

## THE DEFENSIVE ENSEMBLES OF TWO PALATABLE MOTHS

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**ABSTRACT.** I compared the primary (before disturbance) and secondary resting places, relative palatabilities, and escape behaviors of a feces-mimicking moth and a specific background matching moth. The components of the defensive ensemble are discussed.

There are two levels of anti-predation mechanisms, primary and secondary. Primary defensive strategies are those which are effective before the attack of the predator, e.g. background matching, aposematism, dispersion, anachoresis. Secondary techniques include protean escapes, noxious discharges, unpalatability, etc. (Edmunds, 1974). Previously, I had shown that there are different types of secondary protective behaviors which accompany aposematism and crypsis (Evans, 1983) and crypsis and Batesian mimicry (Evans, 1978). Possibly different subtypes of crypsis may be accompanied by different types of secondary defensive behavior. It is possible to recognize at least two types of cryptic organisms. Some animals have a specific color pattern, body outline, and behavior which allows them to match a particular portion of their habitat (Sargent, 1981). Apparently, there are other organisms which because of their generalized dull coloration, can blend into several backgrounds but none perfectly. Some authors (Agee, 1969 with *Heliothis zea*; Knight, 1916 with *Pseudaletia unipuncta*) have noted moths which rest in more than one situation in their habitats, but a similar observation could be made with some large mammals.

Resemblance to dung might be considered a third type of crypsis. Some authorities could argue that dung-like organisms are Batesian mimics, since they do not match any background. Cryptics such as stone-like plants (e.g. *Lithops* spp., Mesembryanthaceae) also resemble inedible objects but are found among a general background of the type of stones they resemble. Conversely, bird dung mimics would always be found naturally in ecosystems where bird droppings exist. The two basic strategies, i.e. crypsis and Batesian mimicry, seem to be parts of a continuum of deception types.

In this study I wished to compare the primary and secondary protective activities of a moth which resembled bird droppings to those activities of a moth which seemed to be a good match of a specific background.

*Concochares arizonae* Hy. Edw. (Noctuidae) is a black and white moth which, in its natural resting position, with wings folded, closely

resembles a medium-sized passerine (Aves) dropping. It does not match the background of its habitat in general but it might seek out those specific situations where it would become inapparent. *Bomolocha vega* (Hübner) (Noctuidae) is a russet and tan colored moth which seemed (to my eyes) successfully cryptic while resting on specific substrates. The dorsal coloration of *B. vega* suggests both the coloration and the texture of the broken stones which are abundant in its environment.

#### METHODS

Cryptic animals match their resting backgrounds to the exposed color pattern of their bodies (Sargent, 1981), display protean escape upon perceiving predator-like stimuli (Evans, 1983; Humphries & Driver, 1970), and are palatable (Rothschild, 1981). A study of a cryptic animal should touch on each of these points.

I conducted this study on the Yuma (Arizona) Desert near Fortuna wash. The area is a mixed *Larrea-Cercidium* community, the ground littered with weathered and broken dark-red stones. I performed the experiments from sunrise to one hour later in March when the ambient temperature varied 9–17°C and the moisture 18–42% R.H. Both moth species were assembled using an ultraviolet light placed on the ground in open areas the evening before the tests. I found it necessary to change the light's location three times during the course of the experiments because the local bird community repeatedly began to disturb the moths. Similar problems have previously been reported with assembling palatable moths in natural settings (Jeffords et al., 1979). I tested the moths' reactions to a dorsal front-wing touch using a needle as in a previous study (Evans, 1983). The front wing touch mimics the initial tentative attack by an avian insectivore. I recorded the reaction duration ( $\pm 0.2$  s), reaction type, and resting places before and after stimulus. I captured each moth after testing and maintained it at  $-20^{\circ}\text{C}$  prior to the palatability tests.

The palatability of the moths was determined using standard techniques (Evans & Waldbauer, 1982; Evans, 1984). The test birds were three wild-caught adult northern catbirds (*Dumetella carolinensis* (L.) and two brown thrashers (*Toxostoma rufum* (L.) (both Passeriformes: Mimidae). Three acceptances in successive offerings for each bird constituted evidence of palatability in that species of moth.

I analyzed the data using  $r \times c$  contingency tables (Snedecor & Cochran, 1980) since there was a non-normal distribution.

