THE FAUNAL SUCCESSION OF THE UPPER BERNICIAN

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(Plates xvi., xvii., xviii.)

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I.

INTRODUCTION.

In this paper are set forth the results obtained by collecting in the calcareous beds of the Bernician or Lower Carboniferous series of Northumberland. The work, which occupied the greater part of a year (1907–8), had for its object an inquiry into the faunal succession of the Upper Bernician.

The scheme adopted for zoning was that used by Dr. Arthur Vaughan in his work on the Carboniferous Limestone formation of the South-West Province, and successfully applied by subsequent workers to other Carboniferous areas in Britain.

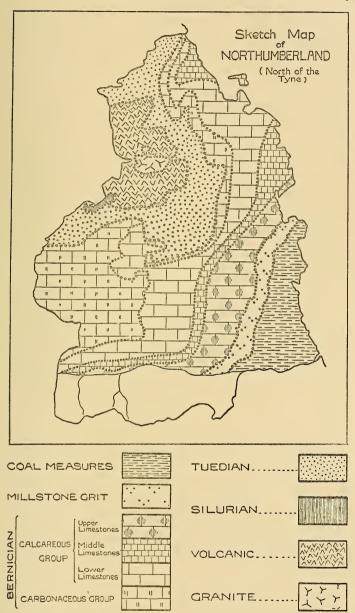
I take this opportunity of thanking those gentlemen who have so generously aided me in my undertaking. I am especially indebted to Prof. G. A. Lebour and Dr. Vaughan, to Prof. Lebour for his advice and encouragement whilst carrying out the field-work, and to Dr. Vaughan for determining the corals and for other valuable assistance. My thanks are also due to Dr. Wheelton Hind for naming the lamellibranchs, and to several members of H.M. Geological Survey, namely to Dr. Traquair for identifying the fish remains, to Dr. Kitchin and to Mr. R. G. Carruthers. Lastly I must express my great obligation to Mr. John Dunn, formerly of Redesdale, for allowing me access to his valuable collection of Redesdale fossils—the result of many years' careful collecting.

II.

THE BERNICIAN SERIES.

The Bernician series forms the upper, and by far the larger, division of the Lower Carboniferous sequence of Northumberland, and covers the greater part of the county. It is divisible into two groups, the upper or Calcareous Division and the lower or Carbonaceous Division. Below the Bernician strata lie the Tuedian beds, including under the term the Fell Sandstone series and the Cementstone group. The Northumberland succession, together with the Lower Carboniferous rocks north of the Tweed, occupies the northern extremity of the Carboniferous Limestone tract, which stretches from Lancashire and Yorkshire into Scotland.

The Carboniferous strata in Northumberland encircle the Cheviots on the south, east, and north, and dip from the volcanic inlier, so that the general strike forms a rough semicircle round the igneous massif, nearest to which consequently lie the lowest beds. (See map.) In the south and east, the strata may be followed as continuous outcrops. In the districts round the volcanic inlier faulting has entirely destroyed the continuity of strike, but in the north it has spread out the scattered and repeated outcrops into belts, which run in the same direction as the general strike.



Geological Sketch-Map of Northumberland to show the Distribution of the Bernician Limestones.

The thickness of the Carboniferous Limestone series in Northumberland is difficult to estimate on account of excessive faulting and also owing to the great variations in thickness displayed by different members. It is probable that one division increases locally at the expense of another. The following figures given by members of H.M. Survey and others afford some idea regarding the thicknesses and variations of the groups; but they are only approximate.

Bernician. Calcareous Division Carbonaceous Division		Tyne & Rede. 4000? 2500	Coquet.	Tweed.
Tuedian. Fell Sandstone Series Cementstone Group	•••	600 600	2000	600 2500

Between the Coquet and the Tweed the Cementstone group thins out locally to a few hundred feet (300 or 400?).

