

LIV.—*The Selection of Helix nemoralis by the Song-Thrush* (*Turdus musicus*). By MAUD D. HAVILAND, Hon. Mem. B.O.U., and FRANCES PITT.

SECTION I. By MAUD D. HAVILAND.

AN article on "Shell-banding as a Means of Protection," by A. E. Trueman, appeared in the Ann. & Mag. Nat. Hist., October 1916, and is of considerable interest, for it deals with the striking habit of the song-thrush (*Turdus musicus*) to break small shells habitually upon certain stones or "anvils," and this habit is rare among birds. At first sight, the author's conclusions seem to give proof of natural selection in operation; but when the matter is examined more closely, it is not so clear, and some of Mr. Trueman's methods invite criticism.

It would have been well if he had given a detailed account of the wide area in which his "anvil" and "control" collections were made. The area is described only as a belt of country on the Magnesian Limestone, some 3 miles long, between certain named localities. *Helix nemoralis* varies almost from one ditch to another, as, indeed, is exemplified in Mr. Trueman's paper, and, unless the control collections were made immediately round their respective anvils, they may be very misleading. In a collection made at Quy Fen, Cambridgeshire—a piece of marshy pasture-land interspersed with clumps of willow and bramble-bushes,—it was found, although exact figures were not kept, that lightly banded snails were more abundant on the open spaces among the short herbage, while the heavily banded specimens predominated in the bushes. If a collection had been made, for instance, only in the open, it would not have been really representative of the snails in the locality in general.

Another weak spot in Mr. Trueman's control collection is that it was formed of dead shells. How can one be sure that the shells were in the same situations and positions as when they were alive? It is much to be doubted whether protective devices are of much avail to any creatures that are preyed upon by ground-feeding birds. Striped coloration is inconspicuous only when viewed from a distance; the pied striping on the snout of the badger or on the neck of the black-throated diver are cases in point. But when a bird sees a snail among herbage at a distance of only a few inches the bands of black and yellow will be clearly defined.

Certainly thrushes seem to destroy plenty of *Helix aspersa*, whose shell appears to be more inconspicuously coloured than that of *H. nemoralis*.

Mr. Trueman's tables do not give an exact idea of the "conspicuousness" of a given shell. For instance, a "two-banded" specimen might answer to the formula (123)(45) and appear nearly black; or it might be described as 00230 and look almost yellow. This would make all the difference to its conspicuousness. But the figures given are certainly curious, and two explanations suggest themselves:—

- (a) The possibility admitted by Mr. Trueman himself in his last paragraph, when he says: "The figures appear to show that banded shells are less liable to be seen—or, at least, to be eaten." The italics are mine.
- (b) That the darker varieties predominate in bushy places and the lighter in the open, where the thrushes generally feed. Hence the birds would find a larger proportion of unbanded shells.

With these ideas in view I made two series of observations in the summer of 1917; I had hoped to continue them in 1918, but circumstances prevented this, and unfortunately neither of them are as complete as they should be.

The first experiments were made on Maidenhead Thicket, in an open grassy place surrounded by bushes, between June 25th and July 2nd. The snails were tethered to pegs by black threads, varying from 6 to 12 feet in length, passed through a hole drilled in the lip of the shell, and the numbers were checked every evening. Snails disappeared on the second and succeeding days, but I did not obtain positive proof that they were taken by thrushes until June 30th. I found a four-banded shell, still fastened to its thread but unmistakably smashed by a thrush, and some yards away was a second four-banded shell, also broken, beside a stone. On the following day, in addition to two three-banded shells which had been carried off altogether, I found three four-banded shells which, with the threads still attached, were lying each beside a stone with the shell smashed, but with the animal uneaten.

For convenience in working, the snails, whose tethering threads became much entangled, were put out in five groups—A, B, C, D, E. Each group consisted of from four to six snails tied to one peg and selected quite haphazard. The groups were all within an area of 25 yards, but A and B were much overhung by bushes, C was a little more exposed, and D and E were quite in the open. Four snails were

taken from A, none from B, three from C, five from D, and five from E, although the two latter groups were not put out until four days after the others. Unfortunately it was not possible to make longer observations, but, as far as they go, they suggest : (a) that the thrushes, so far from choosing the lightly banded shells, actually preferred the four-banded variety, although this was not the most numerous form provided ; (b) that thrushes may break snails which for some reason they do not eat ; (c) that there is a tendency for snails to be taken from the more exposed places. If the distribution of *H. nemoralis* at Quy Fen obtains elsewhere, the latter factor alone might account for the large proportion of unbanded shells at the "anvils" recorded by Mr. Trueman.

