodes only; even if for any reason the stems or branches are not actually prostrate, if, *e.g.*, they are carried up a hedge, or held up among herbage, they often show little embryo roots or processes which, in contact with the ground, might develop their true character. It is quite common for the signs of rooting to extend to the end of the branch, though apparently sometimes with omissions in the middle. But sometimes these side stems, even if prostrate on bare ground, show no evidence of the rooting character. Again, on different flowering branches of one and the same plant, the rooting character is strongly present and nearly absent, at the same moment. At one time, I thought the rooting character a means of diagnosing the soil rather than the variety of *H. nodiflorum*, but that opinion now appears to me at variance with actual facts. It seems impossible at present to explain the variations of this feature.

Other characters, *e.g.*, length of peduncle and shape of leaflet, are as untrustworthy as that of "rooting," for purposes of critical diagnosis. The form taken by the species is very largely determined by the surrounding vegetation, and by the amount of water present. It is a common thing to find the same series, or even the same plant, changing suddenly from the small—or medium—leaved form, with its compact foliage and low growth, as it runs among the open grass by a tiny rill, to the large ditch form, with its tufts of great upright leaves, and large coarse stems and branches: the change being due only to the shade of a copse or bramble.

In 1913, early in the summer, I found a large, rather coarse, form growing by the side of a pond near Llandaff: it was *vulgare* F. Schultz. Later on, in August, the water had receded considerably, and left a broad, soft, muddy margin. The plants had been broken off quite short, but were shooting again from the same roots; this time the form produced was small, compact, rooting at the joints, and, in fact, very close to *pseudo-repens* H. C. Watson. The circumstances had changed in one vital respect, and the plant had consequently changed entirely in appearance.

Hence my third—though somewhat tentative—conclusion follows. It is clear that some of the supposed varieties, at any rate, are simply transient forms due to special circumstances, such as the amount of water present, the amount of shade, and the permeability of the soil; perhaps all are, though I think not. But what is abundantly clear is the desirability of growing on a large number of different forms in one garden, in order to test the question of their fundamental identity, especially if the forms are gathered from widely different localities.

My belief is that almost all the named varieties of *H. nodiflorum* are simply states due to difference of soil, water supply, and cover. They should, therefore, be altogether excluded from our British lists, or, if mentioned, should be lightly and summarily passed over as mere forms due to surrounding circumstances.

But there is one exception, *viz.*, var. *longipedunculatum* F. Schultz, which may even possibly deserve to be called a species. Schultz, indeed, has raised it to specific status as *H. palatinum*, though I am not sure that his *H. palatinum* is identical with his var. *longipedunculatum*; but, in my opinion, such a procedure depresses the rank of species inconveniently. The variety does not differ from type in characters which really have specific value.

Var. *longipedunculatum* F. Schultz, then, is a real variety, and not a "form" of *H. nodiflorum*. Its best known localities are Gullane or Guillon Links, Haddingtonshire, and Duddingston Loch, Midlothian, but it is by no means limited to these places. Herbaria contain many specimens of it, *more or less disguised*, from widely scattered localities, in Suffolk and Cambridge, but I believe that, in spite of their disguise, they are all so many forms of one thing, probably produced simply by surrounding circumstances. A very important feature of this variety is that in certain circumstances it closely simulates *H. repens*, far more closely, in fact, than any form of type *H. nodiflorum* does. English botanists, in fact, have talked of *H. repens* for many years: they have applied the name to small, compact, strongly-rooting forms of type *H. nodiflorum* which are simply caused by the shrinkage of water in a normally wet locality; they have less frequently given the name, though with much more reason, to a form of var. *longipedunculatum*. One of my chief objects in this paper is to distinguish the latter plant from true *H.*

repens. Here is a description of var. *longipedunculatum* F. Schultz. Stem very long, slender, rooting at the lower nodes, internodes long or very long ; leaves with long petioles, not nearly so erect as in var. *vulgare*. Leaflets generally 5 to 7, ovate or broadly ovate, coarsely serrate, occasionally with small lobes. Peduncle long, generally longer than the umbel-rays. Rays 4 to 7. Involucre usually present, *i.e.*, a small leaf-like process (or several of them) at the base of the rays of the umbel—a rare thing in *H. nodiflorum*.

Now, in exposed parts of some of the localities where this variety grows, *e.g.*, among short herbage, or on mud, occurs sometimes the form of it which is, as I have said, very easy to confuse with true *H. repens*, *e.g.*, at Gullane, on Port Meadow, by Oxford, etc., and which I will venture to name *f. simulans*. In essentials it corresponds to var. *longipedunculatum*, but it is small in its parts, grows prostrate, and roots at most or all of the nodes. It produces its leaves, as *H. repens* does, mostly in tufts at the rooting points of the stem, but it shades off by gradual degrees into obvious and typical *longipedunculatum*, as is proved conclusively by a long series of specimens from Gullane, and a less adequate supply from Port Meadow. Schultz's variety, in fact, behaves exactly as does type *nodiflorum* ; it is singularly susceptible to the influences of environment, and, though its variations do not form an exact parallel to those of the type, yet it actually produces clearly distinguishable forms on one root (see B.E.C. report, 1910, p. 564-5) and shades off from one extreme to another in a series in the field, which at different points finds varying amounts of cover, water, etc. And good Port Meadow *simulans* developed in garden soil into *longipedunculatum*.

To this variety I assign plants as follows :—

Nantwich, *Cheshire* ..	Hb. C. Bailey, f. *simulans*
(Tilmire, *Yorks.*	,, ,, this is doubtful)
Fakenham, *Norfolk* ..	Hb. C. Bailey
Port Meadow, *Oxon.* ..	,, f. *simulans*
Binsey Meadows, *Oxon.* ..	Hb. G. C. Druce, f. *simulans*
Foxhall, *Northants* ..	,,
Bungay, *Suffolk* ..	Hb. Kew
Bradwell, *Suffolk* ..	Hb. H. C. Watson, f. *simulans*
Sturbridge Fair Green, *Cambs.*	Hb. C. C. Babington ,,
Upware, near *Cambridge* ..	,,
Haddington, *Cambs.* ..	Coll: Prof. Glück, f. *simulans*

As well as those from *Haddingtonshire* and *Midlothian*.

This raises the question: How distinguish *H. repens* from *H. nodiflorum* var. *longipedunculatum* f. *simulans*? The crucial distinction lies in the fruit. In *H. nodiflorum* the fruit is longer than broad (an occasional fruit is as broad as long), very dark brown, almost black, with light coloured prominent ridges; its colour in section is dark. And this holds true of all the forms which I place under *H. nodiflorum*, including var. *longipedunculatum* and its f. *simulans*. But in *H. repens* the fruit is smaller, broader than long, a light pretty chestnut in colour all over, even on the ridges, and very much the same in internal section. The exposed faces of the fruit, mid-way between every two ridges, are puckered into false ridges, so that there appear to be ten ridges to *H. repens*, five of which are rather less marked than the rest.

This is not, of course, the only distinctive mark of *H. repens*. In it we have a good species; but I do not think that one permanent character, however strong, would justify us in giving it specific rank. Besides the fruit character, then, it has comparative stability of form. In a long series of continental specimens I have found hardly any (if any) which seriously depart from the strong peculiar *repens* habit, with its arching internodes, even when growing in shade. The same holds true of the plat in its occurrence at Skipwith. The description of *H. repens* is:—Plant small, slender; stem prostrate, *rooting at every node, arching*. Leaves springing erect or sub-erect from all the nodes, pinnate, total length 4-6, rarely 9 cm. Leaflets 9-11, *subrotund ovate* in outline, unequally dentate serrate, *upper and middle leaflets sometime lobed as far as the middle or slightly below, making a sub-bifid leaflet*. Peduncle of fully developed plant generally 3-4, rarely 7 cm. long, 2-3 times longer than rays of umbel. Umbel-rays generally 5-6. *Involucre of 3-7 bracts, persistent.* Inflorescence and leaves often approximately equal in length. *Fruit as above.*

It is (1) the leaflets (number and shape), (2) the constancy of the involucre, as well as (3) constancy of habit, and (4) fruit character, which, together, compel me to recognise *H. repens* as a good species. Further research will probably reveal other points.

For a long time I was doubtful whether we have true *H. repens* in Britain: nothing that could lay any claim to come under the species showed fruit; nearly everything was unsatisfactory, in some degree, in other ways. But at last, Mr G. Webster, of York, who sent me his collection of *Helosciadium* forms last year, was able to show me late gathered specimens of *H. repens* from Skipwith, E. Yorks., one of which exhibited the typical fruit of the species. It has long been known from that locality, but its identity is only now conclusively established, and the final and conclusive proof is here published for the first time. I do not certainly know any other locality for it in Britain, though it is hardly likely to be limited to one spot. There is, in fact, a specimen in Mr F. G. Hanbury's herbarium (collected by Syme, whose herbarium is incorporated in Mr Hanbury's) which in all respects except fruit comes nearer it than any other gatherings I have seen; it is from Kinghorn Loch, Fifeshire, 1870. It may also grow at Port Meadow, Oxford.

Gloucestershire is, apparently, not rich in nameable forms of *H. nodiflorum*, nor have I seen anything which could colourably be supposed to come under *H. repens*. But another species, *H. inundatum*, has more local interest. This is a small, slender aquatic plant, usually quite submerged and floating in ponds and canals, but sometimes growing temporarily in a prostrate form on drying up mud. It has normally a considerable number of tiny submerged two (or three) rayed umbels of white flowers with oblong fruit rather narrowed below, and very short or even sessile styles; its leaves are divided and subdivided into capillary segments, except those nearest the top, where the segments are wedge-shaped. The plant grows in profusion in some parts of the Thames and Severn Canal, especially in the vicinity of the Sapperton Tunnel, and it is also found in upland ponds, *e.g.*, on Tidenham Chase, at 700 or 800 ft. above sea level.

From Gloucestershire, in the Thames and Severn Canal, I have seen specimens which must be put under var. *fluitans* Fries. This variety has (I believe) never before been recorded for the British Isles; and some may doubt whether it is worth recording, now or at any time! It is simply a var. in which *all* the leaf segments are capillary. I have seen one of Fries's own specimens in the British Museum, and have no hesitation in naming our Gloucestershire specimens as this var. It grows *with* the type; between the two, intermediates occur. This variety occurs in both E. and W. Gloucestershire, and the Isle of Wight (Hb. Bailey). I have seen a specimen from Cumberland in the same herbarium which is very near it. In Ireland it occurred near Connor Hill, Kerry (Coll. D. Oliver, 1853), in the R. Ma'am, Galway (Hb. Shoolbred), R. Clare, at Tuam, Galway (Hb. Praeger), and Mr Bailey has a specimen from Connemara, Galway, which must be put under the variety.

H. nodiflorum and *H. inundatum* our two common species, inhabit, as we have seen, very similar localitites. The latter is more confined and limited in its choice of watery spots; it particularly affects slow moving and fairly free waters like canals, or ponds on upland heaths. It cannot do with as many competitors as the strong *H. nodiflorum*. But the two, nevertheless, often appear in close proximity, especially in the slow waters of low lying districts. This is markedly the case in certain parts of the Eastern and E. Midland Counties of England, and over the whole of Ireland, except the mountainous S.-West.

Now in the very places so described occurs also a third form of *Helosciadium*, which, I believe, is a hybrid of the two, and which I described in the *Irish Naturalist* for Jan., 1914, under the name of × *Helosciadium Moorei* Riddelsdell. This form has been known now for 60 or 70 years, and has generally been regarded as a variety of *H. inundatum*, but recently was elevated to the status of a species by Mr Druce. It has fallen to my lot, as a result of gathering together large collections of *Helosciadium* from various botanists, in preparation for a description of them for the new Cambridge Flora, to see a very large and varied number of specimens of *H. Moorei* from nearly every known locality. I will indicate enough of my observations to lead up to one important illustration of the phenomena of hybridity.

First, it occurs frequently in Ireland, in counties Limerick, Clare, Galway, Dublin, Meath, Fermanagh, S. Donegal, Armagh, Down, Antrim, and Derry ; *i.e.*, it is most frequent in Ulster, and is unrecorded from the extreme West, and from the whole of the S.-E. of the Island. In England it is known only on the Welland at Peakirk, along the Trent at various spots in N. Lincoln, and at one place in Derbyshire, on the Canal at Renishaw.

Secondly, it constantly differs from both *H. nodiflorum* and *H. inundatum*, and it is fairly intermediate between the two. It has *e.g.* a style and foliage and general habit, as well as several minor points, which, on the whole, come just there, and it is always (I believe) found in the immediate vicinity of the two commoner species.

Thirdly, within the limits so marked out, it varies enormously ; sometimes it is much nearer *inundatum* in habit and in cut of foliage, less often very near small *H. nodiflorum.* "Taking two well-contrasted forms, say that from Tuam, N.-E. Galway . . . and that from Portumna, S.-E. Galway . . . we might illuminate the subject by naming them respectively f. *subinundatum* and f. *subnodiflorum.* The former is, indeed, much larger than most *inundatum*, and the latter smaller than most *nodiflorum.* But the foliage of the former is clearly near that of *inundatum* ; it is broader and longer in all its parts and as a whole ; capillary segments become linear, lobes are larger and broader, and even tend to merge into each other ; but it is of essentially the same character. The texture of this form is more that of a water-plant, whereas in f. *subnodiflorum* the texture reminds one of small dry land (or mud) forms of *nodiflorum.* This latter form of *Moorei* has the leaflets far less cut : in the upper leaves they are very near *nodiflorum* in character, but in the lower leaves are strongly toothed or lobed. The floral characters separate it from *nodiflorum.*"—(*Irish Nat.*, Jan., 1914, p. 7)

This and other reasons, summarised below, led me in the teeth of the opinion of better botanists than myself, especially Mr Druce, of Oxford, and Prof. Glück, of Heidelberg, to decide that the form is probably the hybrid of the two common species. My reasons are based on the usual phenomena of hybrids :—

1. "Great range of variation in habit and facies. This is remarkably impressed on the mind if a line is taken from the ordinary luxuriant Irish forms . . . through those from Derrymore, Castleconnel, and Renishaw, to the curious little form . . . from Portumna and Woodford"

2. Great variability in foliage.

3. Sterility, which apparently (fide Glück) persists even in cultivation.

4. Considerable vegetative development, at the expense of the floral development; this is in strong contrast to the two "parent" species.

5. Intermediate position between the "parents." This does not hold true of all characters, of course.

6. Neighbourhood of the "parents."

The case for hybridity is not thus proved beyond cavil, but it is strongly founded, and, I think, is strengthened by one most interesting feature, and deductions from it, with which this paper shall conclude.

The plant is sterile, and yet it is very abundant where it occurs. This is due to the fact, proved in my garden, where it grows in pots kept in a tub of water, that it propagates itself vegetatively. Broken off pieces of leaf take root and form separate plants, as occurs *e.g.* with *Cardamine pratensis*, etc.

Now, if it reproduced itself by *seed*, the off-spring from the seed would, according to Mendel's principle, vary much in character, and always in certain well-defined directions and proportions. But as it is reproduced vegetatively, it is *in any one locality* singularly homogeneous. The conclusion is that the whole of a local stock generally springs from one original hybrid plant, whose characters are thus reproduced faithfully in all its "vegetative" off-spring. But there are one or two exceptions to this rule: one of them is found at Haxey, N. Lincoln, where the species was gathered by G. Webster in 1881 and 1884. Here it is very variable, both in cut of leaves, and in length of style, though the specimens are all on the small side. Some are very near *inundatum*; but capillary segments of the lower leaves are not to be found; and they are all *Moorei*. This variability at Haxey "means probably (if the hybrid explanation is right) that in most localities the stock has originated from one crossing, which has been propagated vegetatively only, but at Haxey there have either been several original hybrid-plants (differing from each other), all of which have been reproduced vegetatively, or else the plant produces fruit ; or it may be that the hybrid has crossed with one of the parents, perhaps more than once." (*Irish Nat.*, Jan., 1914, p. 8).