The Bernician series is mainly built up of shales and sand-stones, but interbedded among the argillaceous and arenaceous deposits are beds of limestone and coal. Calcareous horizons are found in both divisions of the series, but the beds in the upper contrast strongly with those of the lower. In the Calcareous Division the limestones are thick, truly marine, and constant, some of them traversing the whole length of the county. In the Carbonaceous they are thin and impure, and often contain rootlets of Stigmaria; a few marine limestones make their appearance in the south. It is with the upper limestones that this paper is solely concerned, and my investigations were restricted to the country north of the Tyne.

South of Northumberland the Upper Bernician is mainly represented by the Yoredale rocks; the basal limestones, together with the Carbonaceous Division, are equivalent to the Great Scar Limestone series. The higher Yoredale strata disappear as they are followed southward; till in Wharfedale the Millstone Grit comes almost immediately upon the Main (= Great) Limestone.

III.

PHYSICAL CONDITIONS PREVAILING DURING THE DEPOSITION OF THE SERIES.

This series of thick detrital accumulations, containing numerous beds of coal and frequent interpolations of calcareous strata, could only have been formed in the proximity of land, and under very varying conditions, involving continuous oscillation of the sea floor and repeated change in geographical relationships. The rate of accumulation of sediment must at one period have exceeded the rate of subsidence, so that the sea became so silted up as to form a swamp in which grew the jungles that formed the coal seams. Rapid submergence followed, and these vegetable accumulations often became the floor upon which the calcareous deposits were laid down. The limestones were deposited near enough to the coast to allow frequent invasions of fine sediment, as indicated by the numerous shaly partings and interbedded shales.

IV.

STRATIGRAPHICAL SUBDIVISIONS.

The limestones of the Calcareous Division may be divided into three groups. The limestones above the Little Limestone, which occupy the south and east of Northumberland and which thin out towards the north, form the Upper Group; the Middle Group comprehends those thick and continuous beds which can be followed right across the county, and includes the Great Limestone; whilst to the Lower Group belong the limestones of the Calcareous Division below the Eelwell Limestone.

THE PRINCIPAL LIMESTONES OF THE UPPER BERNICIAN OR CALCAREOUS DIVISION.

Lowick and Scremerston District.		Great or Dryburn Limestone. Lowdean Limestone. Acre Limestone. Eelwell Limestone.	Oxford Limestone. Woodend Limestone. Dun Limestone.		
Alnwick District.	Fell Top Limestone (Alnmouth)	Great Limestone. Eight Yards Limestone. ? Six Yards Limestone. ? Nine Yards Limestone.	Hobberlaw Limestone. Dun Limestone.		
Tyne District.	Fell Top Limestone. *Robsheugh Limestone. *Thornbrough Limestone. *Corbridge Limestone.	Little Limestone. Great Limestone. Four Fathom Limestone. Three Yards Limestone. Five Yards Limestone. Scar Limestone.	Cockle Shell Limestone. Single Post Limestone. Tyne Bottom Limestone. Number of thin limestones. Fourlaws Limestone. Redesdale Limestone. Redesdale Limestone.		
	UPPER GROUP.	MIDDLE GROUP.	LOWER GROUP.		

Besides the beds enumerated above are many thin calcareous horizons and local beds of considerable thickness. * "Intercalated Limestones" of Professor Lebour.

V.

FAUNAL SUCCESSION, AND COMPARISON OF THE SAME WITH THAT OF THE SOUTH-WEST PROVINCE.

The fauna throughout the Calcareous Group closely agrees with the fauna of the Dibunophyllum-Zone, the highest of the palæontological divisions into which the Carboniferous Limestone series of the South-West Province (Bristol area) has been divided by Dr. Vaughan.**

The Bernician sequence yields a faunal succession which is capable of being divided into several marked horizons by means of corals and brachiopods, whilst a number of these horizons can be grouped together as characterised by the presence or abundance of some particular form or forms.

*A. Vaughan, "The Carboniferous Limestone Series of the Avon Gorge." Proc. Bristol Nat. Soc., 1906, ser. 4, vol. i, pt. ii, p. 74.

(See Table 2, p. 598).

