

young (see text-fig. 48). The little Lemur was born while the parents were in Mr. Gilbert's possession. The pair were turned out into a garden in the first week of July 1905 and left out until the 24th of that month; and Mr. Gilbert was inclined to believe that the mating took place during this period of freedom. However that may be, the young one was born on Sept. 26th; and if Mr. Gilbert's surmise as regards the time of pairing be correct, the period of gestation may be estimated as between ten and twelve weeks.

For the first two months of its existence the little one clung to its mother's breast. It afterwards transferred itself to her back, as shown in the photograph, which represents the animal when 20 weeks old, or about half-grown. Towards the end of January (that is to say, when some four months old) the young one began to go about on its own account, always returning, however, to its mother's back when disturbed by anyone entering the room. By the middle of February it was partly weaned, and was feeding readily upon bananas and milk.

Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited a new drawing of the skeleton of the Triassic Rhynchocephalian, *Rhynchosaurus articeps*, from the Keuper Sandstone of Shropshire. He pointed out the differences between this ancient reptile and the modern *Sphenodon*, especially noting the great expansion of its coracoids and ischia, and the probably diminutive size of its sternum. He inferred from the everted rims of the upwardly-turned orbits, and from the sigmoidal bend of the femur, that *Rhynchosaurus* was to a great degree aquatic in habit.

The following papers were read:—

1. On Breeding Experiments with Lepidoptera. By L. DONCASTER, M.A., F.Z.S., Mackinnon Student of the Royal Society, and the Rev. G. H. RAYNOR, M.A., F.E.S.

[Received December 28, 1905.]

(Plate VIII.*)

I.—*ANGERONA PRUNARIA*. (Plate VIII. fig. 1.)

(Experiments by L. Doncaster.)

In the summer of 1903 I began breeding-experiments with *Angerona prunaria* and its var. *sordiata*, in order to find out how the two forms behaved in inheritance. My material was obtained from two sources: pupæ of both varieties were bought from a dealer, and Mr. C. P. Pickett of Leyton gave me eggs which he had bred. In neither case did I know the ancestry of the

* For explanation of the Plate, see p. 133.

insects used. Only three of these original pairings gave larvae which reached maturity. Their results are given in Table I.

TABLE I.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.
03.3...	♀ <i>sordiata</i>	♂ <i>sordiata</i>	gave 22 <i>sordiata</i> ♂, 25 <i>sordiata</i> ♀.
03.6...	♀ <i>prunaria</i>	♂ <i>sordiata</i>	" 27 <i>sordiata</i> ♂, 7 <i>sordiata</i> ♀, 1 <i>prunaria</i> ♀.
03.4...	♀ <i>prunaria</i>	♂ <i>prunaria</i>	" 27 <i>prunaria</i> ♂, 1 <i>sordiata</i> ♂, 40 <i>prunaria</i> ♀.

These figures immediately suggested that the banded var. *sordiata* was a simple Mendelian dominant over the unbanded *prunaria* type. The next year's work confirmed this conclusion; and it must be supposed that the single *prunaria* among the offspring of 03.6 and the single *sordiata* in 03.4 were due to accident. The larvae, when they first hatch, are exceedingly minute, and when the food is changed it is difficult to be certain that no larva clings to the hands and gets transferred to the wrong box.

An inspection of the moths from 03.3 showed that about half of them have the brown bands on the wings, with plain orange or yellow centres, but that the other half, in addition to the banding, have the orange centres speckled as in the typical *prunaria*. Sometimes the speckling is very faint, so that it is hard to give exact numbers of each type, but approximately among the offspring of 03.3 the numbers are 24 speckled and 23 plain. In 03.6 all were speckled. This suggests that the speckled character of *prunaria* is dominant over the plain of *sordiata* at the same time that the banding of the latter dominates over its absence in the former; in this way a heterozygote can be distinguished from a pure *sordiata*.

In 1904, 36 pairings were made, of which 24 yielded imagos in 1905. Their results are given in Tables II.-VII.

TABLE II.—*Prunaria* ♀ × *prunaria* ♂.