My (tentative) arrangement of the British *Helosciadia* is as follows :—

Helosciadium nodiflorum Koch.
f. vulgare.
f. ochreatum.
f. pseudo-repens.
Var. *longipedunculatum* F. Schultz.
f. simulans.
H. repens Koch.
×*H. Moorei* Riddelsdell.
f. subnodiflorum.
f. subinundatum.
H. inundatum Koch.
var. fluitans Fr.

But as the genus *Helosciadium* is by English Botanists usually grouped with *Apium*, it is as well to publish the same list under that genus, in order that under either generic name, the responsibility may belong to the right person. Hence we have :—

Apium nodiflorum Reichb. fil.
f. vulgare.
f. ochreatum.
f. pseudo-repens.
Var. *longipedunculatum* F. Schultz.
f. simulans.
A. repens Reichb.
×*A. Moorei* Riddelsdell.
f. subnodiflorum.
f. subinundatum.
A. inundatum Reichb. fil.
var. *fluitans* Fr.

A DEEP BORING AT CHAVENAGE, NEAR TETBURY, GLOUCESTERSHIRE

BY

L. RICHARDSON, F.G.S.

In 1893-94 a deep bore-hole, roughly of 8 inches diameter and 383 feet deep, was put down near Chavenage House—a mile and three-quarters north-west-by-north of Tetbury Church.

As Chavenage is situated upon the Forest Marble, it is obvious that a bore-hole of such a depth is of considerable interest to students of the Jurassic rocks, because it should throw light upon the thickness of the Great Oolite, Fullers' Earth, and Inferior Oolite in this part of the Cotteswold Hills.

Mr G. Lowsley-Williams, of Chavenage House, most readily acceded to my request for the loan of the section of the rocks passed through by the bore-hole, which had been made by Mr Thomas Holloway, F.G.S., of Chippenham, Wilts., and has very kindly given me permission to publish it.

The geological information given in this section, however, is not very detailed.

As already remarked, Chavenage is situated upon the Forest Marble Series. In Mr Holloway's section the first 39 feet of rocks passed through is assigned to this Series.

The beds from 39 to 158 feet down are labelled "Great Oolite and Stonesfield Beds."

I am inclined to think that the

63 feet of rock from 39 to 102 feet = the ordinary Great Oolite limestones, of which 60 feet were proved in the Kemble bore-hole,[1]

and that the

56 feet of rock from 102 to 158 feet = the "Passage-Beds" of the Kemble bore-hole. The Fullers' Earth—according to

[1] Proc. Cotteswold Nat. F.C., vol. xviii., pt. 2 (1913), pp. 185-189.

Mr Holloway's section—extends from 158 feet down to 246 feet, and the Inferior Oolite from 246 feet down to 380 feet. The bore-hole then penetrated 3 feet of "strong clay; sample not seen."

The "strong clay" is probably the top-portion of the Upper Lias. The Upper-Lias Sands, or "Cotteswold Sands" as they are called in the Cotteswold country, ordinarily immediately underlie the Cephalopoda-Bed, which, in Mr Holloway's section, is obviously included in the Inferior Oolite. The Kemble bore-hole showed that a large amount of argillaceous material was there associated with the sand; but the composition of the deposit, even then, would not have justified the use of the term "strong clay" wherewith to describe it. However, under Chavenage, there may be a thin clay-bed at the top of the Upper Lias, as is the case at Crickley Hill, near Cheltenham[1].

Mr Lowsley-Williams informs me (*in litt.*) that "the supply of water is ample, and even with a steam pump has proved sufficient, the tank holding about 12,000 gallons."

In the following table the thickness of the beds as ascertained by the bore-holes at Kemble Station, Tetbury Water Works (Blind Lane), and Chavenage, are tabulated:—

	Kemble [1]	Tetbury	Chavenage
Forest Marble		Rem.[2] 25 ft.	Rem. 39 ft.
Great Oolite	Rem. 60 ft.	109 ,,	63 ,,
"Passage-Beds"	48 ,,	42 ,,	56 ,,
Fullers' Earth	73 ,,	76 ,,	88 ,,
Inferior Oolite	117[4] ,,	Pen.[3] 48 ,,	134[4] ,,
Upper Lias	Pen. 54½ ,,		Pen. 5 ,,

1 Described, Proc. Cotteswold Nat. F.C., vol. xviii., pt. 2 (1913), pp. 185-189.
2 "Rem." = Remaining. 3 "Pen." = Penetrated.
4 This thickness includes the Cephalopoda-Bed, which, at Kemble, is 6 feet thick.

On page 245 is given an analysis of a sample of water from the Chavenage bore-hole, together with analyses of samples from Tetbury, Kemble, Westonbirt and Sherston, for purposes of comparison.[2]

1 Proc. Cotteswold Nat. F.C., vol. xv., pt. 3 (1906), p. 184. Compare also Doulting railway-cutting section, Quart. Journ. Geol. Soc., vol. lxiii. (1907), p. 390.

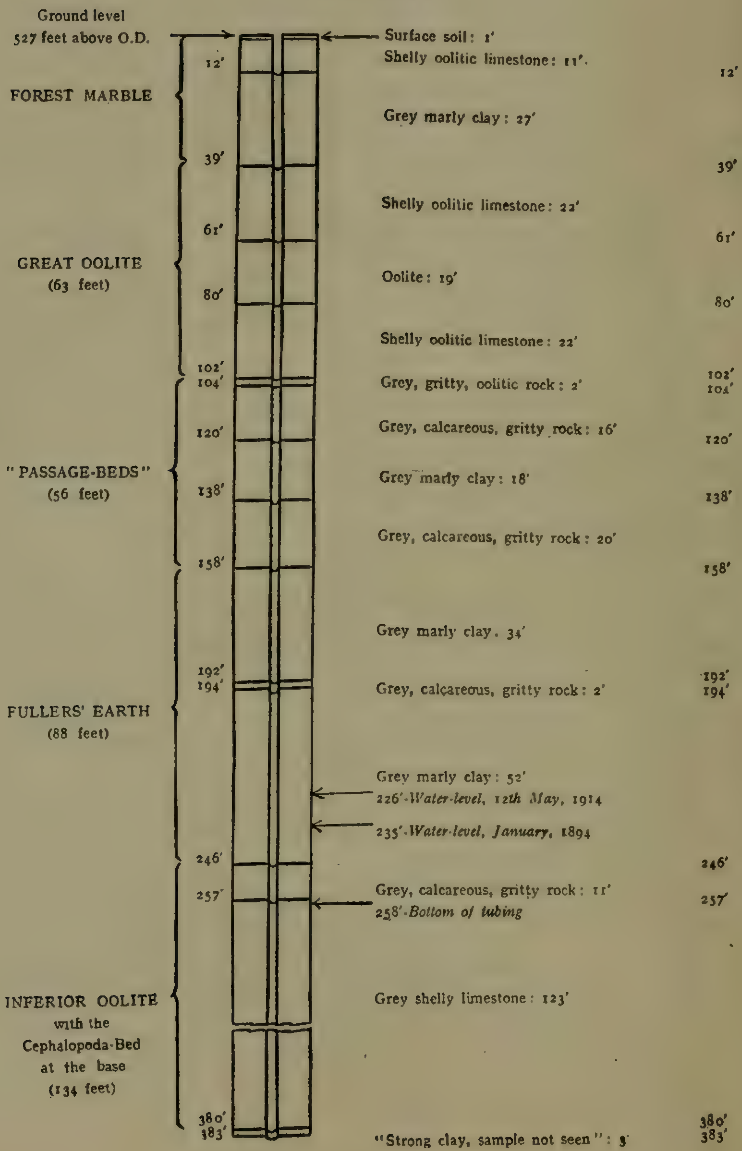
2 I am indebted to Dr J. Middleton Martin, County (Glos.) Medical Officer of Health, for very kindly supplying me with these analyses.

ANALYSES OF SAMPLES OF WATER FROM THE TETBURY DISTRICT.

	Chavenage[1] (G. Embrey 6. vii. 1914)	Tetbury[2] (Dr. P. Frankland 1892)	Tetbury[3] (G. Embrey 16. x. 1913)	Kemble[4] (W. R. Bird 9. xi. 1911)	Westonbirt[5] (G. Embrey 28. iii. 1914)	Sherston (W. J. Read 22. iv. 1914)
TOTAL SOLIDS	45	36·84	36	30·7	35	52
Organic carbon	—	·095	·03	—	—	—
Oxygen absorbed	·021	—	—	—	·05	·02
Free ammonia	abs.	·010	·001	—	abs.	·003
Organic ammonia	·003	—	·005	—	·012	·001
Organic nitrogen	—	·032	—	—	—	—
Nitrogen as nitrates	abs.	·247 (nitrates and nitrites together)	·41	—	·5	trace
Nitrogen as nitrites	abs.		abs.	—	abs.	nil
Total combined nitrogen	—	·287	—	—	—	—
Chlorine	1·7	1·0	1·6	1·07	1·3	15·5
Alkalinity as chalk	—	—	—	21·0	—	—
HARDNESS: Temporary	15·6	24·8	16·6	12·2	14·5	9·5
Permanent	2·0	5·2	4·4	6·0	3·3	7·8
Total hardness	17·6	30·0	21·0	18·2	17·8	17·4

1 Chavenage-House Bore-hole. 2 Bore-hole at the Urban District Council's Water-Works, Blind Lane. 3 Brewery Well (Hampton Street). 4 Kemble Junction Bore-hole. 5 Westonbirt-House supply.

CHAVENAGE HOUSE BOREHOLE
(1893–1894)



A BORING IN THE LOWER LIAS AT WALLSWORTH HALL, NEAR GLOUCESTER.

BY

L. RICHARDSON, F.G.S.

In 1911-12 a boring was put down at Wallsworth Hall—the residence of J. T. Dorrington, Esq., J.P., about two and a half miles north-by-east of Gloucester—in the Lower Lias, in search of water.

At the time there were three wells at the Hall, respectively 20, 22, and 24 feet deep; but the water from the first, that near the south-eastern angle of the house, was so hard that it could not be used for domestic purposes. The yield from the other two wells proving inadequate—especially in the very dry weather—it was desired to augment the supply. The only chance of doing so lay in sinking a bore-hole, but it was realized at the outset that while a satisfactory supply as respects the quantity desired might be obtained, it was likely to prove very hard and possibly mineralized.

From a geological standpoint the proposed enterprise was interesting, because it would throw additional light upon the thickness of the Lower Lias near Gloucester. Under the City it has long been known that it is of great thickness, for a bore-hole put down at what was then Messrs. Robertson & Co.'s Brewery, but is now the milk depôt of the Gloucester Farmers Ltd., Westgate Street, in 1883, proved 350 feet 6 inches of Lias, and when it was abandoned the late Robert Etheridge considered that it had reached only into the

> "lower bed of the *Bucklandi* [-Zone], and he expressed himself confident that if the boring were continued, in 80 feet the Rhætics would be passed through . . . ."[1]

1 Proc. Cotteswold Nat. F.C., vol. viii., p. 215.

Below the Bucklandi-Beds come, in descending order, the

Lias, Lower	..	*Angulata*-Beds *Planorbis*-Beds *Ostrea*-Beds
Rhætic		Upper Lower
Keuper, Upper		Tea-green Marls Red Marls

The *Angulata*-Beds are very rich in specimens of *Lima gigantea* (Sowerby). When a tank was constructed in the field to the north-east of the Hall many specimens of this shell and of *Gryphæa arcuata* (Lamarck) were found. Therefore, Wallsworth Hall is situated upon the *Angulata*-Beds of the Lower Lias.[1]

In Murchison's "Outline of the Geology of the Neighbourhood of Cheltenham" (2nd edition, by H. E. Strickland and James Buckman, 1844, pp. 45-46), these beds are called the *Plagiostoma*-Beds, and are stated to be traceable

> "along the sides of the Lias escarpment more than 100 feet above the Red Marl."

It was thought that the greatest quantity of water was likely to be encountered in the bottom portion of the Lower Lias, where limestone-beds are numerous and close together.

A 4-inch percussion bore-hole was put down to a depth of 170 feet. Progress was slow because of the very tough nature of the Lower Lias clays and limestones.

From a geological standpoint the interesting fact is that at a depth of 170 feet the bore-hole was still in the Lower Lias : it had not reached the Upper-Rhætic marls, etc.

A satisfactory quantity of water was obtained, and a well 40 feet deep and 9 feet in diameter was sunk, so that now there is this well with a 4-inch bore-hole 130 feet deep from its bottom.

1 The *Birchi*-Beds were proved when the well at the pump in Down Hatherley village was sunk. The fossils collected included *Ammonites* (*Arnioceras*) *miserabilis* Qu., *Amm.* (*Agassizoceras*) *sauzeanus* (d'Orb.), *Gryphæa arcuata* (Lam.), *Lima*, *Pecten* (*Chlamys*), *Rhynchonella* and *Spinferina*—an assocation similar to that obtained in the equivalent beds alongside the Gloucester and Sharpness Canal between Sym's and Lower Rea Bridges (*vide* Proc. Cotteswold Nat. F.C., vol. xviii., pt. 2 (1913), p. 110).

The *Microceras-subplanicosta*-Beds were proved one and a quarter miles south-by-west of the well in Down Hatherley at the outfall works of the Churchdown Sewage Works. Here the section was

Alluvial	Brown clay and sand, mixed: 2 to 3 feet. Brown clay and small well-rolled gravel (Lias and Inferior-Oolite limestones) and sand-grains: 1 foot.
Lower Lias	Blue clay; *Microceras subplanicosta* (Oppel) (common), belemnites, *Gryphæa arcuata* (Lam.)

ANALYSES OF SAMPLES OF WATER FROM THE BORE-HOLE AT WALLSWORTH HALL, NEAR GLOUCESTER

By G. EMBREY, F.I.C., F.C.S.

	Sample from 40 ft.	Sample from 50 ft.	Sample from 60 ft.	Sample from 170 ft.
PARTS PER 100,000				
Total solid matter	776	960	540	730
Combined chlorine	150	200	90	110
Nitrates (nitrogen as)	absent	absent	absent	absent
Nitrites	absent	absent	absent	absent
Mineral ammonia	·04	·076	·092	·032
Organic ammonia	·021	·012	·019	·019
Oxygen required for combustion of organic matter	·083	·055	·138	·143
HARDNESS IN DEGREES				
Permanent	60·9	62·3	63·0	24·5
Temporary	39·2	39·2	37·8	38·5
Total	100·1	101·5	100·8	63·0
COMMON SALT (grains per gallon)	173	230·7	103·8	127

The water—as anticipated, and as the above analyses reveal—has proved very hard, but it has been possible to satisfactorily soften it.

NOTE ON A DEEP BORING AT GLOUCESTER

BY

L. RICHARDSON, F.G.S.

It has long been known that the Lower Lias is very thick beneath Gloucester, and that any attempts at boring to obtain a satisfactory supply of water as regards quantity and quality are not likely to meet with success. Nevertheless, it is very desirable that particulars should be kept of all attempts.

The object of this note is to record the fact that a deep boring—between 400 and 450 feet—was put down about two years ago at Messrs Moreland and Sons' match-factory in the Bristol Road, Gloucester—near the Gloucester Wagon Works. Mr Philip Moreland is, unfortunately, not acquainted with the particulars of the trial. All he knows is that the depth was between 400 and 450 feet, that it was in clay "all the way" (very little rock being encountered), and that "the required and guaranteed quantity [of water] per hour" was not obtained.