A second series of observations was carried out near Cambridge round an artificial piece of water. The place, which is of about 4 acres area and surrounded by fields, is lush-grass thickly interspersed with cypress, privet, and bramble-bushes. In the season in question it was inhabited by one pair of thrushes, who reared two broods there. Collections were made at intervals, with the results set out in Table II. On July 31st anvil I. only was taken. On August 13th it was emptied again, and II., III., and IV. were found. Therefore the numbers for anvil I. on this date represent a proportion of the thrushes' takings for a fortnight. The large proportion of *Helicella cantiana* found broken may possibly be accounted for by the dry weather that prevailed at the time. In August attempts were made to form a control collection, but owing to the drought they were unsuccessful, and further opportunity did not arise until October 15th-21st, when, after long search, living (mostly immature) specimens were found, as recorded on Table III.

While the control collection is thus so small, judgment must be suspended ; but so far there seems no ground for supposing that the banded shells were taken less frequently than the unbanded, nor that, when taken, they were not eaten. After my observations on the tethered snails, I was prepared to find that the heavily banded shells were distasteful to the birds ; but the later observations dispose of this idea, and as these anvils were made in the summer, when insect food was plentiful, it could hardly be that hunger drove the birds to eat unpalatable food.

I should like here to express my indebtedness to Mr. H. H. Brindley, M.A., of St. John's College, for his assistance in forming these collections and for much helpful criticism and advice.

TABLE I.
Snails tethered in Maidenhead Thicket.

Number of Bands.	Number of Snails.	Number of Snails taken.
1 band	7	1
2 bands	7	3
3 „	23	4
4 „	12	6
5 „	20	1
Vars. <i>rubella</i> and <i>castanea</i> (unbanded)	11	2
Total	80	17

TABLE II.
Cambridge.

Formulæ.	Anvils.												Total.
	July 30th.				August 13th.				October 21st.				
	I.	II.	III.	IV.	I.	II.	III.	IV.	I.	II.	III.	IV.	
12345 ¹	11	..	..	1	2	1	10	27	5	..	..	..	57
123(45) ²	10	..	..	2	1	..	5	3	..	..	..	..	21
(12)345 ³	1	..	..	4	1	1	..	4	..	..	..	..	11
(12)3(45) ³	1	..	..	3	..	..	..	17	1	..	..	..	22
(12)(345) ³	2	..	..	5	..	2	..	9	..	..	..	..	18
(12345) ³	..	..	..	6	..	1	..	2	1	..	..	..	10
12340 ⁴	11	..	..	7	..	..	..	..	..	..	..	..	18
(12)340 ⁴	1	..	..	8	..	..	..	..	..	..	..	..	9
12305 ⁴	1	..	..	9	..	..	..	..	..	..	..	..	10
12300 ⁴	11	..	..	10	..	..	..	..	..	..	..	..	21
00345 ⁴	..	..	..	17	4	2	1	10	..	..	..	..	34
(12)300 ⁴	1	..	..	11	..	..	..	..	1	..	..	..	13
10345 ⁵	..	..	..	13	..	..	1	..	..	..	..	..	14
02345 ⁵	..	..	..	15	..	2	7	10	..	..	..	..	34
023(45) ⁵	..	..	..	16	..	..	11	5	..	..	..	..	32
103(45) ⁵	..	..	..	14	..	..	1	..	..	..	..	..	15
00340 ⁵	..	..	..	18	..	1	..	1	..	..	..	..	20
00345 ⁵	..	..	..	17	4	2	1	10	..	..	..	..	34
Unbanded var. <i>li-</i> <i>bellula</i> ⁶	13	..	..	19	2	2	8	8	1	..	..	..	53
Unbanded vars. <i>ru-</i> <i>bella</i> and <i>cas-</i> <i>tanea</i> ⁶	9	..	..	20	1	..	4	2	..	..	..	..	36
<i>Helicella cantiana</i> ⁷	9	..	..	..	16	..	..	..	..	..	..	..	25
Total	81	..	..	215	31	13	49	118	9	..	..	..	507

¹ 5 separate bands = 11·2 per cent.

² 5 bands with 4+5 fused = 4·1 per cent.

³ 5 bands with fusions = 12·0 per cent.

⁴ "Plain below" = one or more of bands 3, 4, 5 absent = 20·7 per cent.

⁵ "Plain above" = one or more of bands 1, 2 absent = 29·3 per cent.

⁶ Unbanded = 17·5 per cent.

⁷ *Helicella cantiana* = 4·9 per cent.

TABLE III.

Control Collection for comparison with Table II.

Formula.	Number.	Per cent. of total.
12345 ¹	8	13.5
123(45) ²	3	5.0
(12)3(45) ³	1	1.7
00340 ⁴	1	1.7
12340 ⁴	1	1.7
02300 ⁴	1	1.7
00300 ⁴	1	1.7
00000 (<i>libellula</i>) ⁶	4	17.1
Vars. <i>rubella</i> and <i>castanea</i>	6	
<i>H. cantiana</i>	33	55.9
Total	59	

SECTION II. By FRANCES PITT.