No. of Exp.	<i>prun.</i> ♂.	<i>prun.</i> ♀.	<i>sord.</i> ♂.	<i>sord.</i> ♀.
04. 1	8	2	1	...
2	15	8
3	1
4	11	5
10	7	6
12	3	1
13	4
Total	45	26	1	...

TABLE III.—*Prunaria* ♀ × speckled *sordiata* ♂.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.				
			prun. ♂.	prun. ♀.	speck. sord. ♂.	speck. sord. ♀.	
04. 8	<i>prun.</i> ♀ ex 03.4 × speck. <i>sord.</i> ♂ ex 03.6		10	11	5	5	
		" " × "	27	24	16	23	
		" " × "	1	0	1	1	
		" " × "	10	10	6	7	
		" " × "	25	30	23	23	
			Total	73	75	51	59

TABLE IV.—Speckled *sordiata* ♀ × *prunaria* ♂.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.				
			prun. ♂.	prun. ♀.	speck. sord. ♂.	speck. sord. ♀.	
04.19	♀ speck. <i>sord.</i> ex 03.3 × ♂ <i>prun.</i> ex 03.4		2	1	4	4	
		" ex 03.6 × " "	1	0	2	0	
			Total	3	1	6	4

TABLE V.—Speckled *sordiata* ♀ × ♂.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.						
			prun. ♂.	prun. ♀.	plain sord. ♂.	plain sord. ♀.	speck. sord. ♂.	speck. sord. ♀.	
04.21	♀ ex 03.6 × ♂ ex 03.3		2	1	1	
		" " × "	...	1	3	2	3	...	
		♀ ex 03.3 × "	1	1	...	
		" " × "	1	1	
			Total	2	2	4	3	4	
								2	

TABLE VI.—Plain *sordiata* \times *prunaria*.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.	
04.20	♀ pl. <i>sord.</i> ex 03.3	\times ♂ <i>prun.</i> ex 03.4	speck. <i>sord.</i> ♂.	speck. <i>sord.</i> ♀.
34	" "	\times " "	8	5
28	♀ <i>prun.</i> ex 03.4	\times ♂ pl. <i>sord.</i> ex 03.3	1	3
Total			5	3
Total			14	11

TABLE VII.—Speckled *sordiata* \times plain *sordiata*.

No. of Exp.	♀ PARENT.	♂ PARENT.	OFFSPRING.			
			plain <i>sord.</i> ♂.	plain <i>sord.</i> ♀.	speck. <i>sord.</i> ♂.	speck. <i>sord.</i> ♀.
04.23	♀ spec. ex 03.3	\times ♂ plain ex 03.3	2
33	" "	\times " "	5	2	6	3
35	" "	\times " "	4	...	1	1
Total			11	2	7	4

From these tables I think it is sufficiently clear that the banding of the *sordiata* is dominant over its absence in *prunaria*, but that the speckling of *prunaria* is at the same time dominant over the plain orange of the pure *sordiata*, giving a heterozygote which is both banded and speckled (Pl. VIII. fig. 2). The plain *sordiata*, however, may have some specks along the wing-rays, so that an exact determination of the numbers of "plain" and "speckled" is not possible. The numbers of these two classes in the tables are therefore approximate.

The numbers are not sufficiently large to show whether the different types occur in the proportions demanded by Mendel's Law, with the exception of those in Table III. Here there are 148 *prunaria* to 110 *sordiata*, where equality is expected; but the mortality is so great among the young larvæ, and also during hibernation, that a very small differential mortality will account for this.

The work was partly undertaken to find out whether there was any tendency for a correlation of either of the types with one or other of the sexes, but no evidence whatever of this has appeared.

It is important to notice that no intermediates occurred; in fact the darkest *prunaria* bred were from two *prunaria* parents, and the lightest *sordiata* from *sordiata* parents.

It may be pointed out that this case is so like what is known of some other instances of alternative inheritance in moths, *e. g.* in *Amphidasis betularia* and its var. *doubledayaria*, that it will probably be found that these also are simple cases of Mendelian inheritance.