The precise date of the clays on which the factory is built is not known, but it is either of late *oxynoti*, *raricostati* or early *armati* hemera. From clay dug out of an excavation made to receive the foundations of a new chimney, Mr Charles Upton obtained specimens of a *Rhynchonella* belonging to the same species as examples of a *Rhynchonella* found not uncommonly in the equivalent beds at the Gas Works, Gloucester; foraminifera of the forms that are usually met with in the clays of this date in the neighbourhood, and spicules of *Chirodota*—9 and 10-rayed.

THE CHRONOLOGICAL SUCCESSION OF THE ECHINOID-FAUNAS IN THE INFERIOR-OOLITE ROCKS OF THE STONESFIELD—BURTON-BRADSTOCK DISTRICT

BY

LINSDALL RICHARDSON, F.R.S.E., F.G.S.

I have now done all that I intend doing in connection with the echinoids from the Inferior-Oolite rocks of the district between Stonesfield, in Oxfordshire, and Burton-Bradstock, on the Dorset coast.

The first instalment of the information collected by Mr E. Talbot Paris and myself was published in August, 1908,[1] and the second in April, 1913.[2] Since the latter date I have re-visited the Burton-Bradstock district on three occasions. Only a few additional records were made.

The accompanying list shows the species of echinoids that have been obtained from the deposits of *fuscæ-aalensis* hemeræ inclusive.

With the exception of the specimens marked with an asterisk, Mr Paris or I collected from the horizons indicated examples of all the species recorded. They were identified with the aid of Wright's well-known Monograph (Palæont. Soc.).

The whole of my collection of Echinoids from the Inferior Oolite Series is now in the British Museum (Natural History).

1 Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908), pp. 151-190, and pls. xvi. and xvii. In the list on page 158 of this paper of "forms common to both districts," records from the Top-Beds of Dundry Hill were considered in connection with the Doulting—Burton-Bradstock district. In the present paper, Dundry Hill so far as its "Top-Beds" are concerned, is associated with the Doulting—Stonesfield district, so that *Cidaris wrighti* Desor, *Holectypus depressus* (Leske), and *Magnosia forbesi* Wright will have to be deleted.

Lines 4-6 on page 159 of the 1908 paper should be revised to: "Except for these three echinoids *and Pseudodiadema* [*Trochotiara*] *depressum* Ag., the other species which are given in the above list are confined to beds of *garantianæ, and* post-*garantianæ* date . . . . ." The words in *italic* are additions.

In Table iv., on page 160, *Clypeus hugi* Ag. should be deleted, as it has now been recorded from both districts. "*Hyboclypus ovalis* Wr.," under the heading "Bajocian" must be replaced by *Galeropygus* sp. (see Proc. Cotteswold Nat. F C., vol. xviii., pt. 1, 1912, pp. 79 and 80).

2. Proc. Cotteswold Nat. F.C. vol. xviii., pt. 1 (1912), pp. 73-82 and pl. viii.

TABLE I.—THE CHRONOLOGICAL SUCCESSION OF THE ECHINOID-FAUNAS.

BURTON-BRADSTOCK—DOULTING DISTRICT.[1]		DOULTING—STONESFIELD DISTRICT.
	fuscæ	
Collyrites ovalis (Leske), Common and large. *Holectypus hemisphæricus* (Agassiz), Common. —— —— var. *conica* Wr. *Pygorhytis ringens* (Agassiz).	zigzag	*Collyrites ovalis* (Leske). *Pygorhytis ringens* (Ag.)
Acrosalenia sp. Radiole. Cf. Wright, Monogr., pl. xvii., fig. 10. —— *spinosa* Agassiz. *Cidaris bouchardi* Wright. —— sp. Near to *C. bouchardi* Wr., but smaller. —— cf. *yeovilensis* Wright.[2] Radiole. *Clypeus agassizi* Wright. —— *altus* M'Coy. —— *hugi* Agassiz. *Collyrites ovalis* (Leske). *Holectypus hemisphæricus* Ag. Common. —— —— var. *conica* Wright.	*schlœnbachi*[3]	*Acrosalenia spinosa* Ag. *Cidaris* sp. Radiole. *Clypeus agassizi* Wr. —— *ploti* auctt. (= *C. sinuatus*(Leske).) —— *hugi* Wr. *Collyrites ovalis* (Leske). *Echinobrissus clunicularis* auctt. *Holectypus depressus* (Leske). Common. —— —— var. *conica* Paris. —— *hemisphæricus* Ag. —— —— var. *conica* Wr. *Pedina rotata* Wright. *Pygaster macrostoma* Wright. **Pygurus michelini* Cotteau. Very rare. *Stomechinus bigranularis* (Lamarck).

1 Records from the deposits of *garantianæ* and *post-garantianæ* date of Dundry Hill are included in this list because the "Top-Beds" of that locality are similar to the "Top-Beds" of the Radstock-Midford-Bath district. The records from the Burton-Bradstock-Doulting district do not include any from the neighbourhood of Doulting. Those from Doulting are included in the list of specimens from the Doulting-Stonesfield district.

2 The precise horizon of the type of this species is not known.

3 It is not always possible in the Burton-Bradstock-Crewkerne district to determine the precise date of the limestones between the deposits of *garantianæ* and *zigzag* hemeræ. It is either *truellei* or *schlœnbachi*, but so far as the records in this table are concerned specimens of all the species indicated to have lived during the *truellei* and *schlœnbachi* hemeræ have been obtained from rocks undoubtedly of these hemeræ. In the North Cotteswolds the upper-third of the *Clypeus*-Grit may be regarded as of about *schlœnbachi* date: the lower two-thirds of *truellei*. It has been deemed desirable to keep the records from the Upper Coral-Bed district.

BURTON-BRADSTOCK—DOULTING DIST. (*cont.*)		DOULTING—STONESFIELD DISTRICT (*cont.*)
Hyboclypus gibberulus Agassiz. *Pygorhytis ringens* (Agassiz). *Stomechinus bigranularis* (Lamarck). ? *Rhabdocidaris*. Radioles: two forms. *Trochotiara depressa* (Agassiz).	*schlœnbachi* (cont.)	*Trochotiara depressa* (Ag.)
Cidaris bouchardi Wr. *Clypeus agassizi* Wr. —— *altus* M'Coy. *Collyrites ovalis* (Leske). *Diplopodia pentagona* M'Coy. [**Hemicidaris pustulosa* Agassiz. Horizon doubtful. See Proc. Cotteswold Nat. F.C., vol. xvi., p. 171.] *Holectypus hemisphæricus* (Ag.). Common. —— —— var. *conica* Wr. *Hyboclypus gibberulus* Agassiz. —— cf. *ovalis* Wright. *Pygorhytis ringens* (Agassiz).	*truellei*	*Acrosalenia spinosa* Agassiz. *Clypeus agassizi* Wr. —— *hugi* Ag. —— *ploti* auctt. *Collyrites ovalis* (Leske). —— —— var. *depressa* Paris. *Diplopodia pentagona* M'Coy. *Echinobrissus clunicularis* auctt. —— *richardsoni* Paris. *Holectypus hemisphæricus* (Ag.). Rare. —— —— var. *conica* Wr. *Hyboclypus gibberulus* Ag. *Pedina rotata* Wright. *Pygaster macrostoma* Wright. [**Cidaris confluens* Wright *ex* Forbes MS.: *truellei* or *schlœnbachi*.]
	early *truellei*	UPPER CORAL BED. *Acrosalenia pustulata* Forbes. *Cidaris bouchardi* Wr. *—— *fowleri* Wr. Dundry Hill: E. Wilson.[1] **Clypeus agassizi* Wr. var. *conica* Paris. —— *hugi* Ag. —— —— var. *conica* Paris. *Garantianæ* or *truellei* *Diplopodia pentagona* M'Coy. *Echinobrissus clunicularis* auctt. *Hemicidaris granulosa* Wright. —— cf. *luciensis* d'Orbigny.

1 Inserted on the authority of E. Wilson, Proc. Bristol Nat. Soc., vol. viii., pt. 2 (1896-97), table ii., facing page 212.

Burton-Bradstock—Doulting Dist. (*cont.*)		Doulting—Stonesfield District (*cont.*)
	early *truellei* (cont.)	**Hyboclypus ovalis* Wr.[1] *Magnosia forbesi* Wr. *Pedina rotata* Wr. *Polycyphus normannus* Desor. **Pygorhytis ringens* (Agassiz).[1] **Stomechinus bigranularis* (Lam.).[1] —— *intermedius* (Ag.) —— —— var. *germinans* Phillips.
Cidaris bouchardi Wr. *Clypeus agassizi* Wr. —— *altus* M'Coy. *Collyrites ovalis* (Leske). *Echinobrissus clunicularis* auctt. *Holectypus hemisphæricus* (Ag.) —— —— var. *conica* Wr. *Hyboclypus* cf. *ovalis* Wr. —— *subgibberulus* Rich. and Paris. —— *woolstonensis* Rich. and Paris *Stomechinus bigranularis* (Lam.). *Garantianæ* or *truellei*	*garantianæ*	*Acrosalenia spinosa* Ag. *Diplopodia pentagona* M'Coy. *Holectypus depressus* (Leske). —— *hemisphæricus* (Ag.) Very rare. *Hyboclypus* cf. *ovalis* Wr. ? *Garantianæ*. See Proc. Cotteswold Nat. F.C., vol. xviii., p. 79. *Magnosia forbesi* Wr. *Pedina rotata* Wr. *Polycyphus normannus* Desor. *Pseudopedina smithi* (Forbes). *Garantianæ* or *truellei*. *Pygorhytis ringens* (Ag.) *Stomechinus intermedius* (Ag.)
	niortensis	
	blagdeni	
**Diplocidaris* sp. Radiole. Dundry Hill: E. Wilson[1]	*sauzei*	

1 See footnote on preceding page.

? *Diplocidaris* sp. Radiole. Nearest to the specimen figured by Wright in Monogr., pl. xvii., fig. 12.	*witchelliæ*	*Galeropygus* aff. *agariciformis* Wright.
	shirbuirniæ	*Galeropygus* aff. *agariciformis* (Wr.) Proc. C.N.F.C., vol. xviii., p. 78.
	post-discitæ	*Galeropygus* sp.[1] —— aff. *agariciformis* (Wr.)[2]
	discitæ	*Echinobrissus clunicularis* auctt. *Hyboclypus caudatus* Wr. *Stomechinus intermedius* (Ag.). Very rare.
	concavi	*Hyboclypus harfordensis* Paris. Harford Sands.
Galeropygus aff. *agariciformis* (Wr.)	*bradfordensis*	*Acrosalenia lycetti* Wr. Oolite Marl. *Echinobrissus clunicularis* auctt. Upper Freestone **Hemipedina tetragramma* Wr. O.M. *Hyboclypus caudatus* Wr. U.F., rare. *Magnosia aalensis* Paris. O.M. *Pseudopedina smithi* (Forbes). O.M. *Trochotiara depressa* (Ag.) O.M.
Galeropygus agariciformis (Wr.) —— —— var. *conica* Paris. Very rare.	*murchisonæ*	*Acrosalenia lycetti* Wr. Lower Freestone and Pea-Grit. —— *miliaria* Paris. P.G. *Cidaris bouchardi* Wr. P.G. —— *fowleri* Wr. P.G. —— *wrighti*. Desor. P.G. **Clypeus michelini* Wright. L.F.[3] *Diplocidaris wrighti* Desor. Radiole. Top of Lower Limestone or base of Pea-Grit.

1 Recorded as "*Hyboclypus ovalis* Wr." in table iv. on p. 160 of Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908). Suggested removal to *Galeropygus*, Proc. Cotteswold Nat. F.C., vol. xviii., pt. 1 (1912), pp. 79 & 80.
2 Figured as "*Galeropygus agariciformis* Wr.," in pl. xvi., figs. 4a and b., Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908). See also *id.*, vol. xviii. pl. 1 (1913), p. 78.
3 See Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908), p. 167.

BURTON-BRADSTOCK—DOULTING DIST. (*cont.*)		DOULTING—STONESFIELD DISTRICT (*cont.*)
	murchisonæ (cont.)	? *Echinobrissus clunicularis* auctt.[1] *Galeropygus agariciformis* (Wr.) P.G. or L.L. **Hemipedina bonei* Wr. P.G. —— *perforata* Wr. P.G. —— —— var. *pisolitica* Paris. P.G. *—— *tetragramma* Wr. P.G. *—— *waterhousei* Wr. P.G. *Polycyphus deslongchampsi* Wr. P.G. **Pseudopedina bakeri* Wr. Very rare.[2] *Pygaster semisulcatus* auctt. P.G. —— —— var. *conoidea* Wr. P.G. *Stomechinus intermedius* (Ag.). P.G. —— —— var. *germinans* Phillips. *Trochotiara depressa* (Ag.) P.G. and L.L.
Galeropygus agariciformis (Wr.)	*scissi*	*Galeropygus agariciformis* (Wr.)
	opaliniformis	
	aalensis	

1 See Proc. Cotteswold Nat. F.C., vol. xvi., pt. 2 (1908), p. 170.

2 *Vide id.*, p. 176.

Diplocidaris desori Wright, is not mentioned n the above table because its horizon is not known.

THE MOSSES OF GLOUCESTERSHIRE

BY

H. H. KNIGHT, M.A.

(Read March 17th, 1914.)

Although several local lists of Mosses in different parts of the County have appeared in various publications, no complete list has yet appeared. The account of Mosses for the Victoria County History of Gloucestershire was written some years ago by Mr E. M. Holmes, but the part of this work containing the account has not yet been issued.

The earliest record that I know of a Gloucestershire Moss is in Camden's Britannia, Gough's edition, 1789. In a list of Gloucestershire plants, *Hypnum crispum* L. is mentioned as growing on St. Vincent's Rocks near Bristol. The first botanist in the County who gave attention to Mosses was G. H. K. Thwaites, of Bristol. A list of Mosses found by him in the neighbourhood of Bristol is given in the Annals of Natural History, Series I., vol xii. (1843). Thwaites left a herbarium which contained mosses as well as flowering plants. This herbarium was presented to Clifton College Museum in 1871, but was afterwards sold at an auction, and is now lost. The next bryologist in the County was Henry Beach, of Cheltenham. There is a paper by him on "The Mosses of the District," which was read at the first meeting of the Cheltenham Working Naturalists' Association on November 20th, 1861, and is now in the Library of the Cheltenham Natural Science Society. Mr Beach gave a full and accurate list of the Mosses to be found round Cheltenham. A full list of publications relating to the Mosses of the County, and of botanists who have helped me with local lists, is given further on.

For botanical purposes the County was divided by H. C. Watson, in "Topographical Botany," into two divisions—East Gloucester (33) and West Gloucester (34)—the dividing line being the Thames and Severn Canal, and the River Severn from the point of junction with the canal up to Tewkesbury. I have used these numbers, 33 and 34, after the name of the species or variety, to indicate the "Vice-county" in which it is found.

The Cotteswold Hills, which occupy the greater part of East Gloucester, and the eastern portion of West Gloucester, reaching southwards nearly to Bath, form a very natural division of the County. The Moss-flora throughout this district is very uniform, and calcareous species everywhere predominate. In this district there is no peat and the genus *Sphagnum* is nowhere found. A welcome change in the character of the Mosses is found in some of the sandy districts, such as where the Harford Sands of the Inferior-Oolite Series and the sandy beds of the Middle Lias, in the North Cotteswolds, and the Cotteswold Sands further south in the Mid and South Cotteswolds, occur. I include as part of the Cotteswolds the outliers of Bredon, Dumbleton, Churchdown, and Robins' Wood Hill, which are geologically detached portions of Cotteswold Hills. Characteristic Mosses of the Cotteswolds are *Tortula pusilla*, *T. lamellata*, *Seligeria pusilla*, *Phascum curvicolle*, *Pottia recta*, *P. bryoides*, *Weisia crispata*. Among rare mosses may be mentioned *Bartramia Œderi* and *Eurhynchium rotundifolium*.

