on cell wall antigen structures and electronic data processing, is under study.

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Received October 3; revised December 7, 1967.

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BIOLOGY

Natural Selection by Glow-worms in a Population of *Cepaea nemoralis*

THERE are very dense populations of *Cepaea nemoralis*, the polymorphic land snail, on the sand dunes of the nature reserve of Newborough Warren in Anglesey, Wales. They occur sporadically, chiefly in areas of dune colonized by *Salix repens*, and contain individuals of the usual phenotypes—yellow or pink and banded or unbanded. Some populations also contain considerable numbers of the brown phenotype. While sampling one of these populations with Dr K. Isarankura, glow-worms were occasionally to be found feeding on the snails. During a survey of the area at night, about thirty-three glow-worms were seen in an area of 10 m square, the actual population no doubt being denser than this. Glow-worms may therefore well be an important predator of *Cepaea* and if they preferred one phenotype to another they might have a strong selective effect. An experiment was set up to test for any preferences the glow-worms may have for particular phenotypes. A glow-worm was put in a bowl with a choice of two snails to eat. The choices were either of brown and banded yellow or of unbanded and banded yellow. The experiments were carried out in the autumn of 1965 and 1967. Table 1 gives the data when the choice was of brown and

Table 1. NUMBER OF SNAILS EATEN WITH A CHOICE OF BROWN AND BANDED YELLOW

	Brown	Banded yellow	Totals
1965 Adults	14	10	24
1965 Young	15	8	23
1967 Adults	15	8	23
Totals	44	26	70
Effect tested by χ^2	Degrees of freedom	Value of χ^2	Probability
Deviation of observed Nos. eaten from 1:1 ratio	1	4.6286	0.05 > P > 0.025
Heterogeneity (variation between experiments)	2	0.3201	0.9 > P > 0.8

Table 2. NUMBER OF SNAILS EATEN WITH A CHOICE OF UNBANDED AND BANDED YELLOW

	Unbanded yellow	Banded yellow	Totals
1965 Adults	17	2	19
1965 Young	13	15	28
1967 Adults	8	4	12
Totals	38	21	59
Effect tested by χ^2	Degrees of freedom	Value of χ^2	Probability
Deviation of observed Nos. eaten from 1:1 ratio	1	4.8983	0.05 > P > 0.025
Heterogeneity	2	9.1823	0.025 > P > 0.01

banded yellow and Table 2 the data for unbanded and banded yellow. The results show that both brown and unbanded yellow are preferred to banded yellow but that there is heterogeneity in the results for unbanded and banded yellow. If the data in Tables 1 and 2 are combined, the overall preference for brown or unbanded yellow becomes very significant ($0.005 > P > 0.001$); the heterogeneity in the combined data is not quite significant. If there is significant variation in the results of the experiments, it could be caused by a varying preference in different glow-worms. The data for 1967 were obtained by using some of the glow-worms more than once. The sequences of their choices were recorded: the data and their analysis are shown in Table 3. There is no evidence for a correlation between successive choices of a glow-worm and no evidence therefore for variation in preference between glow-worms.

Table 3. SEQUENCES OF PHENOTYPES EATEN BY GLOW-WORMS THAT FED MORE THAN ONCE

No. of glow-worm in experiment	Sequence eaten			
G1	Bd. Y., Unbd. Y., Unbd. Y., Unbd. Y.			
G7	Bd. Y., Unbd. Y.			
G10	Bd. Y., Bd. Y.			
G11	Bd. Y., Bd. Y.			
G20	Brown, Brown, Brown			
G21	Brown, Brown, Bd. Y., Brown			
G22	Bd. Y., Bd. Y.			
G24	Brown, Brown			
G25	Brown, Brown			
Phenotype of second snail of a pair to be eaten	Phenotype of first snail of a pair to be eaten	Brown or Unbd. Y.	Bd. Y.	Totals
Brown or Unbd. Y.		7	3	10
Bd. Y.		1	3	4
Totals		8	6	14

Fisher's exact test for both tails of the distribution gives a probability of $P = 0.245$ which is without significance.

The preference shown by the glow-worms in these experiments may explain a sharp cline in the frequencies of the brown phenotypes. The population we studied extends along a small dune for about 150 yd. In the area where the glow-worms are found at the northern end of the population browns occur with a frequency of about 10 per cent. But at the extreme southern end of the population about 40 per cent are brown, the frequency of brown decreasing sharply over about 80 yd. The glow-worms are not to be seen where the browns are common. Because there is almost a 2 to 1 preference for brown by the glow-worms it is tempting to suggest that the cline of decreasing brown is caused by increasing glow-worm predation. It is therefore possible that the glow-worm predation may be a factor affecting the "area effects" that were extensively studied by Cain and Currey¹. They showed that in certain areas the frequencies of the different phenotypes in populations of *Cepaea* were not correlated with the background of the environment from which the populations were sampled. Visual selection of the phenotypes by birds was presumably not the factor determining the frequencies. Glow-worms might, however, be a selective predator. Cain and Currey found populations with high frequencies of browns and noted that they were usually in areas where cold air might be expected to accumulate on clear nights suggesting that brown might be hardier, but it would be interesting to know if glow-worms were present or not.

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Received November 10, 1967.

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