II.—ABRAXAS GROSSULARIATA.

(Experiments by the Rev. G. H. Raynor.)

We now turn to the case of *Abraxas grossulariata* and its var. *lacticolor* (*flavofasciata*). Mr. Raynor obtained, some years ago, a rare variety of the female, in which the black markings are very much reduced and assume a partially linear form. They are also characterised by their indefiniteness of outline; instead of the sharp edge to the black marks which is characteristic of the type, in var. *lacticolor* the black spots have an indefinite appearance, which makes them appear to have been put on with a nearly dry brush. The only exception to this rule is the spot in the centre of the fore wing, which is more conspicuous than in the type (see Pl. VIII. figs. 4 & 5). The var. *lacticolor* may therefore be regarded as resembling an albino, in which the black pigment is reduced to a constant extent, but not quite absent. The yellow bands do not differ from those of the type. It should be mentioned that the amount of black varies very widely in the type, but at its most extreme reduction the insect does not resemble *lacticolor*, since the spots are small and definite. Among the many thousand insects bred by Mr. Raynor, no intermediate between *lacticolor* and the type has occurred.

When the original *lacticolor* ♀ was paired with a normal ♂, all the offspring were normal. When, however, two of the progeny of such matings were paired together, some of the female offspring were *lacticolor*, but the var. did not occur among the males (Table VIII.). A number of such families were reared which are not included in the tables, since the numbers were at first not recorded. It appeared, however, that the var. *lacticolor* is a Mendelian recessive of quite a new type, since it was known only in the female, and more exact experiments were undertaken to investigate it further.

In 1903, in addition to pairings of the type DR × DR (first crosses paired together), *lacticolor* ♀s were paired with heterozygous ♂s (see Table IX.). The result of these matings was that *lacticolor* appeared in both sexes, some of the ♂s and some ♀s being *lacticolor*, others of each sex normal. Some of the males used as fathers in these experiments were first crosses, others were heterozygous males of the second generation, which had *lacticolor* sisters. One F₂ male (exp. xliv. '03), which had two *lacticolor* grandparents, when paired with a *lacticolor* ♀ had only normal offspring, showing that in F₂ pure dominant males occur, in addition to heterozygotes, as is expected on the Mendelian theory.

It was now shown that the recessive variety hitherto known in the female only could be transferred to the male by pairing a heterozygous male with a recessive female. It remained to pair male and female of the variety together, and to pair the recessive male with the heterozygous female. Both these pairings were effected in 1904 and repeated in 1905.

Lacticolor ♀ × ♂ (Table XI.) have given exclusively *lacticolor* offspring, male and female; the recessive character breeds true, as was expected.

Lacticolor ♂ × heterozygous ♀ (Table X.) have given all the males normal, all the females *lacticolor*; a result which may have important bearing on the theory of the determination of sex.

To sum up—

$$\begin{array}{ll} \text{DR } \text{♀} \times \text{DR } \text{♂} \text{ gives DD } \text{♂}, \text{ DR } \text{♂}, \text{ DR } \text{♀}, \text{ RR } \text{♀}. \\ \text{R } \text{♀} \times \text{DR } \text{♂} \quad \text{,} \quad \text{DR } \text{♂}, \text{ RR } \text{♂}, \text{ DR } \text{♀}, \text{ RR } \text{♀}. \\ \text{DR } \text{♀} \times \text{R } \text{♂} \quad \text{,} \quad \text{DR } \text{♂} \dots \dots \text{ RR } \text{♀}. \\ \text{R } \text{♀} \times \text{R } \text{♂} \quad \text{,} \quad \dots \text{ R } \text{♂} \dots \text{ R } \text{♀}. \end{array}$$

TABLE VIII.—Heterozygous ♀ × heterozygous ♂.
(Type DR × DR.)

No. of Exp.	gross. ♂.	gross. ♀.	lact. ♂.	lact. ♀.	Total.
03. xii. ...	25	14	...	9	48
03. xxi. ...	22	9	...	11	42
04. x. ...	13	1	...	15	29
L.D. 04. ii. ...	7	1	...	4	12
Total...	67	25	...	39	131

TABLE IX.—*Lacticolor* ♀ × heterozygous ♂.
(Type R ♀ × DR ♂.)