PALÆONTOLOGICAL HORIZONS OF THE UPPER BERNICIAN. Table 2.

Saccam- mina carteri						
Productus $oldsymbol{eta}$				Productus a		
Diphy			yphyllum	Lithostro-		
	ibunophylli muriheadi	um		irre	irregulare	
Horizon of Dibunophyllum aff. muirheadi mut. cf. Dib. ψ	Decadent and impoverished IVa Fauna	Maximum of the Clisiophyllids	Zaphrentid Phase	Lower D2 Fauna Lonsdaleia floriformis enters	Dr Fauna	Shallow Water Phase
IVc	IVb	IVa	III	11.	н	ಡ
Fell Top Limestone	Robsheugh Limestone Thornbrough Limestone Corbridge Limestone	Little Limestone Great Limestone	Four Fathom Limestone Acre Limestone Belwell Limestone	Oxford Limestone	Fourlaws Limestone Redesdale Limestone	Redesdale Ironstone Shale
	Dy		D2-3	DZ	DΙ	

Faunal Diagnoses*.

a.—Shallow water fauna, mainly lamellibranchs and certain brachiopods. Corals extremely rare, but $Dibunophyllum\ \theta$ has been found. The bed corresponds, approximately at least, in position to the concretionary beds immediately below D1 of the South-West Province.

Cyathophyllum murchisoni Ed. and H. very common.

Campophyllum derbiense.

Diphyphyllum subibicinum (M'Coy).

Carcinophyllum θ Vaughan.

Dibunophyllum θ Vaughan.

Clisiophylloid Lithostrotion.

Lithostrotion irregulare, as well as Lith. junceum and Lith. portlocki abundant, but as yet of no value in subdividing the D zone.

The fauna is comparable with that of Dr in the South-West Province.

II. contains forms found in D2 of the South-West Province.

Lonsdaleia floriformis, Flem.

Dibunophyllum φ, Vaughan, and variants.

Lithostrotion irregulare and Lith. junceum.

III.—
$$(D_{2}-3)$$
.

Representing in its main character a Zaphrentid phase.

Caninoid Campophyllum.

Zaphrentis near enniskilleni, E. and H.

* I am indebted for this portion of the paper to Dr. Vaughan, having embodied here his report on the corals submitted to him for examination. What slight alterations have been made were necessitated by the results obtained in subsequent investigations.

Caninia cf. cornucopiæ, Nich.

Zaphrentis near oystermouthensis, Vaughan.

Zaphrentis constricta, Carruthers.

All the species above cited, with the exception of the last, are common in the D2-3 Beds of Gower, South-West Province. Associated with the above are a few representatives of standard conditions D2 and Dy: Clisiophyllum nr. subimbricatum, Thom.; Koninckophyllum magnificum, Thom. and Nich.; Diphyphyllum lateseptatum, M'Coy, and small variant.

IVa.—(Dy).

The main fauna represents standard conditions, and is extremely rich.

Dibunophyllum muirheadi, Thom. and Nich., and var. D. splendens. Dibunophyllum ϕ Vaughan and variants.

Koninckophyllum magnificum, Thom. and Nich., and numerous variants, including Dibunophylloid and Diphyphylloid varieties, e.g., Diphyphyllum dianthoides (M'Coy) and Koninckophyllum near interruptum, Thom. and Nich.

Diphyphyllum subibicinum, D. lateseptatum, and D. concinnum.

Lonsdaleia duplicata, Phill., and massive variant L. conaxis, M'Coy.

Also Cyclophyllum aff. pachyendothecum, Thom., which does not as yet possess any great value except as an index of D. (Some forms referred to Aulophyllum by Thomson are merely the young stages of the species cited above).

The fauna appears to represent a somewhat higher coral development than is found in the D2 subzone of *Lonsdaleia floriformis* of the South-West Province, and consequently the beds are probably higher than the uppermost limestone of that area. Whenever both *Lonsdaleia floriformis* and *Lonsdaleia duplicata* are found, their maxima occur in the order above stated. In the S.W. Province the only massive *Lonsdaleia* is

L. floriformis. In Northumberland this species is rare, but L. duplicata, var. conaxis, is common.

The branching out into numerous variants, which both *Dibunophyllum* and *Koninckophyllum* exhibit, illustrates the instability which frequently precedes extinction.