The low ground of the Severn Valley north of Berkeley, consisting principally of Lower-Lias clays and Keuper Marls, is very unproductive of Mosses. Much of this country is cultivated, either pasture or arable land, and there are no rocks which form a suitable habitat for many species. The only noteworthy Mosses in this district are species like *Tortula mutica* and *Brachythecium cæspitosum*, which thrive in situations where they get periodical inundations. Further south, in the Bristol district, there is more variety in the geological formations, and on the Coal Measures a small quantity of *Sphagnum* still survives.

In the neighbourhood of Newent there is a small district which lies on the Keuper Sandstone. This rock is exposed in numerous cuttings through which the roads pass. *Tortula marginata*, *T. augustata*, *Bryum Donianum*, and *Brachythecium illecebrum* are common here, and in one place

Tortula Vahliana. The two species of *Sphærocarpus* and several species of *Riccia* are abundant in cultivated fields on the Sandstone.

The Forest of Dean is composed of Coal Measures, surrounded by the Carboniferous Limestone, and this by Old Red Sandstone rocks. This district, together with the Silurian tract of May Hill, is the only part of the County where *Sphagnum* is found in any quantity, and with the *Sphagnum* are associated many species of Mosses and Hepatics that are rare or absent from other parts of the County. The Carboniferous Limestone is present in the Bristol District as well as in the Forest of Dean, and these rocks in the Avon Gorge near Bristol and in the wooded valley of the River Wye afford a suitable habitat for many rare species. *Weisia calcarea, Trichostomum nitidum, Eurhynchium circinatum* and *striatulum* are found in both valleys ; and *Bryum provinciale, Anomodon longifolius, Thuidium recognitum, Orthothecium intricatum,* and *Amblystegium compactum* in the Wye Valley. Close to the Limestone in the Forest of Dean are the conglomerate-beds of the Old Red Sandstone. These rocks form a conspicuous feature at The Buckstone, near Staunton, and also appear near Mitcheldean, at Rodmore Grove, and at Abbott's Wood and Viney Hill, near Blakeney. The following Mosses are, in this County, confined to the Old Red Sandstone :—*Cynodontium Bruntoni, Dicranum fuscescens, D. Scottianum, D. montanum, Grimmia trichophylla, D. Hartmani, Orthotrichum rupestre, Hedwigia ciliata, Schistostega osmundacea.*

In this list I have followed Dixon's " Handbook of British Mosses " (2nd edition, 1904) for the names and arrangement of the species. The number of species and subspecies for the whole County is 304, and of these 234 are found in East Gloucester, and 286 in West Gloucester. The larger number of species in the West is accounted for by the greater variety of the geological formations, which consist of a succession of strata from the Silurian to the Jurassic, while the East is composed almost entirely of the Jurassic.

Unlike the Flowering-plants, there are very few mosses in this County which are not truly native. *Leptobryum pyriforme* is an exception, as it is usually found only as a weed in greenhouses and gardens; but it grows on rocks to the west of the Severn in situations where it may be native. Mountain species like *Rhacomitrium lanuginosum* and *R. fasciculare* are probably casuals in this County. Near Cheltenham several species are found on slag on the railway-embankments, and they are evidently recent introductions, though they are maintaining themselves well in this habitat. These are *Rhacomitrium lanuginosum*, *R. canescens*, *R. fasciculare*, and *Ptychomitrium polyphyllum*. Sometimes mosses are found in situations which are not suitable for their growth, and where they soon disappear; for example, *Hypnum uncinatum*, which appeared one year on Cleeve Hill, near Cheltenham, and the Oolitic Moss *Tortula pusilla*, found by the Rev. Augustin Ley near Mitcheldean. Another doubtful native is *Grimmia commutata*, which, so far, has only been found on roofs in the Forest of Dean.

There are several mosses which never bear fruit in Britain, others in which the fruit is rare. In the case of those which rarely bear fruit, I have indicated, sometimes by the abbreviation c. fr. (*cum fructu*), that fruit has been found in this County. Three common mosses for which there is no record of fruit in this County are *Barbula lurida*, *Encalypta streptocarpa*, and *Leucodon sciuroides*.

The publications and works dealing with Gloucestershire Mosses are the following:—

G. H. K. Thwaites.—" List of Mosses Found in the Neighbourhood of Bristol." Annals of Natural History. Series I. Vol. xii. 1843.

H. Beach.—" The Mosses of the District." Proceedings of the Cheltenham Working Naturalists' Association. Nov., 1861.

W. W. Stoddart, F.G.S.—" Geological Distribution of Some of the Bristol Mosses." Proceedings of the Bristol Naturalists' Society. New Series. Vol. I., 1874.

[This list is evidently inaccurate, and I have made no use of it.—H.H.K.]

G. Holmes and *E. J. Elliott.*—" The Mosses and Hepaticæ of the Forest of Dean." Hardwicke's Science Gossip. March, 1885.

Augustin Ley.—" The Botany of Mitcheldean District." Proceedings of the Woolhope Naturalists. May, 1887.

W. A. Shoolbred.—" The Mosses of the lower part of the Wye Valley in West Gloucestershire." *G.Holmes.* " Notes on some Mosses of the Stroud District." The Fauna and Flora of Gloucestershire by C. A. Witchell and W. B. Strugnell. 1892.

E. Armitage.—" Vegetation of the Wye Gorge at Symonds Yat." The Journal of Ecology. June, 1914.

William Wilson.—" Bryologia Britannica." 1855.

R. Braithwaite.—" The British Moss-Flora." 1887-1905.

A Census Catalogue of British Mosses, compiled under the direction of the Moss Exchange Club, 1907.

Moss Exchange Club, Annual Reports, 1896-1914.

[In the Census Catalogue mentioned above the following records are due to errors :—*Dicranella squarrosa* for Vice-County 33 East Gloucester, and *Weisia rupestris, Bryum affine, Eurhynchium speciosum, E. megapolitanum, Hypnum elodes, H. dilatatum,* for Vice-County 34 West Gloucester. I have been unable to trace these records :—*Dichodontium flavescens, Trichostomum flavovirens, Bartramia pomiformis* for V.C. 33, and *Dicranella cerviculata* for V.C. 34.—H.H.K.]

The following Herbaria contain Gloucestershire Mosses :—

Thwaites' Herbarium, formerly at Clifton College Museum.

Leipner's Herbarium, at the Bristol Museum, which contains some of Thwaites' Mosses.

Holmes' Herbarium at the Museum at Stroud.

Reader's Herbarium at Bristol University Museum.

Ley's Herbarium at Birmingham University Museum.

I am indebted to the following for records and specimens from various parts of the County :—Rev. H. P. Reader, Woodchester and elsewhere ; Mr E. J. Elliott, of Stroud, for records in many parts of the County ; Miss E. Armitage and Rev. C. H. Binstead for many records, especially in the Symonds Yat country ; Miss Ida M. Roper, and Mr. W. B. Waterfall, of Bristol ; Mr J. Taylor, of Fairford ; Mr C. P. Hurst for records from Moreton-in-the-Marsh, and Miss J. Raymond Gingell, of Burleigh, Stroud, for a list of Mosses at Dursley, which were named by Mr J. E. Bagnall.

In naming critical plants I have had the assistance of Messrs. H. N. Dixon, W. E. Nicholson, W. Ingham, J. A. Wheldon, and D. A. Jones. Messrs Dixon, Nicholson, Jones and J. B. Duncan have also visited the County and made additions to the list. I am also indebted to Mr E. M. Holmes for his notes on Mosses for the Victoria County History, which contained a list of Gloucestershire Mosses in Thwaites' Herbarium ; to Mr A. B. Jackson for sending me records from the Herbarium at South Kensington ; and to Mr E. Cleminshaw for sending specimens from Ley's Herbarium at Birmingham University.

LIST OF MOSSES FROM GLOUCESTERSHIRE

SPHAGNACEÆ

Sphagnum cymbifolium Ehrh. 34. Forest of Dean (Herb. Holmes, also Elliott). Tidenham Chase (Shoolbred). Near Speech House (Miss Armitage). May Hill. Recorded from Mitcheldean Meend by Rev. A. Ley, but the specimen in his Herbarium is the next species.

Sphagnum papillosum Lindb. 34. Common in the Forest of Dean wherever Sphagna occur. Both varieties *normale* Warnst. and *sublæve* Limpr. are found.

Sphagnum rigidum Schp. — **S. compactum** DC. 34. Mitcheldean Meend (Ley), Drybrook Meend. Tidenham Chase (Shoolbred). The plant on Mitcheldean and Drybrook is var. *imbricatum* Warnst., and that on Tidenham Chase var. *squarrosum* Russ.

Sphagnum tenellum Ehrh. — **S. molluscum** Bruch. 34. Forest of Dean (Holmes and Elliott). Mitcheldean Meend.

Sphagnum subsecundum Nees. 34. This is the most frequent form of Sphagnum in all parts of the Forest of Dean; also May Hill, Chase End Hill. In the Gloucestershire part of the Bristol Coalfield district this is the only species found. The different species according to Warnstorf's arrangement are, *S. subsecundum* Limpr., Fox's Bridge, near Speech House. *S. inundatum* Warnst., Forest of Dean (Elliott); Spruce Drive, near Speech House. *S. crassicladum* Warnst., Mitcheldean Meend; Old Roman Road, Viney Hill. *S. rufescens* Warnst. Common in the Forest and on May Hill. Rodway Hill, Mangotsfield (Miss Roper); Yate Common.

Sphagnum molle Sull. 34. May Hill.

Sphagnum acutifolium Ehrh. 34. Common wherever *Sphagnum* occurs in the Forest of Dean and May Hill. All the plants of this aggregate belong to *Sphagnum subnitens* Russ. and Warnst.

Sphagnum fimbriatum Wils. 34. Forest of Dean (Elliott, specimen named by E. C. Horrell).

Sphagnum intermedium Hoffin — *S. recurvum* Warnst. 34. Forest of Dean (Holmes and Elliott). Near the Speech House in the marsh by Fox's Bridge, and in the valley near the railway-station. These all belong to the var. *mucronatum* Warnst.

TETRAPHIDACEÆ

Tetraphis pellucida Hedw. 33, 34. On tree stumps in woods in all parts of the County, but rare on the Cotteswolds. Common in the Forest of Dean, where it also grows on Old Red Sandstone Rocks. Fruit is frequent in the Forest, and is sometimes found in specimens on the Cotteswolds.

POLYTRICHACEÆ

Catharinea undulata Web. and Mohr. 33, 34. Common.

Catharinea angustata Brid. 33. Sparingly on sandy ground (Harford Sands), Cleeve Hill Common, near Cheltenham.

Polytrichum nanum Neck. 33, 34. Rare on the Cotteswolds; sometimes found on the Harford Sands as on Cleeve Hill and Bourton Downs; also in field by the Four Shire Stone, Moreton-in-Marsh (Hurst); Woodchester Park (Reader), and Cam Down, near Dursley. Near Bristol (Thwaites). Rather common in Forest of Dean and May Hill districts. Sometimes, as at Abbott's Wood, with long seta approaching var. *longisetum* Hampe.

Polytrichum aloides Hedw. 33, 34. Like the last, rare on the Cotteswolds; Hilcot, near Colesbourne; Woodchester (Reader); Cam Down. In several places in the Bristol district, and common in the Forest of Dean and May Hill; also near Bromsberrow.

Polytrichum urnigerum L. 33, 34. In a field by the Four Shire Stone near Moreton-in-Marsh (Hurst). Sparingly on a bank at Ham Hill, near Cheltenham. In several places in the Forest of Dean, and especially about quarries where fruit is plentiful.

Polytrichum alpinum L. 34. Forest of Dean (Holmes, 1886). There is a fine fruiting specimen of this moss in the Herbarium at Stroud.

Polytrichum piliferum Schreb. 33, 34. Rare on the Cotteswolds, but found sparingly on many of the downs. More common in the Bristol district, and common in the Forest of Dean, and on the western border of the County up to Chase End Hill.

Polytrichum juniperinum Willd. 33, 34. This moss often grows with the last, and its distribution is the same.

Polytrichum gracile Dicks. 33. On tree stump, Chatcombe Wood, near Cheltenham c.fr

Polytrichum formosum Hedw. 33, 34. In woods on the Cotteswolds. Common in the western portion of the County.

Polytrichum commune L. 33, 34. On sandy bank (Cotteswold Sands), Woodchester Park c. fr. (Reader). This is the only locality I know for this moss on the Cotteswolds. Mr Beach's record for Cheltenham district is probably an error. It also grows on heathy ground on the gravel (" Northern Drift ") near Moreton-in-Marsh. In several localities in the Bristol district, and common in many parts of the Forest of Dean ; also May Hill.

DICRANACEÆ

Archidium alternifolium Schp. 33, 34. On the gravel drift near Moreton-in-Marsh. Broadway Hill (just within the county-boundary). May Hill and on paths in wood near the Speech House. The fruit, which is inconspicuous, is usually present.

Pleuridium axillare Lindb. 33, 34. On paths in woods and cultivated fields. Generally distributed but not common. In the North Cotteswolds it can always be found on the sandy clays of the Middle Lias.

Pleuridium subulatum Rabenh. 33, 34. Generally distributed and common in the west of the County.

Pleuridium alternifolium Rabenh. 33, 34. Widely distributed, but except on the Cotteswolds, less common than the last.

Ditrichum homomallum Hampe. 34. Rare and found only in the Forest of Dean district. Sandstone rocks below Madgetts (Shoolbred). Near Mitcheldean. Anchorbury Hill, above Lydbrook. Wood near The Buckstone. Near Speech House Road Station. May Hill.

Ditrichum flexicaule Hampe. 33, 34. Common on the Cotteswolds and also on the limestone of the Bristol and Forest of Dean districts.

Seligeria pusilla B. and S. 33, 34. Common on rocks and stones in woods on the Cotteswolds. Also found sparingly on limestone rocks in the lower part of the Wye Valley.

Seligeria calcarea B. and S. 33, 34. On shady walls and old quarries in several places on the Cotteswolds. This species is more at home on the Chalk, and does not thrive so well on the Oolitic rocks.

Seligeria recurvata B. and S. 34. On rocks at Symonds Yat (Binstead and Miss Armitage), and near the Devil's Pulpit in the lower part of the Wye Valley.

Ceratodon purpureus Brid. 33, 34. Generally distributed, though not one of the common mosses of calcareous districts like the Cotteswolds.

Ceratodon conicus Lindb. 33. On mud-cap of walls on the Cotteswolds. Near Bisley; Poulton; Fairford; and Stow-on-the-Wold.

Cynodontium Bruntoni B. and S. 34. On Old Red Sandstone rocks and walls in the Forest of Dean. Near The Buckstone (Miss Armitage), and near Mitcheldean. Also recorded by Thwaites in the Annals of Natural History, but this may be a mistake, as there was no specimen in his herbarium.

Dichodontium pellucidum Schp. 33, 34. On rocks by streams, not uncommon in the Forest of Dean. Rare on the Cotteswolds; Woodchester (Reader); near Boxwell; and in the Slad Valley near Stroud. Usually sterile, c. fr. by R. Wye at Symonds Yat (Miss Armitage).

Dichodontium flavescens Lindb. 34. By stream near Symonds Yat, barren (Nicholson). A specimen in Ley's herbarium, from "Rill side Bicknor Walks," is, I think, *D. pellucidum*.

Dicranella heteromalla Schp. 33, 34. Generally distributed, but not one of the common mosses of the Cotteswolds. Var. *sericea* Schp. (34) on sandstone rocks near Oxenhall; near Mitcheldean; and the Hudnalls (near St Briavels). Mr Ley in his "Flora of Herefordshire," and in "The Botany of Mitcheldean District," records *Dicranella secunda* Lindb. from a sand-pit near Mitcheldean. I have seen the specimen in his herbarium, and the plant is a curious form of *D. heteromalla*. See "Journal of Botany," 1912, p. 306.