No. of Exp.	gross. ♂.	gross. ♀.	lact. ♂.	lact. ♀.	Total.
03. iv.	3	...	3
03. viii. ...	10	4	6	2	22
04. v. ...	18	6	11	1	36
Total...	28	10	20	3	61

TABLE X.—Heterozygous ♀ × *lacticolor* ♂.
(Type DR ♀ × R ♂.)

No. of Exp.	<i>gross.</i> ♂.	<i>gross.</i> ♀.	<i>lact.</i> ♂.	<i>lact.</i> ♀.	Total.
04. xi. ...	16	8	24
04. xxxvii. ...	3	1	4
04. ii. ...	10	2	12
Total... ...	29	11	40

TABLE XI.—*Lacticolor* ♀ × *lacticolor* ♂. (Type R ♀ × R ♂.)

No. of Exp.	<i>gross.</i> ♂.	<i>gross.</i> ♀.	<i>lact.</i> ♂.	<i>lact.</i> ♀.	Total.
04. i.	4	1	5
05. ii.	2	5	7
04. viii.	5	7	12
Total...	11	13	24

It will be noticed that while the results given in the tables are qualitatively in full agreement with Mendel's Law, yet the numbers depart widely from Mendelian expectation. There is always great mortality in rearing insects, especially in those species which hibernate in the larval state, and the discrepancy is probably accounted for by the greater strength and healthiness of *lacticolor*, which we have frequently noted, and which has doubtless caused a selective mortality in favour of the variety as compared with the type.

The following tentative hypothesis is put forward to account for the relations between the variety *lacticolor* and the sexes.

Castle * has suggested that the determinants for the two sexes are segregated from one another in gametogenesis like Mendelian characters, and that a male-bearing spermatozoon always meets a female-bearing egg or *vice versa*, so that in respect of sex all zygotes are heterozygous. He has further supposed that somatic characters may occasionally be coupled with one or other sex-determinant, so that of the gametes produced by a heterozygote AB, the male-bearing may all carry one somatic character A, while the female-bearing carry its allelomorph B.

* Castle, "Heredity of Sex," Bull. Mus. Zool. Harvard, xi. no. 4, 1903, pp. 189, 208.

9*

This hypothesis, with slight modification, leads to the results observed in the cross *grossulariata* \times *lacticolor*. If we suppose that among the eggs the male-bearing all carry *grossulariata*, the female-bearing all *lacticolor*, while in the spermatozoa there is no coupling, so that we have male- and female-bearing of both kinds, we shall get the following results:—

$$\begin{array}{ll} \text{DR } \varphi \text{ gives eggs } & \text{D } \delta, \text{ R } \varphi. \\ \text{DR } \delta \text{ gives spermatozoa } & \text{D } \delta, \text{ R } \delta, \text{ D } \varphi, \text{ R } \varphi. \end{array}$$

Since in fertilization a male-bearing gamete must always meet a female-bearing, the possible combinations of egg and spermatozoa are as follows:—

$$\begin{array}{ll} (a) \text{ Egg D } \delta \times \text{sperm. D } \varphi = \text{ zygote DD } \delta \varphi. \\ " \text{ D } \delta \times " \text{ R } \varphi = " \text{ DR } \delta \varphi. \\ " \text{ R } \varphi \times " \text{ D } \delta = " \text{ DR } \varphi \delta. \\ " \text{ R } \varphi \times " \text{ R } \delta = " \text{ RR } \varphi \delta. \end{array}$$

In the combination *lacticolor* $\varphi \times$ heterozygous δ we shall similarly have eggs $R \delta$, $R \varphi$, spermatozoa $D \delta$, $R \delta$, $D \varphi$, $R \varphi$ giving combinations—

$$\begin{array}{ll} (b) \text{ Egg R } \delta \times \text{sperm. D } \varphi = \text{ zygote DR } \delta \varphi. \\ " \text{ R } \delta \times " \text{ R } \varphi = " \text{ RR } \delta \varphi. \\ " \text{ R } \varphi \times " \text{ D } \delta = " \text{ DR } \varphi \delta. \\ " \text{ R } \varphi \times " \text{ R } \delta = " \text{ RR } \varphi \delta. \end{array}$$

