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¹ Robinson, R., *Nature*, 176, 353 (1955).

Experimental Studies of Mimicry in some North American Butterflies

EXPERIMENTS have been conducted to test the effectiveness of presumed mimicry in two groups of North American butterflies: (1) *Danaus plexippus* Linn. (model) and *Limenitis archippus archippus* Cram. (mimic), the monarch and viceroy respectively; (2) *Battus philenor* Linn. (model) and *Papilio troilus* Linn., *P. polyxenes* Stoll, and *P. glaucus* Linn. (black female) (mimics).

Eight caged Florida scrub jays (*Cyanocitta coeruleascens coeruleascens* Bosc) were used as predators in feeding experiments in which they were given presumed models and mimics, as well as non-mimetic butterflies. For the purpose of this communication, non-mimetic butterflies are those butterflies which are not involved in mimicry either as mimics or models. These studies were carried out at the Archbold Biological Station in southern Florida in the spring of 1956. The same individual birds, with the exception of one, were used throughout both groups of experiments, which were carried out in the order listed above.

After preliminary tests with various orders of insects to accustom the eight birds to laboratory conditions, four were randomly selected as experimental birds; the remaining four were control birds. Throughout the experiments each butterfly, if alive, was immobilized by pinching the thorax before it was given to a bird. Each butterfly was placed in a lateral position on the floor of the cage, and each bird was allowed a total of 2 min. to react to each butterfly given. The treatment of each butterfly by each bird was recorded according to four categories: (1) not touched; (2) pecked, but not injured; (3) killed or injured, but not eaten; (4) eaten. A total of 2,508 butterflies was given to the birds in the course of these experiments. The following procedure was used in the experiments with both mimicry complexes.

Experimental birds: (a) Each experimental bird was given approximately fifty trials with models; and with non-mimetic butterflies which were shown in the preliminary tests to be palatable to all the birds. Each trial consisted of the presentation of two butterflies: one model and one non-mimetic butterfly. The order of presentation of these in any given pair was determined with a table of random numbers.

(b) After the fifty initial trials with models and non-mimetic butterflies, the experimental birds were given mimics in place of models.

Control birds: The control birds were given mimics and non-mimetic butterflies; the same species of non-mimetic butterflies and the same method of presentation described for the experimental birds were used. The control birds were never given models.

The results showed that the non-mimetic butterflies were eaten in every case by all eight birds throughout

all the experiments. It was found that the experimental birds, after they had pecked models in the first few trials, would 'not touch' models on sight alone in 205 out of 339 trials (60 per cent) for *D. plexippus*, and in 161 out of 209 trials (77 per cent) for *B. philenor*. The experimental birds ate none out of 339 (0 per cent) *D. plexippus* given to them, and only 2 out of 209 (1 per cent) *B. philenor*. When mimics instead of their models were offered in later trials with these experimental birds, the 'not touched' treatment of mimics was as follows: 42 out of 60 trials (70 per cent) for *L. a. archippus*; 27 out of 41 trials (66 per cent) for *P. troilus*; 12 out of 13 trials (92 per cent) for *P. polyxenes*; and 6 out of 12 trials (50 per cent) for *P. glaucus* (black female). The experimental birds ate none out of 60 (0 per cent) *L. a. archippus* presented; 9 out of 41 (22 per cent) *P. troilus*; 1 out of 13 (8 per cent) *P. polyxenes*; and 3 out of 12 (25 per cent) *P. glaucus* (black female).

In contrast to the experimental birds, the control birds, having had no laboratory experience with models, did 'not touch' the mimics in only 10 out of 100 trials (10 per cent) for *L. a. archippus*; none out of 392 trials (0 per cent) for *P. troilus*; none out of 40 trials (0 per cent) for *P. polyxenes*; and none out of 12 trials (0 per cent) for *P. glaucus* (black female). Moreover, the control birds ate the mimics in 60 out of 100 trials (60 per cent) for *L. a. archippus*; 392 out of 392 trials (100 per cent) for *P. troilus*; 39 out of 40 trials (98 per cent) for *P. polyxenes*; and 12 out of 12 trials (100 per cent) for *P. glaucus* (black female).

The results given above are lumped for all the experimental birds, and for all the control birds. It should be remembered that, in experiments with caged predators, the predator is actually afforded a closer and longer scrutiny of a model or mimic than would usually be possible under natural conditions, where an attacking bird might get only a glimpse of a flying butterfly.

The treatment ('not touched' vs. 'pecked-killed-eaten'), and 'not touched-pecked-killed' vs. 'eaten') of the mimics (*L. a. archippus*, *P. troilus* and *P. polyxenes*) by the experimental and control birds was analysed with the chi-squared test on the hypothesis, in each case, that both sets of birds treated the mimics the same; the calculated values for *P* were less than 0.001. The significant difference in treatment is attributed to the fact that the experimental birds had about fifty initial trials with each model before experiencing the mimic; the colour pattern of the model, in each case, was associated with the learned unpalatability of that butterfly. Then when the mimics were presented, the experimental birds in general were unable to discriminate the colour pattern of the mimic from that of the model. Under the conditions of the experiment, the effectiveness of mimicry in the case of *L. a. archippus*, and of *P. troilus* and *P. polyxenes* has been demonstrated.

Full results and an extended discussion of these experiments and others will appear elsewhere at a later date. This work was aided by a Fanny Bullock Workman Scholarship from Wellesley College and a National Science Foundation terminal predoctoral fellowship.

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