Dicranella rufescens Schp. 33, 34. Not common, and usually found in small quantity. In several localities near Cheltenham, Woodchester, Symonds Yat (Miss Armitage), and the Hudnalls (near St. Briavels).

Dicranella varia Schp. 33, 34. Common.

Dicranella Schreberi Schp. 33, 34. Sides of ditches and damp woods. Rare but probably overlooked, as it is usually found barren. Near Cheltenham, Alderton, and Wormington. Below Coldwell Rocks near Symonds Yat c. fr.; Hudnalls. Var. *elata* Schp. (33) Nottingham Hill, near Cheltenham.

Dicranella squarrosa Schp. 34. Tidenham Chase (Shoolbred). This moss seems now to have disappeared from Tidenham Chase. The record is probably correct for Dr Shoolbred sent most of his specimens to the Rev. C. H. Binstead.

Dicranoweisia cirrata Lindb. 33, 34. Common on trees, wooden palings, and thatch. In the Forest of Dean this species also grows on Old Red Sandstone rocks.

Campylopus flexuosus Brid. 33, 34. Rare on the Cotteswolds, where it is found only on tree stumps in woods. More frequent in the Forest of Dean and the west of the County, where it also grows on rocks and heaths. Also Yate Common (Miss Roper). Fruit, which is rare, in Chatcombe Wood, near Cheltenham, and Abbots Wood, near Little Dean.

Campylopus pyriformis Brid. 33, 34. On heathy ground, very rare on the Cotteswolds; sparingly on Cleeve Hill Common; gravel drift near Moreton-in-Marsh; wood near Wolford. Woodchester (Reader). Yate Common. Common on heaths in the Forest of Dean; also on May Hill. Fruit is not uncommon.

Campylopus fragilis, B. and S. 33. Sandy bank, Hilcot, near Colesbourne.

Campylopus brevipilus B. and S. 34. Tidenham Chase and Drybrook Meend.

Dicranum undulatum Ehrh. 34. Woodchester, on bank with *Dicranum paludosum, Leucobryum* (Reader).

Dicranum Bonjeani De Not. 33, 34. In several places on the Cotteswolds but not common; also on Yate Common. More frequent in the Forest of Dean, May Hill and Chase End Hill. Always barren.

Dicranum scoparium Hedw. 33, 34. Common. Var. *paludosum* Schp. (34) Woodchester (Reader). Var. *orthophyllum* Brid. (33) occasionally on the Cotteswolds.

Dicranum majus Turn. 33, 34. In woods on the Cotteswolds, not common. Frequent in the Forest of Dean and woods near Newent. Fruit rare, in wood near The Buckstone.

Dicranum fuscescens Turn. 34. This is found only on the Old Red Sandstone conglomerate rocks in the Forest of Dean. Near Mitcheldean (Ley), and in wood near The Buckstone (Miss Armitage). Var. *falcifolium* Braithw. (34). Wood near The Buckstone (Miss Armitage). Fruiting on the rocks near Mitcheldean.

Dicranum Scottianum Turn. 34. The Buckstone (Miss Armitage) and rocks near it. Sterile.

Dicracum montanum Hedw. 34. On a rock, Lea Bailey, near Mitcheldean (Ley's herbarium). This moss is usually found on trees; here it grows on the Old Red Sandstone conglomerate.

Leucobryum glaucum Schp. 34. Sparingly at Woodchester (Reader). This is the only record in the County east of the Severn. In woods and turfy ground in the Forest of Dean, not uncommon. In Wilson's "Bryologia Britannica" it is stated that fruit has been found in Gloucestershire, but I have no recent record of fruit.

FISSIDENTACEÆ

Fissidens exilis Hedw. 33, 34. Generally distributed and common in woods on the Cotteswolds.

Fissidens viridulus Wahl. 33, 34. Common; also var. *Lylei* Wils. (33, 34), which sometimes grows with the type.

Fissidens pusillus Wils. 33, 34. Common on stones in woods on the Cotteswolds, and also in other parts of the county on sandstone or limestone.

Fissidens algarvicus Solms. 33. In wood, Hilcot, near Colesbourne. This moss was plentiful in the autumn after the wet summer of 1912, but I have not been able to find it since.

Fissidens incurvus Starke. 33, 34. Common, and found in all parts of the County.

Fissidens bryoides Hedw. 33, 34. Common, though on the Cotteswolds it appears to be less frequent than many of the preceding species.

Fissidens crassipes Wils. 33, 34. On stones in rivers (Severn and Wye) as well as smaller streams, canals, and sometimes on the Cotteswolds on rocks by springs ; not uncommon.

Fissidens adiantoides Hedw. 33, 34. Wet ground by streams, not common on the Cotteswolds. More frequent in the Forest of Dean. Most of the old records for this species belong to the next.

Fissidens decipiens De Not. 33, 34. Common on shady rocks and stony banks on the Cotteswolds ; also on the limestone of the Forest of Dean and Bristol districts. Frequently fruiting. Var. *brevifolius* Lindb. (33, 34). Withington and Corse Wood Hill (Corse).

Fissidens taxifolius Hedw. 33, 34. Common everywhere.

Octodiceras Julianum Brid. 33, 34. On old barges in the Severn at Wainlode, and on stones in the river at Haw Bridge. Also in the Stroud and Sharpness canals. On the south or Berkshire side of the River Thames at St. John's Locks, near Lechlade.

GRIMMIACEÆ

Grimmia apocarpa Hedw. 33, 34. Common on rocks and walls. Var. *rivularis* Web. and Mohr. (34). On rocks by R. Wye below Redbrook, and by the stream at Blackpool Bridge, near Blakeney.

Grimmia pulvinata Smith. 33, 34. Common everywhere, and very abundant on the Cotteswolds. Var. *obtusa* Hubn. (34) St. Vincent's Rocks, Clifton (Thwaites).

Grimmia orbicularis Bruch. 33, 34. St. Vincent's Rocks (1843 Thwaites). Durdham Downs (1863, Boswell). Wall below Battlefields, Lansdown, Bath, just within the county-boundary (Miss Roper). On rocks and walls in many places in the district between Cheltenham, Stroud, and Cirencester. Quarry near Mitcheldean.

Grimmia trichophylla Grev. 34. On Old Red Sandstone rocks in many parts of the Forest of Dean, sometimes fruiting.

Grimmia Hartmani Schp. 34. On rocks Rodmore Grove, near Hewelsfield (Ley); also Hudnalls, near St. Briavels. This moss is abundant at Rodmore Grove.

Grimmia commutata Hübn. 34. Found only on roofs in the Forest of Dean. Roof near Blakeney c.fr., and roof at Staunton.

Rhacomitrium aciculare Brid. 34. On rocks by streams in the Forest of Dean; also May Hill. Not common.

Rhacomitrium fasciculare Brid. 33, 34. Damp rock near Mitcheldean (Ley). Quarry near Milkwall. On slag on railway embankment, Dowdeswell. Barren plants only have been found in this County. This moss has certainly been introduced with the slag at Dowdeswell, and is probably only a casual in the other localities.

Rhacomitrium heterostichum Brid. 34. Forest of Dean; not common. The Buckstone, Staunton c.fr. (Ley). Near Brookweir (Shoolbred); Hudnalls c.fr.; Rodmore Grove. The plant from The Buckstone in Ley's herbarium was named **R. sudeticum.** Var. *alopecurum* Hubn. (34) a form with obtuse leaves. The Buckstone (Miss Armitage); Abbot's Wood; near Mitcheldean; Hudnalls; Rodmore Grove. Both the type and variety seem to be confined to the Old Red Sandstone rocks.

Rhacomitrium lanuginosum Brid. 33, 34. Tidenham Chase and on wall built of Old Red Sandstone conglomerate, Brookweir (Shoolbred); Hudnalls; rocks by railway at Oxenhall; Chase End Hill. On slag, railway embankment, Dowdeswell. Certainly introduced with the slag at Dowdeswell, and only a casual elsewhere. Barren plants only found.

Rhacomitrium canescens Brid. 33, 34. Near Bristol (Thwaites). By Symonds Yat Station (Ley). On heaths and stony ground in various parts of the Forest of Dean. On rocks by railway at Oxenhall. On slag by the railway at Dowdeswell c.fr. Sparingly on Cleeve Hill Common. A native moss in the Forest of Dean; probably introduced elsewhere.

Ptychomitrium polyphyllum Fürn. 33, 34. On rocks (not calcareous) in many parts of the Forest of Dean. Near Bristol (Thwaites). Hanham (Miss Roper). On slag by the railway at Dowdeswell. Like the species of *Rhacomitria* this has been introduced with the slag.

Hedwigia ciliata Ehrh. 34. On Old Red Sandstone rocks in the Forest of Dean. Near Chepstow (Shoolbred). Rocks in a field near Rodmore Grove. Rocks at Staunton.

TORTULACEÆ

Acaulon muticum C.M. 33. Near Cheltenham (Beach). On the Harford Sands on Cleeve Hill Common, and on the Middle Lias in several woods near Cheltenham; also at Churchdown.

Phascum cuspidatum Schreb. 33, 34. Common. A small form of this, frequent on the Cotteswolds, has been named var. *piliferum* by Rev. H. P. Reader, but the leaves do not end in the long filiform point of this variety. Var. *curvisetum* Nees and Hornsch. (34) growing with the type on Downham Hill, near Dursley.

Phascum curvicolle Ehrh. 33, 34. Common on the Cotteswolds on bare ground and earth-covered walls. I have not seen a specimen elsewhere, but it is recorded from Black Rock Gully ("The Gully") and Durdham Down, near Bristol (Wheeler).

Pottia recta Mitt. 33, 34. Widely distributed on the Cotteswolds, but less common than the last. Also on the limestone of the Bristol district (Thwaites, Miss Roper), and Symonds Yat (Miss Armitage).

Pottia bryoides Mitt. 33, 34. On bare ground, wall tops, and quarries; not common, but widely distributed on the Cotteswolds. Elsewhere recorded only from Durdham Down, near Bristol (Miss Roper).

Pottia Heimii Fürn. 34. Durdham Down, probably by the tidal waters of the Avon (Thwaites); Wye bank below Pen Moel (Shoolbred); salt spring by R. Leadon below Ketford.

Pottia truncatula Lindb. 33, 34. Common, except in some parts of the Cotteswolds, where its place is taken by the next species. The Cotteswold plants with the short truncate capsule of this species often have the leaves of T. *intermedia*.

Pottia intermedia Fürn. 33, 34. Common on the Cotteswolds, less common elsewhere, and not recorded for the Forest of Dean.

Pottia minutula Fürn. 33, 34. Another common Cotteswold moss. Rare in other parts of the County.

Pottia Starkeana C.M. 33, 34. Bristol (Thwaites); Cheltenham (Beach); railway-cutting at Gotherington. This moss is plentiful in the Avon Gorge near Bristol on the North side of the river.

Pottia lanceolata C.M. 33, 34. Common everywhere.

Tortula pusilla Mitt. 33, 34. On mud at the top of walls; also bare ground in quarries and elsewhere. Common on the Cotteswolds, rare or absent from other parts of the County. On clay at Silverstone Farm, near Mitcheldean (Ley).

Tortula lamellata Lindb. 33, 34. In similar situations as the preceding, with which it often grows. Common on the Cotteswolds and not found in other parts.

Tortula rigida Schrad. 33, 34. "Abundant on stone walls" about Cheltenham (Beach). On wall tops and bare ground, where it often grows with the next two species; widely distributed on the Cotteswolds. Elsewhere found at Yate, near Bristol (Thwaites), and on walls near Westbury-on-Severn, and Mitcheldean.

Tortula ambigua Angstr. 33, 34. Wall tops and bare ground; common, especially on the Cotteswolds.

Tortula aloides De Not. 33, 34. Wall tops, banks, and quarries; common.

Tortula Vahliana Wils. 33, 34. In a road-cutting in the Keuper Sandstone near Newent; also sparingly at Deerhurst.

Tortula marginata Spruce. 33, 34. On the Cotteswolds on Inferior Oolite rock on Stanway Hill, and on sandy rock (Cotteswold Sands) near Upton Cheyney. Common on Keuper Sandsone in the Newent district. Sandstone rocks below Madgetts (Shoolbred); Symonds Yat, and Rosemary Topping (Miss Armitage and Binstead); English Bicknor (Ley).

Tortula muralis Hedw. 33, 34. Common. Var. *rupestris* Schultz. (33, 34) also common, especially on the Cotteswolds. Var. *æstiva* Brid. (33, 34). Hill near Mitcheldean (Miss Armitage and Binstead). Nottingham Hill, near Cheltenham.

Tortula subulata Hedw. 33, 34. Common. Var. *subinermis* Wils. (34). On willow-tree by R. Wye, near Lydbrook (H. N. Dixon).

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Tortula angustata Wils. 34. Common about Newent and Bromsberrow; Chase End Hill; Damery quarry, near Tortworth.

Tortula mutica Lindb. 33, 34. On trees or walls where subject to inundation. Common by rivers and streams on the low ground; not on the hills. In fruit on tree near the Severn at Tirley.

Tortula lævipila Schwaeg. 33, 34. On trees (common). Var. *laevipilæformis* Limpr. (33, 34). On trees in the Severn Valley.

Tortula intermedia Berk. 33, 34. Walls and roofs; common. A conspicuous moss on the Cotteswold walls.

Tortula ruralis Ehrh. 33, 34. Walls, roofs, and stony ground; common.

Tortula ruraliformis Dixon. 34. Limestone quarry, near Mitcheldean. This moss is usually found on sandy ground by the sea.

Tortula papillosa Wils. 33, 34. On trees, especially elms; rare, but widely distributed on the Cotteswolds, and more frequent in the Severn and Avon Valleys. Also on an old tombstone at Dumbleton. Not recorded from the Forest of Dean or Bristol districts.

Barbula lurida. Lindb. 33, 34. Common, and found in all parts of the County. Always barren.

Barbula rubella Mitt. 33, 34. Walls and stony ground; common.

Barbula tophacea Mitt. 33, 34. Common, and found in all parts of the County.

Barbula fallax Hedw. 33, 34. On bare ground, rocks and walls; common. Var. *brevifolia* Schultz (33, 34) is also common.

Barbula recurvifolia Schp. 33, 34. In old quarries and stony ground; rare, but widely distributed on the Cotteswolds. Also in the Avon Gorge near Bristol and in the limestone parts of the Forest of Dean.

Barbula spadicea Mitt. 33, 34. On rocks and stones in woods in many parts of the Cotteswolds, but scarce. Also at Symonds Yat; and by R. Leadon, near Newent.

Barbula rigidula Mitt. 33, 34. Common, a frequent moss on Cotteswold walls, where it fruits abundantly.

Barbula Nicholsoni Culmann. 34. On rocks by R. Wye at Symonds Yat and below Lydbrook.

Barbula cylindrica Schp. 33, 34. Common, but seldom in fruit. Symonds Yat c.fr. (Ley) ; Staunton c.fr.

Barbula vinealis Brid. 33, 34. On walls particularly in the neighbourhood of towns and villages, common, but fruit rare. Cheltenham c.fr ; Wainlode c.fr. Sometimes forms occur which are not easy to distinguish from the last species.

Barbula sinuosa Braithw. 33, 34. On rocks and walls and sometimes at the base of trees. Found in all parts of the County, and common on the Cotteswolds.

Barbula gracilis Schwaeg. 33, 34. On the calcareous sand by road sides ; widely distributed on the Cotteswolds, and nearly always mixed with *B. fallax*. Durdham Downs (Thwaites). Always barren.

Barbula Hornschuchiana Schultz. 33, 34. On bare ground and tops of walls ; common on the Cotteswolds, and also in limestone districts in other parts of the County. The fruit, which is rare, has been found in many parts of the county.