In the mating heterozygous $\varphi \times$ *lacticolor* δ the eggs are $D \delta$, $R \varphi$, the spermatozoa $R \delta$, $R \varphi$, the combinations—

$$(c) \text{ Egg D } \delta \times \text{sperm. R } \varphi = \text{ zygote DR } \delta \varphi. \\ " \text{ R } \varphi \times " \text{ R } \delta = " \text{ RR } \varphi \delta.$$

It is now obvious that if the sex borne by the egg is uniformly dominant over that carried by the spermatozoon, the results are exactly in accordance with the observed phenomena. The sex carried by the egg is that written first in the zygote columns, and we get—

$$\begin{array}{ll} \text{In group (a)} & \text{DD } \delta, \text{ DR } \delta, \text{ DR } \varphi, \text{ RR } \varphi. \\ " (b) & \text{DR } \delta, \text{ RR } \delta, \text{ DR } \varphi, \text{ RR } \varphi. \\ " (c) & \text{DR } \delta \dots \dots \text{ RR } \varphi. \end{array}$$

It is possible to get the same result in other ways, e. g. by assuming coupling between the two characters and the respective sex-determinants in both eggs and spermatozoa and random conjugation between them ; but in any case, if Castle's assumption of coupling be taken for granted, it is necessary to assume that it is always the egg which determines the sex.

NOTE.—The sex-hypothesis here outlined seems at first sight to be at variance with that propounded by Wilson (*Journ. Exp.*

Zool. vol. ii. p. 543)*, and based on his work on chromosomes. We may suppose, however, the two "idiochromosomes" (or "heterotrophic chromosomes") in the female before reduction to bear the male and female sex-determinants respectively, while in the male the female-bearing chromosome is reduced or absent. Then in the female we shall have segregation of the sex-determinants at the maturation-divisions, and we may suppose that female-bearing eggs are fertilized by male-bearing spermatozoa, giving females, the male-bearing egg being fertilized by the spermatozoon which has no "heterotrophic" chromosome. This is in full accord with the hypothesis suggested by the behaviour of the var. *lacticolor* †.

EXPLANATION OF PLATE VIII.

- Fig. 1. *Angerona prunaria*, ♂: p. 125.
- 2. Heterozygote *prunaria* × *sordiata*, ♂: p. 128.
- 3. Pure var. *sordiata*, ♂: p. 128.
- 4. *Abraxas grossularia*, ♀: p. 129.
- 5. Var. *lacticolor*, ♀: p. 129.

2. Contributions to the Osteology of Birds.—Part VIII.‡
The "Tracheophone" Passeres; with Remarks on Families allied thereto. By W. P. PYCRAFT, F.Z.S., A.L.S., &c.

[Received December 28, 1905.]

(Text-figures 49–52.)

i. INTRODUCTORY REMARKS.

In the following pages I have endeavoured to describe the main features of the Osteology of the Tracheophone Passeres; and, further, I have striven to embrace in these remarks such other anatomical facts as may seem to bear trustworthy evidence as to the systematic position of the group.

The "Tracheophones" seem to form a natural group, allied on the one hand to the Eurylemidæ, Cotingidæ, and Philiépittidæ, and on the other to the Tyrannidæ and Pittidæ: details on this point will be found later (p. 158).

This paper is by no means so complete as I could have wished, inasmuch as many genera yet remain to be examined. The position ascribed to some of these at the present day is open to grave suspicion; but these doubts cannot be set at rest until skeletons and birds in spirit are sent home in place of skins.

* Also 'Science,' xxii. 1905, p. 500.

† Since this paper was written, Wilson has suggested an explanation of his results identical with that outlined here (Journ. Exp. Zool. vol. iii., Feb. 1906).

‡ For Part VII. see P. Z. S. 1905, vol. ii. p. 30.