Diphyphyllum reaches its acme of development in D. dianthoides, which is only foreshadowed in the D2 of the South-West Province.

On the other hand one of the variants of Koninckophyllum is less highly developed than the D2 species of the South-West Province, and is but little advanced on the D1 form. Also Cyclophyllum aff. pachyendothecum is not much more advanced than the form in D1.

The rich coral fauna which reaches its maximum development in IVa is represented by exaggerated and decadent forms in IVb and IVc.

The tendency in the Dibunophyllids towards Aspidophylloid structure, already marked in IVa, reaches its highest development in the Aspidophyllum of the Thornbrough Limestone. Dibunophyllum muirheadi (typical) is, nevertheless, abundant in this limestone.* A new genus of Cyathophylloid Dibunophyllum, which occurs in the Robsheugh Limestone, shows convergence with Caninia cf. cornucopiæ and Densiphyllum in the regularly spaced interseptal intersections in the large medial area.

$$IVc.$$
—(Dy).

The index of IVc is Dibunophyllum muirheadi (mut. cf. Dib. ψ). The genus Koninckophyllum is represented by a loose-structured, irregular and decadent form. The Cyathophyllum characteristic of the horizon has the vaulted vesicular tabulæ of Cyathophyllum regium, but exhibits reversion in the fact that the tabulæ are only partially replaced by vesicles.

^{*} In Thornbrough Quarry, Corbridge.

This phenomenon is to some extent exhibited in certain specimens of the simple form of *Cyath. regium* from D₂ of the Avonian. The reduction in size and the conical form of the simple coral is an intimation of approaching inimical conditions.

The IVb and IVc fauna is probably the moribund representative of the Avonian coral fauna which reaches its acme in IVa.

The following correlation of the Bernician with the Dibunophyllum Zone of the South-West Province seems the most probable:—

Northumberland	South-West Province		
Millstone Grit.			
$Dy \qquad \begin{cases} \frac{IVc.}{IVb.} \\ \frac{IVa.}{IVa.} \end{cases}$	Millstone Grit.		
III.	D2-3.		
II.	D2.		
I.			
a.	Concretionary beds at top of S2?		

N.B.—No attempt has been made in the above table to indicate the relative thickness of the various horizons.

VI

THE BERNICIAN LIMESTONES, THEIR GEOGRAPHICAL DISTRIBUTION, STRATIGRAPHICAL CHARACTERS AND FAUNAL CONTENTS.

The Redesdale Ironstone Shale, Redesdale Limestone and Fourlaws Limestone.

Geographical Distribution.

These limestones are the most northerly of those running parallel to the Tyne. They cross the North Tyne south of

Wark and turn northwards. Their course being checked by a fault west of Sweethope Lough, they and their associated beds occur as faulted outliers among the Carbonaceous strata to the northward.

Redesdale Ironstone Shale. Redesdale.

Stratigraphical Character.

Thickness about 30 feet. This shale is separated from the Redesdale Limestone by a thin but variable layer of black shale (r-2) feet) and a thin bed of sandstone, about 5 feet. The Ironstone Shale consists of a black argillaceous deposit with numerous bands of ironstone nodules and a layer of clay ironstone (4-6) inches).

Faunal Diagnosis.

CORALS: -- Corals exceedingly rare, except Alveolites.

Brachiopods:—Productus undatus and Lingula scotica characteristic forms. P. concinnus and Orbiculoidea nitida very abundant.

Lamellibranchs:—This class is represented by a large number of species; the most plentiful forms being *Schizodus* axiniformis and *Nucula gibbosa*.

Faunal List:-

Dibunophyllum near θ , Vaughan. Fistulipora incrustans, Nich. and Foord.