Barbula revoluta Brid. 33, 34. Common on walls, rocks, etc. ; fruit not uncommon.

Barbula convoluta Hedw. 33, 34. Common ; also var. *Sardoa* B. and S. (33, 34), a form with larger leaves and usually barren.

Barbula unguiculata Hedw. 33, 34. Common everywhere.

Leptodontium flexifolium Hampe. 34. A rare moss found only in the Forest of Dean. Near Symonds Yat (Miss Armitage and Binstead). Abundant on Staunton Meend c.fr. ; Rodmore Grove. Mr Beach has this on his Cheltenham list—probably an error.

Weisia crispa Mitt. 33, 34. Widely distributed on the Cotteswolds ; also on St. Vincent's Rocks at Clifton, and on a wall at Tidenham. At the last place it was growing with *W. crispata*, and there were some hybrid capsules *W. crispata* ♀ × *W. crispa* ♂. Var. *aciculata* Braithw. (33, 34). Sparingly on the hills near Cheltenham, and formerly abundant on the new railway from Cheltenham to Winchcomb, but now decreasing with the growth of other vegetation. Also in a field at Tidenham, near Chepstow.

Weisia sterilis Nicholson. 33. On the hills, near Cheltenham; and also Bredon Hill, near Kemerton. The fruit is usually present, but is produced sparingly. Mr Beach mentions "a variety of *W. crispa* resembling *W. multicapsularis*," which is probably this.

Weisia microstoma C.M. 33, 34. Common on the Cotteswolds, rare in other parts of the County.

Weisia tortilis C.M. 33, 34. "On Cleeve Hill sparingly" (Beach). In several places on the Cotteswolds; also on St. Vincent's Rocks, Clifton. The Gloucestershire plants resemble *W. crispata* in all respects except the complete absence of a peristome.

Weisia crispata C.M. 33, 34. Common on the Cotteswolds, and found also on the limestone near Bristol, and rarely on the limestone in the Wye Valley.

Weisia viridula Hedw. 33, 34. Common, and occurs in all parts of the County, though on the Cotteswolds it is less frequent than *W. microstoma* and *crispata*.

Weisia mucronata B. and S. 33, 34. Rare, but probably, often overlooked. Railway-cutting near Gotherington. Top of cliff, Symonds Yat (Miss Armitage and Binstead). Near Blakeney.

Weisia tenuis C.M. 33, 34. Not uncommon in old quarries and on walls on the Cotteswolds and frequently fruiting. Also cutting near Beechwood, Mitcheldean (Ley), and near Symonds Yat (Miss Armitage).

Weisia calcarea C.M. 34. On limestone rocks in the Wye Valley, in fruit at Symonds Yat (Miss Armitage and Binstead). Also on Keuper Sandstone rocks by R. Leadon near Newent. Var. *mutica* Boulay (34), St. Vincent's Rocks (Waterfall), and in the Avon Gorge below Durdham Down.

Weisia verticillata Brid. 33, 34. On damp calcareous rocks in all parts of the County, but not often in fruit. Chalford, near Stroud c.fr. (Holmes and Elliott). On Keuper Sandstone in road-cutting near Newent c.fr.

Trichostomum crispulum Bruch. 33,34. Common on the limestone of the Wye Valley and of the Avon Gorge, near Bristol. Also on the Cotteswolds, where, however, it is rare. Fruiting sparingly at Symonds Yat (Miss Armitage), and near Bristol.

Trichostomum mutabile Bruch. 33, 34. Common on the limestone of the Wye Valley, and of the Avon Gorge near Bristol, where fruit is occasionally found. Rare on the Cotteswolds. Rodborough Common, Stroud ; rocks in Wood, Scotesquar Hill, near Stroud ; Cleeve Hill Common ; and bank of the Windrush, near Seven Springs (near Bourton-on-the-Water). Var. *littorale* Dixon (34) by the Avon, near Bristol. Var. *cophocarpum* Schp. (34) in several places in the Wye Valley.

Trichostomum tenuirostre Lindb. 34. On trees by R. Frome, Stapleton (Thwaites). On rocks by stream near Symonds Yat (Miss Armitage and Binstead).

Trichostomum inclinatum Dixon. 33. On the Cotteswolds at Snowshill ; also at Cutsdean—an isolated part of Worcestershire. Mr Dixon says that the Gloucestershire plant agrees well with T. *inclinatum*, though, as fruit has never been found in this country, there is some doubt as to whether this is a British moss.

Trichostomum nitidum Schp. 34. Plentiful on the limestone of the Avon Gorge, near Bristol, and also of the Wye Valley.

Trichostomum tortuosum Dixon. 33, 34. Common on rocks and walls on the Cotteswolds, especially on or near the escarpment ; also on limestone rocks near Bristol and in the Forest of Dean. The fruit is found in many woods on the Cotteswold escarpment, and also in the Wye Valley. A small form of this moss with leaves straight when moist grows on stony ground on Cleeve Hill. This moss grows in the form of balls, quite unattached, on the stony slopes of Witcomb Wood and elsewhere on the Cotteswolds.

Pleurochæte squarrosa Lindb. 33, 34. On stony ground in calcareous districts ; rare and usually found in small quantity. Symonds Yat (Miss Armitage and Binstead) ; quarries at Whittington ; Minchinhampton Common ; Stinchcombe and Downham Hills, near Dursley ; Avon Gorge below Durdham Down, Bristol.

Cinclidotus Brebissoni Husnot. 33, 34. Common by streams and rivers in the low ground. Fruit rare. On trees by R. Frome, Stapleton, Bristol, c.fr. (Thwaites) ; Weston-upon-Avon, c.fr. ; Carrant Brook, Beckford c.fr.

Cinclidotus fontinaloides P. Beauv. 33, 34. On stones in rivers and canals in many parts of the County, and common in the R. Wye.

ENCALYPTACEÆ

Encalypta vulgaris Hedw. 33, 34. Walls and quarries in all parts of the County, and common on the Cotteswolds.

Encalypta streptocarpa Schwaeg. 33, 34. On the ground in calcareous districts and on the mortar of walls ; common. The fruit has not been found in the County.

ORTHOTRICHACEÆ

Zygodon viridissimus R. Brown. 33, 34. Common on trees, fruit rare. Hartley Bottom c.fr. (Beach), and Nottingham Hill c.fr., near Cheltenham ; Woodchester c.fr. (Reader). This moss frequently grows on walls, both on the Cotteswolds and elsewhere, and then is sometimes named var. *rupestris* Hartm.

Zygodon Stirtoni Schp. 34. The Dells, Wigpool, near Mitcheldean (Ley). On limestone, Symonds Yat (Miss Armitage and Binstead), and also in the lower part of the Wye Valley.

Ulota Bruchii Hornsch. 33. Near Cheltenham (Beach). Plentiful on trees at Hilcot, near Colesbourne, along with the next species. Probably occurs elsewhere, but the starved specimens often met with on the Cotteswolds are not easy to distinguish from the next species.

Ulota crispa Brid. 33, 34. Plentiful at Hilcot, and found sparingly on the Cotteswolds on beech and other trees. In the Forest of Dean at Abbott's Wood ; Rodmore Grove ; and near Mitcheldean. Var. *intermedia* Braith. (33), "The Scrubs," near Stroud (Holmes).

Ulota phyllantha Brid. 33. On wooden rail, Leckhampton, and on beech Buckle Wood, near Cranham.

Orthotrichum rupestre Schleich. 34. On Old Red Sandstone rock at Staunton.

Orthotrichum anomalum Hedw. var. *saxatile* Milde. 33, 34. Common on rocks and walls on the Cotteswolds and in the Severn Valley. Also on the limestone of the Bristol and Forest of Dean districts.

Orthotrichum cupulatum Hoffm. 33, 34. Less common than the last, but widely distributed on the Cotteswolds ; often on bridge walls and canal locks. Near Bristol (Thwaites), and on limestone rocks at Yate, Staunton, and Symonds Yat (Miss Armitage). The Symonds Yat plant has eight-ribbed capsules, and Mr Nicholson considers it may be the var. *octo-striatum* Limpr. (Moss Exchange Club Report, 1907, 1908). Var. *nudum* Braithw. (33). On locks by R. Avon, Welford.

Orthotrichum leiocarpum B. and S. 33, 34. A rare moss found sparingly in many parts of the Cotteswolds. Not recorded from the Forest of Dean or Bristol districts.

Orthotrichum Lyellii Hook and Tayl. 33, 34. Common but rare in fruit. Hartley Bottom c.fr. (Beach) and Whittington c.fr. near Cheltenham ; Painswick c.fr. (Holmes) ; Woodchester Park c.fr. (Reader).

Orthotrichum affine Schrad. 33, 34. Common. Var. *rivale* Wils. (34) on trees by R. Wye near Lydrook Junction.

Orthotrichum rivulare Turn. 33, 34. On tree roots by R. Severn, Wainlode, and on tree by R. Wye at Redbrook.

Orthotrichum Sprucei Mont. 33, 34. On trees by R. Frome, Stapleton (Thwaites). Trees by R. Severn at Deerhurst and Ashleworth. Willow by R. Wye, Lydbrook Junction (H. N. Dixon). This is the *O. Rogeri* of Thwaites' list in the Annals of Natural History.

Orthotrichum stramineum Hornsch. 33, 34. A rare moss which is found sparingly on various trees in all parts of the County.

Orthotrichum tenellum Bruch. 33, 34. On trees in many parts of the Cotteswolds ; rare. Not recorded from the part of the County west of the Severn, or from the Bristol district.

Orthotrichum pulchellum Smith. 33. Near Cheltenham (Beach). On tree at Hilcot, near Colesbourne. On beech in Buckle Wood, near Cranham. Very rare and when found it grows in very small quantity.

Orthotrichum diaphanum Schrad. 33, 34. On trees ; also on walls ; common.

Orthotrichum obtusifolium Schrad. 33, 34. Mr Beach in his Cheltenham list, mentions that he was the first discoverer of this moss as a British species. The following records are taken from the Herbarium of the British Museum :—" On trunk of pollard ash near Cheltenham, May and June, 1855. H. Beach. Herb. Musc. W. Wilson. On young elm trees near Cheltenham on the road to Gloucester, April, 1857 (third station). Mr Beach. On a solitary ash tree at Mickleton tunnel, May 27, 1857. T. Kirk, Coventry. Herb. J. Carroll. Near Chipping Campden, May, 1857. Herb. Musc. W. Wilson. On trunks of trees, Bristol. Herb. H. B. Holl."

This moss is still to be found on a pollard ash near Cheltenham, probably the tree on which Mr Beach first found it. Abundant on an elder at the border of Chatcombe Wood, near Cheltenham. This elder was cut down in 1913. On elm at Sherborne, near Northleach.

SCHISTOSTEGACEÆ

Schistostega osmundacea Mohr. 34. Mr Ley mentions in the " Flora of Herefordshire " and in " The Botany of Mitcheldean district " that he found this moss in hollows of the Old Red Sandstone conglomerate near Mitcheldean in Gloucestershire. There were two specimens in his herbarium with the labels " Sandpits near Ruardean, 1873 " and " Mitcheldean, 1878." These two specimens probably came from the same locality near the county-boundary, between Ruardean and Mitcheldean.

FUNARIACEÆ

Ephemerum serratum Hampe. 33, 34. Widely distributed but rare in many parts of the county. In the northern parts of the Cotteswolds it occurs most frequently in woods and fallow fields on the Middle Lias. Common in fallow fields on the sandstone (Trias) about Newent.

Physcomitrella patens B. and S. 33, 34. At the side of pools and on damp ground, not uncommon in the Severn Valley and on the Cotteswolds. Not recorded from the Forest of Dean or Bristol districts.

Physcomitrium pyriforme Brid. 33, 34. Common.

Funaria fascicularis Schp. 33, 34. In fallow fields ; rare, but found in all parts of the County. Common in cultivated fields in the Newent district.

Funaria ericetorum Dixon. 34. In woods in the Western part of the County ; rare. Wood below Eastcliff, and at base of quarry below Pen Moel in the Wye Valley (Shoolbred). Symonds Yat (Miss Armitage and Binstead). In wood, Shaw Common near Newent.

Funaria calcarea Wahl. 33, 34. St. Vincent's Rocks, Clifton (Thwaites) ; Symonds Yat (Miss Armitage) ; Wye Valley near Pen Moel ; on ant-hills, Cleeve Hill, Cheltenham (Beach) ; near Seven Springs, by the Windrush (near Bourton-on-the-Water) ; Woodchester (Reader). This moss is abundant on the limestone of the Avon Gorge near Bristol. Elsewhere it has been found only sparingly. In Thwaites' list this plant is named *Funaria Muhlenbergii* var. *patula*.

Funaria hygrometrica Sibth. 33, 34. Common.

MEESIACEÆ

Aulacomnium palustre Schwaeg. 33, 34. Common in the Forest of Dean ; also May Hill and Chase End Hill. Rare elsewhere. Yate Common. Heath near Moreton-in-the-Marsh. Fruit not found.

Aulacomnium androgynum Schwaeg. 34. Sandy banks ; rare. Near Bristol (Thwaites). Mitcheldean Meend (Miss Armitage and Binstead).

BARTRAMIACEÆ

Bartramia Œderi Swartz. 34. Pen Wood above Frocester (Holmes and Reader).

Bartramia pomiformis Hedw. 34. Very rare on the Cotteswolds ; found sparingly at Woodchester Park (Reader), and near Dursley (Miss Gingell). Not common in other parts of the County. Near Bristol (Thwaites), and sparingly at Moorend (Miss Roper) ; near Chepstow (Shoolbred) ; near Mitcheldean ; Bromsberrow. This moss is found near Symonds Yat, but over the border in Herefordshire.

Philonotis fontana Brid. 33, 34. Not uncommon in the Forest of Dean and occasionally fruiting. Also May Hill c.fr. and Chase End Hill. East of the Severn only on the hill above Southam, near Cheltenham.

Philonotis calcarea Schp. 33, 34. "At spring heads on the hills near Cheltenham, occasionally fruiting" (Beach). Very scarce now near Cheltenham. Whelford (Taylor); Woodchester Park (Reader); Mitcheldean Meend (Ley); and elsewhere in the Forest (Holmes).

Philonotis capillaris Lindb. 34. Damp sandy (May Hill Sandstone) ground on May Hill.

BRYACEÆ

Leptobryum pyriforme Wils. 33, 34. Usually a weed in greenhouses and gardens. Also under rock at Staunton, and on rocks at Bromsberrow.

Webera nutans Hedw. 33, 34. Rare on the Cotteswolds, where it is usually confined to tree stumps in woods. On sandy and peaty ground in the Forest of Dean; common. Also in the Bristol district. In the Proceedings of the Woolhope Naturalists' Field Club, Mr Ley records var. *bicolor* B. and S. from Mitcheldean Meend, but the specimen from there in his herbarium is certainly the type.

Webera annotina Schwaeg. 34. Not uncommon in the Forest of Dean and May Hill. Always barren.

Webera carnea Schp. 33, 34. Common.

Webera albicans Schp. 33, 34. Common. The fruit is rare and has not been recorded for the County.

Webera Tozeri Schp. 34. Roadside bank (Old Red Sandstone), Purton, near Severn Bridge Station; sparingly and only barren plants.

Bryum pendulum Schp. 33, 34. Walls and stony ground, generally distributed, but not common. Thwaites' specimen from Westbury-on-Trym in the Bristol Museum is correctly named.

Bryum inclinatum Bland. 33, 34. In similar situations and more frequent than the last.

Bryum pallens Swartz. 33, 34. Common but nearly always barren. The fruit is sometimes found in the Forest of Dean.

Bryum pseudo-triquetrum Schwaeg. 33, 34. Common in wet places, but rarely fertile. Forest of Dean c.fr. (Holmes).

