Anolis carolinensis: Effects of Feeding on Reaction to Aposematic Prey

Abstract. *During a 15-day experiment, green anoles,* Anolis carolinensis, *were: (i) presented with one of two aposematic insects,* Oncopeltus fasciatus *or* Photinus pyralis, *during days 4, 6, and 8; (ii) maintained on one of four different food levels during days 9–14; and (iii) presented with the original model on day 15. Lizards on low rations tended to capture more* Photinus *on day 15 than did anoles on higher rations. No such correlation was observed with* Oncopeltus.

The effectiveness of any warning or aposematic color pattern depends on the characteristics of the species of both predator and prey. Many such characteristics are not stable, changing according to a wide variety of conditions. For example, the degree of hunger in the predator may vary according to the availability of all prey, independently of the abundance of a particular model. It is conceivable that change in the availability of food may influence the behavior of both experienced and naive predators; we now summarize a study of the reaction toward models by predators kept under different food regimens.

The predators used were male green anoles, *Anolis carolinensis* (*1*), insectivorous lizards of the southeastern United States; all were individually caged and kept in a room maintained at 27° ± 1°C and on 12-hour light schedule; each was weighed and placed in one of four weight categories: 2.51 to 3.50 g, 3.51 to 4.50 g, 4.51 to 5.50 g, and 5.51 to 6.50 g. Lizards of each weight class were divided into four groups: 0X, 1X, 2X, and SX, each group being subjected to one food regimen. *Tenebrio* larvae were fed to the four groups (Table 1). A local firefly, *Photinus pyralis*, and the milkweed bug, *Oncopeltus fasciatus*, both distasteful to the anole, were used to test reaction of the lizards toward the models.

Table 1. Amount of *Tenebrio* larvae fed to lizards of the four food regimens on the basis of the body weight of lizards.

Energy regimen	*Tenebrio* larvae (mg) to lizards weighing (g)			
	2.51–3.50	3.51–4.50	4.51–5.50	5.51–6.50
0X	0	0	0	0
1X	54	72	90	108
2X	108	144	180	216
SX	Ad lib.	Ad lib.	Ad lib.	Ad lib.

Food was withheld from all lizards during the first 3 days of the 15-day test period to be sure that all were hungry. On day 4 a model (either an *Oncopeltus* or a *Photinus*) was placed in each lizard's cage for 5 minutes, and the reactions of the lizards to the models were recorded as follows: negative (lizard displayed, lizard retreated, prey not attacked), or positive (prey unsuccessfully rushed, prey captured and rejected, prey captured and eaten). Any model remaining after 5 minutes was removed.

Next, the lizards of all four categories were fed *Tenebrio* larvae at the 2X level; this procedure was repeated on days 6 and 8, when each lizard was presented with the same species of model it had encountered on day 4. The period from day 4 to day 8 is called the training period. Thereafter, the animals were fed according to their group classifications: group OX received no food at all, while groups 1X and 2X were given their respective amounts of food on days 11 and 13; group SX was fed larvae ad libitum on days 11 through 14.

On the final day 15 (the testing period) each lizard was again presented with the same species of model offered on day 4; its reactions were noted. In instances in which the lizards made no positive move toward the models, some acceptable prey were substituted to see if the lizards were hungry. Those taking the substitute prey were judged hungry enough to have eaten the model if it had not been obnoxious; those refusing the substitutes were judged not hungry. After elimination of records for lizards that died or escaped, there are 325 useable tests in all: 178 with *Photinus* and 147 with *Oncopeltus*. Each lizard was used for only one test.

Partial r's were used so that the effects of certain variables, some unimportant in the study proper, could be controlled. Three matrices, two with four variables and one with five, were used to interpret the raw data. The variables in the four-variable matrices were (i) the predator's response to the model on the test day, (ii) the predator's response to the model during the training period, (iii) the weight of the predator, and (iv) the food level offered to the predator on days 9–14. Separate four-variable matrices were determined for anoles tested with *Photinus* and *Oncopeltus*. To the four variables listed above, a fifth, the model used, was added to form a five-variable matrix.

On the basis of the four-variable matrices, reactions of the anoles to the two models during the training period seemed to have no bearing on their subsequent behavior in the final test ($r_{12.34}$, .05099 for *Photinus*; .00885 for *Oncopeltus*). The correlation of predator's response toward the model on the test day and the food level on days 9–14 ($r_{14.23}$) was highly significant with *Photinus* (− .34236) but not significant with *Oncopeltus* (.02306). The *Photinus* statistic indicates that animals in the lower-food-intake groups are more likely to make a positive response toward this insect than are those in the higher-intake groups. These statistics also indicate that the anoles treated the two models differently. The value of $r_{25.134}$ from the five-variable matrix also shows that this lizard treated the two models differently, for at .406 it is highly significant.

The data show that earlier food intake can influence the extent to which a predator will make a positive response toward a model, but that this interaction in turn depends upon the particular model used. The differential treatment of the models, shown in this report, corroborates an earlier paper (*2*) showing that anoles fed restricted diets for 11 months were still able to distinguish between certain models, including *Oncopeltus* and *Photinus*.

A finding of this study is that energy intake by the predator must be controlled in any predator-model study, especially if comparative studies are being run; this point also applies when conceptual models of predator-model relations are constructed.

Owen J. Sexton
Charles Hoger
Edward Ortleb

Department of Biology,
Washington University,
St. Louis, Missouri 63130

References and Notes

1. Obtained as adults from a Louisiana dealer.
2. O. J. Sexton, *Anim. Behavior* **12**, 101 (1964).
3. Supported by NSF grants GB-1861 and GB-3063. Facilities of the Washington Univ. Computation Center (supported by NSF grant G-22296) were used; we thank Jean Fitch for her help.

24 June 1966