Alveolites.
Ceriopora interporosa (Phill.)
Heterotrypa tumida (Phill.)
Fenestella.
Seminula ambigua (Sow.)
Dielasma gillingensis (Dav.)
Spiriferina cf. laminosa (M'Coy.)
Martinia glabra (Mart.)

Reticularia lineata (Dav.)
Pugnax pleurodon β (Phill.) and young forms of P. pleurodon.
Orthid.
Orthotetid.

Leptæna analoga(Phill.)var. distorta (Sow.)

Productus corrugatus, M'Coy. Productus corrugato-hemisphericus Productus antiquatus, Sow. Productus pugilis, Phill.

Faunal List (continued).

Productus concinnus, Sow. Productus scabriculus (Mart.)=P. cf. quincuncialis, Phill. Productus punctatus (Mart.) Productus undatus, Defr. Chonetes volva, M'Coy. Chonetes cf. crassistria, M'Coy. Lingula mytiloides (Sow.) Lingula squamiformis (Phill.) Lingula scotica (Dav.) Orbiculoidea nitida (Phill.) Limatulina desquamata (M'Coy.) Pterinopecten granosus (Sow.) Aviculopecten semicostatus (Portl.) Aviculopecten incrassatus (M'Cov.) Pseudamusium redesdalense, Hind. Actinopteria persulcata (M'Coy.) Pinna mutica (M'Coy.) Posidoniella elongata (Phill.) Myalina pernoides (Portl.) Myalina redesdalensis, Hind. Myalina verneuillii (M'Coy.) Nucula gibbosa (Flem.) Nucula undulata, Phill. Ctenodonta lævirostris (Portl.) Nuculana attenuata (Flem.) Nuculana brevirostris (Phill.) Schizodus axiniformis (Phill.) Protoschizodus axiniformis (Portl.) Protoschizodus fragilis (M'Cov.) Cardiomorpha parva, Hind. Edmondia arcuata (Phill.) Edmondia pentonensis, Hind. Edmondia rudis, M'Coy. Edmondia sulcata (Phill.) Sedgwickia ovata, Hind. Sanguinolites clavatus (M'Coy)

Sanguinolites plicatus (Portl.) Sanguinolites striatogranulosus. Hind. Sanguinolites tricostatus (Portl.) Sanguinolites variabilis (M'Coy.) Sanguinolites V-scriptus, Hind. Sanguinolites visetensis, de Kon. Allorisma sulcata (Flem.) Allorisma variabilis, Hind. Conocardium aliforme (Sow.) Bellerophon decussata (Flem.) Bellerophon urei (Flem.) Loxonema murchisoniana, de Kon. Loxonema scalaroidea, Phill. Macrocheilina imbricata, Sow. Naticopsis acuta, Sow. Conularia quadrisulcata, Sow. Orthoceras annulatum, Sow. Orthoceras attenuatum (Flem.) Orthoceras cylindraceum (Flem.) Cyrtoceras rugosum (Flem.) Glyphioceras diadema (Goldf.) Glyphioceras truncatum (Phill.) Stroboceras sulcatum (Sow.) Archæocidaris urei (Flem.) Lepidodiscus lebourii?, Sladen. Taxocrinus nobilis (Phill.) Several other crinoids. Dithyocaris dunni, Scoulen. Dithyocaris glaber, Jones and Woodward Dithyocaris tricornis, Woodward and Etheridge. Teeth and scales of fish including:-Gyracanthus.

Psammodus.

Chomatodus, etc.

Notes:—Mr. John Dunn, who collected in the shale for upwards of twenty years, found a single specimen of a simple coral, namely Dibunophyllum. The structure is not wholly preserved, nevertheless Dr. Vaughan has determined the species as Dibunophyllum near θ but showing variation towards Dib. ϕ .

Productus scabriculus Mart. (quineuncialis, Phill.) common. A mutation of the genus P. aff. scabriculus intermediate between C and D forms and converging towards P. corrugatohemisphericus,* is also plentiful and characteristic of the shale. Lingula scotica, a large triangular species with fine laminose concentric lines of growth, is not only restricted to this horizon but has not yet been reported from any other locality in England.