Bryum bimum Schreb. 33, 34. Rare, often growing with the preceding. Woodchester (Reader); Postlip Valley, near

Cheltenham ; Fairford (Taylor) ; Cerney Wick ; near Newent. In this species the fruit is generally present.

Bryum pallescens Schleich. 34. Forest of Dean (Holmes and Elliott). Stony ground near Milkwall.

Bryum intermedium Brid. 33, 34. Damp ground, not common. By the railway at Charlton Kings, and at the old Pilford Brickworks, Pilley, Leckhampton ; by railway between Newent and Dymock.

Bryum cæspiticium L. 33, 34. Common on walls, etc.

Bryum provinciale Philib. 34. Limestone rocks Symonds Yat c.fr. (Miss Armitage and Binstead) ; and limestone rocks above the Wye near Tidenham.

Bryum capillare L. 33, 34. Common. Var. *torquescens* Husn. (33, 34). "On the hills near Cheltenham, about old stone quarries" (Beach). Quarry by R. Wye above Chepstow. Var. *rosulatum* Mitt. (33), Horn's Valley, Stroud (Holmes).

Bryum obconicum Hornsch. 34. Symonds Yat.

Bryum Donianum Grev. 34. On roadside banks in several places about Newent and Bromsberrow. Fruit not found.

Bryum erythrocarpum Schwaeg. 33, 34. Sterile plants with the radicular gemmæ are not uncommon on the Cotteswolds and elsewhere in cultivated fields and woods. Railway embankment near Cheltenham c.fr ; woods and heaths in the Forest of Dean, where fruit is more frequent ; also in the Avon Gorge, near Bristol.

Bryum rubens Mitt. 34. In woods near Symonds Yat (Miss Armitage and Binstead) ; near Slaughter, Staunton (Ley). This species is hardly distinguishable from the last.

Bryum atropurpureum (Web. and Mohr). 33, 34. Common. A form with gemmæ, var. *gracilentum* Tayl. (33, 34) is also common.

Bryum murale Wils. 33, 34. On the mortar of walls ; not common, but found in all parts of the County. Also in limestone quarry by the R. Wye above Chepstow.

Bryum alpinum Huds. 34. On May Hill. This species is recorded for Cheltenham by Mr Beach, probably an error.

Bryum argenteum L. 33, 34. Common. The var. *lanatum* B. and C. (33, 34) is not uncommon.

Bryum roseum Schreb. 33, 34. Not common, found sparingly in most parts of the County. The fruit has not been found.

Mnium affine Bland. 33. Rare and found only in marshy places on the Cotteswolds, a form which is usually named var. *elatum* B. and S. Lypiatt (Elliott); Brimpsfield and Slad Valley; Withington. Also brick-pits by the R. Severn, Sandhurst. Sterile plants only.

Mnium cuspidatum Hedw. 33, 34. Rare and seldom found in fruit. It sometimes grows in pastures where it is easily overlooked. Bristol (Thwaites); Cheltenham (Beach); Cleeve Hill by the ancient camp, and in field by Puckham Wood, near Cheltenham; Wigpool Common, near Mitcheldean; on rocks in wood at Symonds Yat c.fr.

Mnium rostratum Schrad. 33, 34. Common, but fruit rare on the Cotteswolds. The fruit is more frequent in the west of the County.

Mnium undulatum L. 33, 34. Common, and fruiting in many parts of the County.

Mnium hornum L. 33, 34. Common.

Mnium serratum Schrad. 34. Plentiful in Pen Wood, above King's and Leonard Stanley; wood near Dursley (Miss Gingell); sparingly by R. Wye at Symonds Yat.

Mnium stellare Reich. 33, 34. Common in woods on the Cotteswolds and also in the Forest of Dean; mostly on the limestone, but not confined to it. Also near Newent. Fruit has not been found in the county.

Mnium punctatum L. 33, 34. Common. In woods on the Cotteswolds it is usually poor and barren.

FONTINALACEÆ

Fontinalis antipyretica L. 33, 34. In rivers, streams, and pools; common, but rarely in fruit. Toadsmoor, near Stroud c.fr. (Holmes).

CRYPHÆACEÆ

Cryphæa heteromalla Mohr. 33, 34. A rare moss found sparingly on trees all over the Cotteswolds; also near Bristol (Thwaites). Very rare on the west of the Severn. In wood near Highnam; and in hedge on Pope's Hill, near Little Dean.

NECKERACEÆ

Neckera crispa Hedw. 33, 34. Common on the Cotteswolds, especially on or near the escarpment. Also on the limestone of the Wye Valley and the Bristol district. The fruit is found in many woods on the Cotteswolds; also on St. Vincent's Rocks (Thwaites); and Symonds Yat (Miss Armitage). Var. *falcata* Boul. (33, 34). In exposed places on the Cotteswolds, and at Symonds Yat (Miss Armitage).

Neckera pumila Hedw. 33, 34. On trees, not uncommon on the Cotteswolds, and fruiting at Hartley Bottom, near Cheltenham (Beach); Hilcot; Rendcomb; Climperwell; Woodchester (Reader); near Bristol (Thwaites). Rare on the west of the Severn. Purton, near Severn Bridge Station. Var. *Philippeana* Milde (33) often grows with the type.

Neckera complanata Hübn. 33, 34. Common on walls and trees in all parts of the county, occasionally fruiting.

Homalia trichomanoides B. and S. 33, 34. On trees and on the ground in woods; common.

HOOKERIACEÆ

Pterygophyllum lucens Brid. 34. Not uncommon on woods in or near the Wye Valley; near Bristol (Thwaites); on the Cotteswolds, found only near Dursley (Miss Gingell).

LEUCODONTACEÆ

Leucodon sciuroides Schwaeg. 33, 34. On trees and walls; common on the Cotteswolds, less common in the west of the County. The fruit has not been found.

Pterogonium gracile Swartz. 34. Rare and sterile. On oak, Woodchester Park (Reader); on rocks, Staunton in the Forest of Dean.

Autitrichia curtipendula Brid. 33. Rare and sterile. Usually found growing on walls. Cheltenham (Beach); wall, near Bisley (Holmes and Reader); Hilcot, near Colesbourne; wall, Oakley Park, Cirencester.

Porotrichum alopecurum Mitt. 33, 34. Common on hedgebanks and in woods; occasionally fruiting.

LESKEACEÆ

Leskea polycarpa Ehrh. 33, 34. Common on trees by streams and rivers in the low ground; less frequent on the hills.

Anomodon longifolius Hartm. 34. On rocks at Symonds Yat (Miss Armitage and Binstead).

Anomodon viticulosus. Hook. and Tayl. 33, 34. Common on walls and trees. The fruit is not uncommon on the Cotteswolds; also Wigpool, near Mitcheldean c.fr. (Ley).

Heterocladium heteropterum B. and S. 34. On rocks which are not calcareous in many parts of the Forest of Dean. Also sparingly on rocks in the Avon Gorge near Bristol (Waterfall). Always sterile. The usual form is the small plant known as var. *fallax* Milde (34), but the type is found in The Buckstone Wood near Staunton (Duncan), and at Rodmore Grove.

Thuidium abietinum B. and S. 33. Plentiful at Dodwell Quarries, near Whittington, and sparingly on Cleeve Hill Common.

Thuidium tamariscinum B. and S. 33, 34. Common in woods, and occasionally fruiting. This is the only species of this genus in which fruit has been found.

Thuidium delicatulum Mitt. 34. On Old Red Sandstone rocks in Abbott's Wood, near Little Dean.

Thuidium recognitum Lindb. 34. In the woods at Symonds Yat (Miss Armitage), and near the Devil's Pulpit in the lower part of the Wye Valley.

Thuidium Philiberti. Limpa. 33, 34. Generally distributed on the Cotteswolds in stony pastures, old quarries, and sometimes in wet fields. Also in the limestone districts of the Bristol and Forest of Dean districts. This plant has had frequent changes of name; in Mr Beach's list it appears as *T. delicatulum*; then, till recently, it was known as *T. recognitum*. See "*Thuidium recognitum*, and its Allies," by H. N. Dixon in "Journal of Botany," June, 1913.

HYPRIACEÆ

Climacium dendroides Web. and Mohr. 33, 34. Marshy ground; rare, but widely distributed. Fruiting in the marsh on Sevenhampton Common. This moss grows on rocks in a quarry on Frocester Hill (Reader).

Cylindrothecium concinnum Schp. 33, 34. Generally distributed on the Cotteswolds, often in small quantity and mixed with other mosses. Also on roadside bank near Deerhurst. Symonds Yat (Miss Armitage and Binstead) and Staunton.

Pylaisia polyantha, B. and S. 33, 34. On wooden railings and on elder at Dowdeswell, near Cheltenham. In hedge Marian's enclosure near Staunton. In both places with abundant fruit.

Orthothecium intricatum B. and S. 34. Symonds Yat (Miss Armitage and Binstead) and on limestone rocks in the Wye Valley at Tidenham.

Camptothecium sericeum Kindb. 33, 34. Walls and trees; common.

Camptothecium lutescens B. and S. 33, 34. Common everywhere on the Cotteswolds; found also in the Severn Valley and on the limestone of the Bristol and Forest of Dean districts. Fruiting in many places on the Cotteswolds.

Brachythecium glareosum B. and S. 33, 34. On banks, rocks, and walls, generally distributed and often common on the Cotteswolds. Common also on the limestone of the Forest of Dean. Also at Penpole Point near Bristol (Miss Roper; Damery; and Bromsberrow. Fruit rare; found only in Pen Wood above King's Stanley (Holmes and Elliott).

Brachythecium albicans B. and S. 33, 34. Widely distributed, but not common. In the North Cotteswolds, often abundant on the Middle Lias. Fruit rare. Thatch at Fairford c.fr. (Taylor).

Brachythecium salebrosum B. and S. 33. In wood at Hilcot, near Colesbourne c.fr. Also recorded by both Thwaites and Beach, but these old records probably refer to *B. glareosum*, with which this species was formerly confused. Var. *palustre* Schp. (34). Roadside in Buckholt Wood, near Nympsfield (Reader.)

Brachythecium rutabulum B. and S. 33, 34. Common.

Brachythecium rivulare B. and S. 33, 34. On rocks and stones by streams, common, but rarely in fruit. Symonds Yat c.fr. (Miss Armitage); Abbott's Wood, near Little Dean c.fr. Var. *chrysophyllum* Bagnall (33) Slad, near Stroud (Holmes).

Brachythecium velutinum B. and S. 33, 34. Common.

Brachythecium populeum B. and S. 33, 34. On walls and stones in woods, and sometimes on trees. Found in many parts of the Cotteswolds, but rare. More frequent in the west of the County.

Brachythecium plumosum B. and S. 34. On rocks by streams, confined to the Forest of Dean, where it is not uncommon.

Brachythecium cæspitosum Dixon. 33, 34. On rocks, walls, and trees; in places which are subject to inundation during floods. Near Bristol (Thwaites); stones by R. Wye under Bicknor Woods (Ley); on bridge walls and trees on both sides of R. Severn between Tewkesbury and Gloucester; base of tree by R. Coln, Fairford. Always barren.

Brachythecium illecebrum De Not. 33, 34. Calfway, near Bisley (Holmes); hedge bank, Damery. Not uncommon on the Keuper Sandstone rocks about Newent and Bromsberrow. Always barren.

Brachythecium purum Dixon. 33, 34. Common, and occasionally fruiting.

Eurhynchium piliferum B. and S. 33, 34. Common, rarely fruiting. Near Fairford c.fr. (Taylor); Woodchester c.fr. (Reader); near Symonds Yat c.fr. (Miss Armitage).

Eurhynchium crassinervium B. and S. 33, 34. On shady walls and roots of trees; common on the Cotteswolds and on the limestone of the Bristol and Forest of Dean districts. In the Forest it also grows on Old Red Sandstone rocks. Fruit not uncommon on the Cotteswolds. This plant varies much in size and is sometimes very slender, var. *tenue* Braith.

Eurhynchium speciosum Schp. 33. Well at Fairford and sheep-pool at Whelford c.fr. (Taylor).

Eurhynchium prælongum Hobk. 33, 34. Common. Var. *Stokesii* Brid. (33, 34). Hilly woods about Stroud (Reader); Symonds Yat (Miss Armitage).

Eurhynchium Swartzii Hobk. 33, 34. Common, and occasionally fruiting.

Eurhynchium abbreviatum Schp. 33, 34. On hedge banks and in woods; not uncommon but often barren. Fruit abundant in woods at Woodchester and near Dursley.

Eurhynchium pumilum Schp. 33, 34. Common, and fruit not rare.

Eurhynchium curvisetum Husn. 33, 34. On rocks in streams ; not uncommon on the Cotteswolds in suitable places. The leaves of this plant always have a short nerve, but in other respects this does not differ much from the next species.

Eurhynchium Teesdalii Schp. 34. Symonds Yat (Miss Armitage and Binstead), and on rocks by streams in many parts of the Forest of Dean.

Eurhynchium tenellum Milde. 33, 34. Common. This species is especially abundant on Carboniferous-Limestone rocks.

Eurhynchium myosuroides Schp. 33, 34. Common on trees and rocks and often fruiting in the Forest of Dean. Rare elsewhere, and confined to trees in woods, and usually barren. On trees near Fairford c.fr. (Taylor). Var. *debile* Braith. The Dells near Mitcheldean (Miss Armitage).

Eurhynchium myurum Dixon. 33, 34. In woods ; common.

Eurhynchium circinatum B and S. 34. Bristol (Thwaites). Raven Crag, Coldwell Rocks near Symonds Yat (Ley). This moss is abundant on the Carboniferous-Limestone of the Avon Gorge near Bristol, and is found sparingly near Symonds Yat.

Eurhynchium striatum B. and S. 33, 34. Common ; fruit not rare.

Eurhynchium striatulum B. and S. 34. St. Vincent's Rocks, Bristol (Thwaites) ; Symonds Yat (Miss Armitage and Binstead), and on the limestone rocks in the lower part of the Wye Valley. This moss is scarce on the Gloucestershire side of the Bristol Avon, but it still grows on the rocks below Durdham Down. It is more plentiful in the Wye Valley. The fruit has not been found.

Eurhynchium rusciforme Milde. 33, 34. On rocks by streams ; common.

Eurhynchium murale Milde. 33, 34. Common. This moss is very fine and abundant on the Cotteswolds. A form with long branches, var. *julaceum* B. and S. (33, 34) is found about Stroud (Holmes and Elliott) and Cheltenham.

Eurhynchium confertum Milde. 33, 34. Common on walls and trees.

Eurhynchium rotundifolium Milde. 33. Calfway, near Bisley (Holmes and Elliott, 1901). Mr Elliott says that this moss has now disappeared from the locality.

Plagiothecium depressum Dixon. 33, 34. Common on stones in woods on the Cotteswolds ; also in the Forest of Dean, mostly on the limestone, but sometimes on the Old Red Sandstone. Fruit rare. Woods near Cheltenham c.fr ; near Mitcheldean c.fr. (Miss Armitage).

Plagiothecium elegans Sull. 33, 34. Common in woods, not on limestone, in the Forest of Dean, and in fruit at Rodmore Grove. Rare elsewhere. Woods at Damery ; on the Cotteswolds in woods on the Middle Lias at Lineover near Cheltenham, Witcombe, and Cranham ; and on the Cotteswold Sands in Woodchester Park (Reader).

Plagiothecium denticulatum B. and S. 33, 34. Common.

Plagiothecium silvaticum B. and S. 33, 34. Common, but rarely fruiting.

Plagiothecium undulatum B. and S. 34. Common in woods in the Forest of Dean, mostly on the Old Red Sandstone. Fruit not uncommon. Elsewhere only recorded from Woodchester Park (Reader).