At the request of Miss M. D. Haviland, I obtained a young song-thrush in the spring of 1918, and reared it by hand, in order to ascertain whether the thrush has a preference for a particular variety of *Helix nemoralis*, and also if the habit peculiar to the thrush of breaking snail-shells on an "anvil" is instinctive or acquired through experience by each young bird.

When the bird was fully fledged I offered it two examples of *Helix nemoralis*, of formulæ 00000 and 12345 respectively. The thrush paid no attention to them unless they moved, and then it pecked at the protruding tentacles until the snails withdrew into the shells, after which the bird ignored them.

The experiment was repeated the next day, with the same result, except that the bird pecked the shells sharply two or three times.

On the third day four snails were offered—two 12345 and two 00000. This time, when the bird's attack caused the snail to retract, the thrush turned one shell over, looked into the cavity, and shook it vigorously before casting it aside.

At the fourth trial, two days later, five *nemoralis* were offered—two 00000 and three 12345. This time the thrush carried one of the former variety round the cage, and struck it on the ground until it fell from his grasp, whereupon he picked it up again and battered it on a stone. As it did not crack readily, he seized each of the others in turn, and tried in vain to break them. Finally, he took the first snail again, and ultimately broke it open and ate it.

From the foregoing observations I am inclined to believe that the only part of the snail-cracking habit which is

inherited is the impulse to beat living prey on some hard object, although in one instance I saw the thrush hammer a snail on a sofa-cushion. The habit can be perfected by time and practice, and as it grew older the bird became increasingly expert, for the work requires considerable effort, especially when dealing with strong mature shells.

As regards the selection of a particular type of shell, my experiments gave negative results. I never offered more than three snails at one time—formulae 00000, 12345, and (12345). The results, which are summarized in Table IV., seem to show that the snails were selected quite at random, so that any preponderance of unbanded types at “anvils” is not due to selection by thrushes. I offered specimens of both *castanea* and *rubella* to the bird, and the results show that, although a greater number of *castanea* were left unbroken than of other hues, this was due to the stouter shell. As it became more practised, the bird learnt to break them as readily as the more thin-shelled varieties.

Table V. shows the contents of three “anvils” found near Bridgenorth in Shropshire on a roadside bank in a wooded district, and Table VI. shows a control collection made in the vicinity.

From the evidence afforded by this captive thrush, and by the “anvils” in this district, I conclude that the proportions of varieties of *Helix nemoralis* found at the breaking-stones is influenced chiefly by the proportions present in the locality.

TABLE IV.

Helix nemoralis offered to and eaten by Thrush.

Formula.	Offered.	Eaten.	Per cent.
00000.....	56	26	46.4
12345	49	21	42.8
(12345)	39	23	56.4

TABLE V.

“Anvil” Collection from Bridgenorth, Shropshire.

Formula.	Number.	Per cent.
00000.....	5	17.7
12345.....	13	28.8
12(345).....	1	2.2
123(45).....	4	8.8
1(23)(45).....	1	2.2
(12)(345).....	1	2.2
(123)(45).....	7	15.5
(12345).....	10	22.2

TABLE VI.
Control Collection to Table V.

Formula.	Number.	Per cent.
00000.....	14	22·2
00300.....	1	1·5
12345.....	17	26·5
123(45).....	8	12·5
1(23)(45).....	10	15·6
(12345).....	14	25·0

SUMMARY.

The conclusions drawn from the foregoing observations are :—

The selection of snails by thrushes is entirely haphazard, and the evidence does not suggest that one form is more palatable than another.

There is some evidence that many-banded specimens of *H. nemoralis* are more abundant in bushy shaded places.

As the thrushes as a rule prefer open feeding-grounds, it is possible that this may account for the higher proportion of unbanded shells at certain "anvils."

The young thrush does not recognize and crack snail-shells instinctively, but each individual probably learns to do so by personal experience.

LV.—On the Genus *Lepidobatrachus*, Budgett.

By G. A. BOULENGER, F.R.S.

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THE British Museum has recently received, by way of exchange with the Cambridge Museum of Zoology, the type-specimens of the problematic Paraguayan Frogs discovered by the late J. S. Budgett, and very shortly described by him in the 'Quarterly Journal of Microscopical Science,' xlii. 1899, p. 329, under the names of *Lepidobatrachus asper* and *L. lævis*. I seize this opportunity for expressing an opinion on their systematic position, which had not been dealt with by the author, and for correcting some errors in which he had fallen.

I can see no reason for maintaining the genus *Lepidobatrachus* (etymological justification not stated). On comparing Budgett's diagnosis with that of *Ceratophrys*, one



Haviland, Maud D. and Pitt, Frances. 1919. "LIV.—The selection of *Helix nemoralis* by the song-thrush (*Turdus musicus*).*" The Annals and magazine of natural history; zoology, botany, and geology* 3, 525–531.

<https://doi.org/10.1080/00222931908673853>.

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