More genera and species of lamellibranchs have been obtained from this bed than from the rest of the Bernician series. The Pteropod *Conularia quadrisulcata* is common at Bellingham, but true gasteropods are not very plentiful.

Redesdale Limestone.

Stratigraphical Character.

Thickness 17 feet (at Redesdale). The upper 6 or 7 feet are argillaceously inclined, otherwise the limestone is massive.

Faunal Diagnosis.

Corals:—The corals are mainly typical of D_I, but contain forms belonging to D₂. Dibunophyllum θ , Carcinophyllum θ , Cyathophyllum murchisoni, Diphyphyllum subibicinum and Clisiophylloid Lithostrotion (all D_I forms), common and highly characteristic. Lithostrotion (D₂), very abundant.

Brachiopods:—Giganteid *Producti* (*Prod. a*) exceedingly numerous, otherwise the number of brachiopods is very much less than in the limestone above.

^{*} Dr. A. Vaughan.

Faunal List:—

Dibunophyllum θ , Vaughan. Dibunophyllum ϕ , Vaughan (DI Carcinophyllum θ , Vaughan.

Cyathophyllum murchisoni, Ed.

and H.

Diphyphyllum subibicinum (M'Coy) Campophyllum murchisoni, Ed.

Clisiophylloid Lithostrotion. Lithostrotion irregulare (Flem.) Lithostrotion junceum (Flem.) Lithostrotion portlocki (Brom.)large and small varieties, also a Lonsdaloid mutation.

Zaphrentis sp. Alveolites.

Athyris royssii (L'Eveillé.)

Dielasma sacculus (Mart.) Dielasma vesicularis (de Kon.) Reticularia lineata (Mart.) Leptæna analoga (Phill.), var. distorta (Sow.)

Giganteid Producti-Productus a and varieties.

Productus corrugatus, M'Coy. Productus longispinus, Sow. Productus punctatus (Mart.) Productus spinulosus, Sow. Pinna flabelliformis, Mart. Leveillia puzo, L'Eveillé. Naticopsis plicistria (Phill.) Naticopsis variata (Phill.) Platyschisma helicoides (J. de C.

Sow.)

Notes:-Lithostrotion junceum is not only most prolific in its growth but it is exceptionally well developed. The corallites are very long and very straight.

I obtained most of the corals in the above list from two small quarries at Birtley. Dibunophyllum ϕ and Campophyllum murchisoni (marked by an asterisk) were found in the bed of a burn near Elsdon, and some doubt exists as to the limestone from which they have been derived being the Redesdale Limestone. Both specimens are in Mr. Dunn's collection.

Fourlaws Limestone.

Stratigraphical Character.

A dark-coloured compact limestone of at least 10 feet in thickness.

Faunal Diagnosis.

CORALS:—Not very plentiful.

Brachiopods:—The Productids are represented by a large number of species, including P. mesolobus and P. spinulosus. Productus a exceedingly abundant. Papilionaceous Chonetes occur.

Faunal List :--

Cyclophyllum aff. pachyendothecum
Thom.

Campophyllum aff. murchisoni, Ed. and H.

Lithostrotion irregulare (Phill.) Lithostrotion junceum (Flem.) Lithostrotion portlocki (Bronn)

Alveolites. Heterophyllia sp.

Hyalostelia smithii, Young.

Athyris planosulcata (Phill.)

Seminula ambigua, Sow.

Dielasma gillingensis (Dav.)

Dielasma vesicularis (de Kon.)

Spirifer trigonalis (Mart.)

Spirifer planicosta, M'Coy.

Martinia glabra (Mart.)

Reticularia lineata (Mart.)

Reticularia ovalis (Phill.)

Pugnax pleurodon (Phill.) Leptæna analoga (Phill.) var.

distorta (Sow.)

Orthotetes, including some very large forms and O. radialis (Phill.) Giganteid Producti - Productus α

and variants.