Plagiothecium latebricola B. and S. 33, 34. " Sparingly in woods near Cheltenham " (Beach). On tree stump, Lineover wood ; on roots of fern in wood by The Buckstone, Forest of Dean (Duncan). Barren plants only with numerous gemmæ on the leaves.

Amblystegium Sprucei B. and S. 34. Symonds Yat (H. N. Dixon).

Amblystegium confervoides B. and S. 33, 34. Sparingly in woods on the Cotteswolds, and usually fruiting. Puckham Wood near Cheltenham ; Chedworth Wood ; and woods near Boxwell. Also in several places on the limestone in the Wye Valley.

Amblystegium compactum Aust. 34. Under overhanging rocks and in crevices of an old wall near Symonds Yat.

Amblystegium serpens B. and S. 33, 34. Common.

Amblystegium Juratzkanum Schp. 33, 34. Usually in damper situations than the last; not uncommon.

Amblystegium varium Lindb. 33. Tree stumps near Wyck Rissington. *Hypnum radicale* on Beach's Cheltenham list may be this, or perhaps the next species.

Amblystegium irriguum B. and S. 33, 34. On stones in streams on the Cotteswolds and the Forest of Dean; not common. Fruit usually plentiful.

Amblystegium fluviatile B. and S. 33, 34. On old barges in the Severn at Wainlode, and on stones in the Wye at Symonds Yat. This moss has been carried down by the stream from the upper parts of these rivers.

Amblystegium filicinum De Not. 33, 34. Common, and sometimes fruiting. Var. *Vallisclausæ* Dixon (33, 34) in springs and streams; not uncommon on the Cotteswolds.

Hypnum riparium L. 33, 34. By streams and ponds; common. Also var. *longifolium* Schp. (33).

Hypnum elodes Spruce. 33. Marshy ground near Wyck Rissington.

Hypnum stellatum Schreb. 34. Wet ground; common where Sphagnum grows in the Forest of Dean and May Hill; also near Bristol (Thwaites). Fruiting plants not seen. Var. *protensum* Röhl. (33, 34). On walls, stony ground, and also in marshes; common on the Cotteswolds; also at Newent and Symonds Yat (Miss Armitage); marshy ground near Wyck Rissington c.fr.

Hypnum chrysophyllum Brid. 33, 34. Common, fruit rare. Field near Tidenham c.fr.

Hypnum Sommerfeltii Myr. 33, 34. On shady walls, rocks, and sometimes at the base of trees in woods. Common on the Cotteswolds and the calcareous parts of the Forest of Dean. Also on Keuper Sandstone rocks near Bromsberrow.

Hypnum aduncum Hedw. 33, 34. Common on the Cotteswolds and in the low ground by the Severn in ponds and slow streams. Also at Bristol (Thwaites). Var. *gracilescens* Schp. (33). On damp bank near Deerhurst, and on Wistley Hill, near Cheltenham. Var. *polycarpon* Bland. (33). Toadsmoor, near Stroud (Holmes); Siddington. Var. *intermedium* Schp. (33). Wainlode—Coombe Hill Canal, and Siddington, near Cirencester. Var. *paternum* Sanio (33, 34). The common form in ponds and reservoirs.

Hypnum fluitans L. 34. On Beach's Cheltenham list, but probably an error. Var. *falcatum* Schp. (34), Mitcheldean Meend c.fr.

Hypnum exannulatum Gümb. 33, 34. Not uncommon on damp ground in the Forest of Dean where *Sphagnum* grows. May Hill c.fr. The usual form is var. *pinnatum* Boulay (34). Var. *brachydictyon* Ren. (34) near Speech House Road Station. *Forma stenophylloides* Ren. (33). Margin of pool on the gravel (" Northern Drift ") near Moreton-in-Marsh.

Hypnum uncinatum Hedw. 33, 34. Forest of Dean (Holmes). Sparingly on Cleeve Hill, near Cheltenham.

Hypnum intermedium Lindb. 33, 34. Marsh on Sevenhampton Common, and near Seven Springs on the Windrush above Bourton-on-the-Water; also on May Hill.

Hypnum commutatum Hedw. 33, 34. A variable moss, not uncommon in springs and streams on the Cotteswolds, and also in the Wye Valley, occasionally in fruit.

Hypnum falcatum Brid. 33, 34. In similar places to the last but less common. Postlip Valley, Cleeve Hill, near Cheltenham; Puckham Wood; Seven Springs, by the Windrush (near Bourton-on-the-Water); Toadsmoor near Stroud (Holmes); Mitcheldean Meend (Ley). Always barren.

Hypnum cupressiforme L. 33, 34. Common. Var. *resupinatum* Schp. (33, 34). On walls and trees; not common, and usually sterile. Forest of Dean c.fr. (Holmes). Var. *filiforme* Brid. (33, 34). On trees; common. Var. *minus* Wils. (33, 34). About Stroud (Elliott); Witcombe Wood. Var. *mamillatum* Brid. (34) Woodchester Park (Reader). Var. *ericetorum* B. and S. (33, 34). Common in the Forest of Dean and west of the County, less common on the Cotteswolds. Var. *tectorum* Brid. (33, 34); common. In addition to these Holmes had in his herbarium specimens of the following, which had been submitted to Mr Dixon. Var. *brevisetum* Schp. On base of oak in willow-bed, Woodchester. Var. *longirostre* B. and S. Horns Valley, Stroud.

Hypnum Patientiæ Lindb. 34. Not common; occasionally found in the Forest of Dean; also in the Newent district. East of the Severn, recorded only from Rodborough Common (Reader).

Hypnum molluscum Hedw. 33, 34. Common, especially in calcareous districts. Fruit not rare.

Hypnum palustre Huds. 33, 34. On rocks by streams, generally distributed, and common in the Forest of Dean.

Hypnum stramineum Dicks. 34. This grows with *Sphagnum intermedium* in the marsh by Fox's Bridge, and near Speech House Road Station. Sterile.

Hypnum cordifolium Hedw. 34. Forest of Dean (Holmes). By Fox's Bridge near the Speech House and Tidenham Chase. Sterile.

Hypnum cuspidatum L. 33, 34. Common. Fruit plentiful when growing in marshes.

Hypnum Schreberi Willd. 33, 34. This common moss is rare on the Cotteswolds, though found sparingly in many parts, especially where there is sand. Conham, near Bristol (Thwaites); common in the Forest of Dean, except on the limestone and along the Western border to Chase End Hill. Fruit rare. Wood near Mitcheldean c.fr. (Miss Armitage).

Hylocomium splendens B. and S. 33, 34. Common, but rarely in fruit. Fruit at Woodchester (Reader), and near Cheltenham.

Hylocomium brevirostre B. and S. 33, 34. In woods on the Cotteswolds; not common, but plentiful in some woods on or near the escarpment; also in woods in the Forest of Dean, and plentiful in parts of the Wye Valley. Fruit rare. Woodchester Park c.fr. (Reader); woods near Dursley c.fr. (Miss Gingell).

Hylocomium loreum B. and S. 33, 34. Not common, but like the last, found in many woods in the Cotteswolds, and also in the Forest of Dean. Plentiful in some woods on the Old Red Sandstone. Fruit rare. Woodchester Park c.fr. (Reader); Witcombe Wood c.fr.

Hylocomium squarrosum B. and S. 33, 34. Common and occasionally fruiting.

Hylocomium triquetrum B. and S. 33, 34. Common, fruit not rare.

Obituary Notices

H. B. WOODWARD, F.R.S., F.G.S.[1]

BORN, 20th AUGUST, 1848. DIED, 6th FEBRUARY, 1914.

Horace B. Woodward

Horace Bolingbroke Woodward was elected an Honorary Member of the Club in 1902, in recognition of the useful work he had done in geology, especially in connection with the Jurassic rocks. His three volumes on "The Jurassic Rocks of Britain" are a monument of industry, and invaluable to all workers on the rocks to which they refer. To those more generally interested in geology his name will be familiar as the author of the well-known work on "The Geology of England and Wales."

The value of his work was recognized by the Geological Society in the successive awards of the Murchison Geological Fund in 1885, the Murchison Medal in 1897, and the Wollaston Medal in 1909. Mr Horace Woodward was President of the Geologists' Association 1893-4.

1 A detailed obituary notice appeared in the *Geological Magazine* for March, 1914, pp. 142-144. The portrait illustrating the present notice was kindly lent by the Editor of the *Geological Magazine*.

O. H. FOWLER, M.R.C.S.

BORN, 10th AUGUST, 1840. DIED, 9th AUGUST, 1914.

In the removal by death of "The Doctor" the Club has to mourn the loss of a Member and friend who was the life of every meeting he attended.

"Mr. O. H. Fowler[1] was born at Kingsclere, Hants, where Mr Fowler, senior, was in practice for over 30 years, removing to Cheltenham on his retirement, and living there for many years. The subject of our memoir received his medical and surgical training at St. Bartholomew's Hospital, Sir James Paget being one of his teachers. After filling one or two temporary appointments, he came to Cirencester, a young man of between 26 and 27, as *locum tenens* to the late Mr Edward Cripps, who had succeeded to the old and valuable practice of the late Mr Thomas Warner, with whom Mr Cripps was associated for some years before Mr Warner's retirement. Mr Cripps found that he required permanent assistance, and he and Mr Fowler found that their relations were so mutually satisfactory that a partnership was entered into. Mr Fowler at once took a leading position in the life of the town and district, for it was speedily recognised that allied to his breezy and cheery manner, which was occasionally a trifle brusque, and sometime disconcertingly outspoken, there was medical knowledge and surgical skill of an unusually high order, and a courageous self-reliance which gave his patients a complete confidence in him which was never misplaced. The result was that his practice became such as few country doctors could boast, for all the leading families of a very wide district sought his aid. On his 'at home' days his consulting room was as thronged as that of many a fashionable

1 Extracts from the "Wilts and Gloucestershire Standard," August 15, 1914. The Club is indebted to the Editor of this paper for the loan of the portrait block.

physician, and he covered prodigious journeys in visiting his widely scattered patients under conditions from which, in these days of motor cars, modern doctors are happily now delivered. For many years it was his custom to do a morning journey on horseback. After a hasty lunch he would again take the road in his lofty gig, and finish up the day with town calls in his smart brougham, tiring out two or three horses in the day but himself finishing up smart and unwearied, and ready to respond to a midnight call of suffering and distress as if his strictly professional and irreproachable tall hat—he relaxed into a white one for summer wear—had accompanied him to his pillow and never lost its accustomed and characteristic angle. After a long day thus spent in the service of afflicted humanity he was ready, when professional duties permitted, to be the life and soul of a congenial dinner party either in his own home—where he was a model host—or at the table of one of his wide circle of friends. Nor was the regard in which Mr Fowler was held by his patients confined to his professional capacity. His strong common sense and sound business habits caused his advice to be frequently sought in other than medical affairs, and he was a valued *confidant* in many cases of difficulty and delicacy. Mr Edward Cripps held a commission as surgeon in the old Royal North Gloucester Militia, and though Mr Fowler did not accept military rank, he was for many years civil surgeon in medical charge of the regiment, and was always an acceptable guest at the officers' mess. He was also throughout his career, in conjunction with his several partners, the kindly and considerate doctor to many of the leading benefit societies of the town, including the Oddfellows, the Foresters, the East Gloucestershire Benefit Society, and others, and a frequent chairman at the annual dinner of some of these bodies.

"Perhaps the most attractive and realistic pen portrait of Dr Fowler—for though he may not have troubled to procure from the schools the affixed initials formally entitling him to the prefixed designation, this latter was accorded him by public acclaim—was that drawn by Mrs Allen Harker in one of a charming series of sketches she contributed to the *Outlook* some years ago. :—

OUR COUNTRY DOCTOR.

'Not an ordinary one, mind you! Our doctor is unique, a *rara avis* among doctors; we are sure of it, and are proud of him accordingly.

'What other doctor wears his top hat (in summer it is a white one) at so jaunty an angle, or drives at such a breakneck speed? But the speed would need to be exceptional, for he often travels over seventy miles in his day.

'What other doctor dares to tell the pretty ladies that they are 'as clever as the very Devil,' and every plain one that she is 'an ornament to the county?' Yet no one is ever offended. I do not believe he has an enemy in the whole county, unless it be some churl at whom he has sworn for dilatoriness in the matter of opening gates, and even then I doubt it; for our doctor may swear at whomsoever he pleases and nobody bears him a grudge.

'I wonder if there exists another doctor in England who dares to bawl out embarrassing professional questions, in the public way, interspersed with objurgations on the antics of his mare. What other doctor pays such flying visits? He generally gives his last instructions as you pursue him down the drive. It is only when the patient is very young and pretty that the visit lasts five minutes.

'He never seems to take a holiday, yet, when any of us go to town, whom should we meet airily strolling down Bond-street but the doctor, with a flower in his button-hole, just as if he had grown there.

'He pays his visits round about the country town in which he lives driven demurely in a brougham. But for the long distances, when he has to battle with wind and rain and frightful roads, he sets forth jauntily in that smartest of high dog-carts, looking for all the world like a jolly country squire driving to the meet to save his leathers.

'Much appreciated as are his dinner-parties, excellent as is his cellar, it is upon his friends he lavishes his best; for, in spite of his red face and husky voice, it is well known that the doctor is the most abstemious man alive. There are people who say he is a doctor by intuition rather than by erudition; but whichever way it is, we fly to him in every emergency with a faith that is always justified. It is true he is something of an alarmist, much given to informing nervous patients that 'You'll be dead in twenty-four hours if you don't do' —— so and so. But when he has brought you back from the jaws of death, how gleefully he stands upon the hearthrug warming his coat tails, while he congratulates himself upon his treatment of your case. He is fond of ordering champagne for weakly people, and not infrequently sends it himself to ensure that his prescription is followed. His memory is prodigious; but there are those among his patients (who are poor and do not like to mention it) who have known him to forget to send in any bill—a sin of omission which we hope the recording angel will not fail to note.'

"At Christmas, 1906, after 40 years arduous professional life, Mr Fowler decided to retire, and to seek leisure and relaxation while still blessed with health and strength to enjoy it.

"On retiring from practice, Mr Fowler was able to take a share in public life which had hitherto been denied him, and in 1908 he offered himself as a candidate for election to the Cirencester Urban District Council, being returned at the head of the poll. He was re-elected in 1911, and as Mr Haygarth relinquished the chairmanship the following year, Mr Fowler was appointed to the post, carrying out the duties, and also those of *ex officio* magistrate associated therewith, in an admirable manner, so that his decision last Spring not again to seek election was a subject of general and genuine regret. Mr Fowler has also done excellent service for some years past as honorary secretary to the Cirencester Children's Care Committee. Another direction in which he found congenial relaxation was in attending the meetings and excursions of the Bristol and Gloucestershire Archaeological Society and the Cotteswold Naturalists' Field Club."

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(COMPILED BY ROLAND AUSTIN).

The objects of the Club are to promote the systematic investigation of the Natural History and Antiquities of the County; to make excursions in the County and to other parts; to facilitate intercourse on scientific matters, and to aid in obtaining more general attention for the objects of Science.

Members are elected on a Certificate of Recommendation, signed by two Members, one of whom must have personal knowledge of the Candidate. The Admission Fee is £1; and the Annual Subscription is 15/-.

Winter Meetings are held at Gloucester, and there are frequent Field Meetings. Proceedings are published annually.

Forms of proposal for Membership and any further information may be obtained on application to the Hon. Secretary.

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PAPERS PUBLISHED

*** The Publication Committee's decision as to the publication of any paper is final, and the Committee will not be able to consider any paper unless it is placed in the Secretary's hands within a month of its being read.

[*The Editor of the Proceedings of the Cotteswold Naturalists' Field Club is directed to make it known to the Public that the Authors alone are responsible for the facts and opinions contained in their respective Papers.*]