Productus latissimus, Sow.

Productus corrugatus, M'Coy. Productus antiquatus (Mart.)

Productus pugilis, Phill.

Productus concinnus, Sow.

Productus sulcatus, Sow.

Productus longispinus, var. sinuatus, de Kon.

Productus scabriculus (Mart.)

Productus punctatus (Mart)

Productus fimbriatus, Sow.

Productus aculeatus (Mart.) Productus spinulosus, Sow.

Productus mesolobus, Phill.

Chonetes buchiana, de Kon.

Chonetes volva, M'Coy.

Papilionaceous Chonetes.

Lingula squamiformis (Phill.)

Aviculopecten dissimilis (Flem)

Palæolima obliquiradiata, Hind.

Pinna flabelliformis, Martin,

Modolia jenkinsoni (M'Coy.)

Grammatodon reticulatus (M'Coy.)

Grammatodon bistriatus (Portl.)

Cardiomorpha oblonga (Sow.)

Edmondia arcuata (Phill.)

Edmondia lowickensis, Hind.

Edmondia maccoyi, Hind.

Edmondia oblonga, M'Cov.

Edmondia rudis, M'Coy.

Edmondia sulcata (Phill.)

Edmondia unioniformis (Phill.)

Sanguinolites tricostatus (Portl.)

Sangumontes tricostatus (1 orti.)

Sanguinolites variabilis (M'Coy.)

Allorisma sulcata (Flem.)

Allorisma variabilis, Hind.

Solenomya costellata, Phill. Solenomya primæva, M'Coy.

Clinopistha abbreviata

(de Ryckholt.)

Clinopistha parvula, de Kon.

Nothamusium radiatum, Hind.

Conocardium aliforme (Sow.)

Bellerophon sp.

Dentalium ingens (de Kon.)

Euomphalus pentangulatus, Sow.

Euomphalus cirrus, Sow.

Loxonema lefebvrei, L'Eveillé.

Loxonema rugifer, Phill.

Macrocheilina acuta, Sow.

Macrocheilina rectilinea, Phill.

Macrocheilina sp.

Murchisonia telescopium,

Haughton.

Naticopsis variata (Phill.)

Naticopsis plicistria (Phill.)

Faunal List (continued):-

Naticula tabulata (Phill.)
Pleurotomaria carinata, Sow.
Pleurotomaria decipiens, M'Coy.
Platyschisma zonites, M'Coy.
Orthoceras gesneri (Sow.)
Actinoceras giganteum (Mart.)
Ephippisceras bilobatum (Sow.)
Nautilus ingens (Mart.)
Nautilus nodiferus, Armstrong.
Sohenscheilus cf. crassiventer,
de Kon.

Thyringoceras hibernicum, Foord. Vestinautilus cariniferus (Sow.) Vestinautilus cf. crateriformis. Phillipsia derbiensis (Mart.) Phillipsia gemmulifera (Phill.) Phillipsia scabra, H. Woodward. Griffithides longispinus, Portl. Psammodus rugosus, Ag. Petaločius hastingsii, Owen. Cladodus.

Notes:—The Fourlaws Limestone is a richly fossiliferous bed; cephalopods and gasteropods are numerous. - All the forms in the above list are from the Waterfalls quarry near the village of Redesdale.

The faunal lists of the Fourlaws and Redesdale Limestones and the Redesdale Ironstone Shale have been considerably augmented by the addition of genera and species supplied by Mr. John Dunn's fine collection of Redesdale fossils. I have completed the list of the lamellibranchs from the list recently drawn up by Dr. Wheelton Hind.

The Woodend and Dun Limestone.

THE WOODEND LIMESTONE=THE HOBBERLAW LIMESTONE=

Geographical Distribution.

The outcrops of the Woodend and Dun Limestones form with the Carbonaceous beds a belt girdling the Cheviots on the east and north, but separated from the volcanic mass by the Tuedian beds. Approaching the Tweed this belt bends round to the east and strikes out to sea south of Tweedmouth.

Stratigraphical Character.

Both compact beds; the Woodend is about 10 or 12 feet in thickness, the Dun about 6 feet,

Woodend Limestone.

Faunal Diagnosis.

CORALS :-

Lithostrotion maccoyanum, L. irregulare, and L. junceum abundant. Dibunophyllids not uncommon.

Brachiopods:—*Productus* a very abundant. Semireticulate *Producti* plentiful.

Faunal List:-

Dibunophyllum sp.
Lithostrotion irregulare (Phill.)
Lithostrotion martini, Ed. & H.
Lithostrotion junceum (Flem.)
Lithostrotion portlocki (Bronn.)var.
maccoyanum, Ed. & H.
Zaphrentis sp.
Syringopora sp.
Favositoid coral.
Heterotrypa tumida (Phill.)
Seminula ambigua (Sow.)

Spirifer planicosta, M'Coy.

Giganteid Producti (Productus a)
Productus longispinus, Sow.
Productus semireticulatus (Mart.)cf.
P. pugilis, Phill.
Aviculopecten.
Lithodomus lingualis (Phill.)
Bellerophon sp.
Dentalium ingens, de Kon.
Euomphalus pentangulatus, Sow.
Loxonema murchisoniana, de Kon.
Orthoceras sp.
Archæocidaris urei (Flem.) (plates)

Notes:—Lithostrotion maccoyanum occurs in large masses. Productus semireticulatus is represented by a small form closely approaching Phillip's P. pugilis.

This very fossiliferous bed needs much further exploration.

Dun Limestone.

The bed lies about 100 or so feet below the Woodend Limestone.

Lithostrotion junceum common, L. irregulare present. North of the Tweed, L. maccoyanum plentiful. Clisiophyllids rare; small gasteropods not uncommon.*

*I am indebted for the information respecting the fauna of the Dun Limestone to Mr. Carruthers and to Mr. Bishop of Berwick. I have examined the bed near Spital but found no fossils.

The Calcareous Beds lying between the Scar Limestone and the Fourlaws Limestone, Tyne and Rede District.

Time has not allowed of a systematic examination of these limestones. In the country north of the Tyne are some ten or so of them, which, although little quarried, are exposed in the numerous burns. To the west of the North Tyne a number of quarries afford access to them.

These limestones mainly belong D2, but the lowest of them yield forms characteristic of D1.

The limestone which lies above the Fourlaws Limestone, and which is exposed in Shanks Kiln Quarry, contains in addition to forms common to D₁ and D₂:

Campophyllum derbiense,* Vaughan. Cyathophyllum murchisoni, Ed. and H.

Through the kindness of Miss Dinning of Simonburn, I have had the opportunity of examining a number of forms she has collected from the shale exposed by one of the burns in that neighbourhood. The shale represents a low horizon in II of the table on p. 598, but occurs some distance above the limestone previously mentioned.

Dibunophyllids.
Lithostrotion (? irregulare) (Phill.)
Lithostrotion maccoyanum,

Ed. and H.

Fenestella sp.
Rhabdomeson sp.
Athyris planosulcata (Phill.)
? Seminula sp.
Reticularia lineata (Mart.)
Rhipidomella michelini (L'Eveillé)
Orthotetids.
Productus a.
Productus latissimus, Sow.

? Productus longispinus, Sow.
Productus muricatus, Phill.
Productus semireticulatus, Mart.
? Productus martini, Sow.
? Chonetes buchiana, de Kon.
Aviculopecten dissimilis (Flem.)
Pseudamusium anisotum (Phill.)
Amusium concentricum, Hind.
Actinopteria persulcata (M'Coy.)
Pteronites latus (M'Coy.)
Pinna mutica (M'Coy).
Archaeocidaris urei (Flem.) (plates)
Encrinital columns very numerous.

The lamellibranchs constitute a group of forms characteristic of the muddy conditions of deposition.†

* Found by Mr. John Dunn. † Dr. Wheelton Hind.