#### RESULTS

Both species of birds ate the moths. *B. vega* was eaten quickly and usually in preference to the alternative prey, *Tenebrio molitor* L. pu-

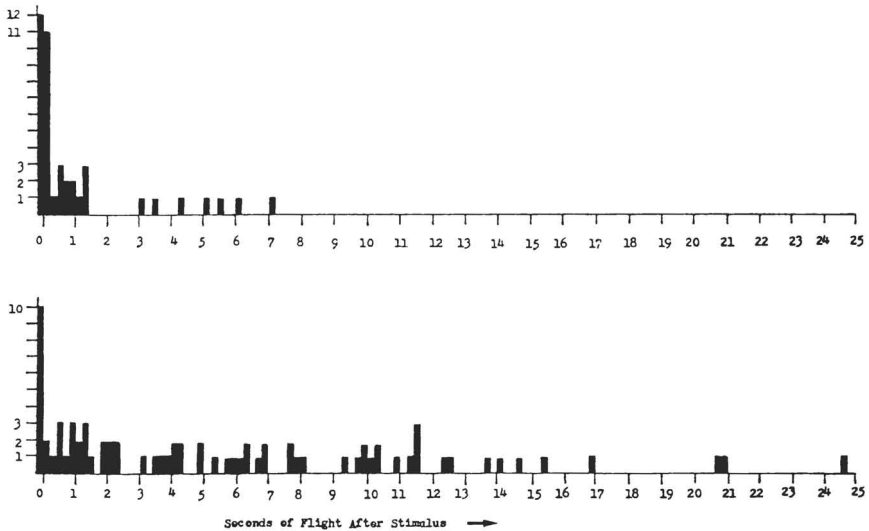


FIG. 1. Flight duration histogram. Flights timed  $\pm 0.2$  s. Each moth was killed after a single test. The **upper graph** illustrates the flight duration frequencies of *Conochara arizonae* and the **bottom graph** those of *Bomolocha vega* (both Lepidoptera: Noctuidae). Additional times for *C. arizonae* not shown: 34.2 and 66.8 s. Additional durations of *B. vega* not shown: 36.8 and 55.8 s. The two moths have statistically significantly different flight duration frequencies ( $P < 0.005$ ,  $r \times c$ ).

pae (Coleoptera: Tenebrionidae). This moth is doubtless a highly palatable species: I found numbers of their body-less wings near the light later in the day and saw (through a blind) house sparrows (*Passer domesticus* L.) feeding on the insects by first tearing off the moths' wings. The catbirds initially accepted *C. arizonae* with hesitation and after consuming the alternate prey. Upon subsequent presentations, the catbirds became more receptive to *C. arizonae* and began to eat them more quickly. Bent (1948) reports that adult female catbirds sometimes feed on their nestlings' droppings. Initially, nestling droppings are differently shaped than those of adults which *C. arizonae* resembles. The thrashers refused the latter moth species at first, but one of the thrashers began to eat them in later presentations. The other thrasher never touched the droppings-mimic. All four birds would hold this moth in their beaks for some time before ingesting it.

Near the ultraviolet light, I found all of the *B. vega* resting initially on substrates matching that of the dorsal (exposed) surface of their outstretched wings. There was really nothing other than bird feces in the area which matched *C. arizonae*. None of these moths was resting on or near bird feces.

Figure 1 illustrates the flight durations of the two species. I divided

the 128 flight durations into 7 groups: 0 (no flight), 0.2–0.8 s, 1.0–1.6, 1.8–2.8, 3.0–4.0, 4.2–5.6,  $\geq 5.8$ . The difference between the responses in the two moths is statistically significant ( $P < 0.005$ ). Thirty-nine percent of the chi-square value came from the last classification.

Most of the flying moths changed the direction of flight at least once while in the air (*B. vega*, 84%; *C. arizonae*, 80%). The brief ( $\leq 0.4$  s) flights of the feces mimics, however, were largely (88% of those short flights with at least one change in direction) straight away from the substrate and almost straight back to a place close to the starting point. These moths seemed to land on random objects. *B. vega* flights were typically protean (Roeder & Treat, 1961). When the moths landed, 82% of the *B. vega* landed on a matching substrate. The initial location of the moth was one that it had made, presumably, without the recent stress of the predator-like stimulus. The moths select the secondary landing site under potential pressure from a predator so that occasional mistakes must be made. I saw a few *B. vega* change their secondary landing site.

#### DISCUSSION

Clearly, the mimic of bird droppings was more likely to make quicker, shorter flights than the specific background matcher, *B. vega*. It seems logical that *C. arizonae* had brief flights since there was no particular background which they matched. In any case, the strategy of a fecal mimic is not to blend in exactly with a particular area but to be an apparent but ignored object. A bird dropping which flew relatively long horizontal distances would attract attention. Conversely, the *B. vega* encountered on their longer flights some non-matching or poorly matching substrates (trees, bushes, dead twigs, etc.) which most avoided. This activity would be likely to require more time. Apparently, if the optimal match is not discovered then a poorer match is sometimes accepted temporarily. In an earlier study (Evans, 1983), another moth resembling an inanimate object, *Datana ministra* (Drury) (dead twig mimic), exhibited a somewhat different pattern of escape behavior than that of taxonomically related general background matchers. Moth flight is ambient temperature dependent; therefore, these two studies are not precisely comparable since the present investigation was conducted with moths at lower air temperatures. Nevertheless, it appears that different escape behavior patterns may accompany different cryptic techniques. There are unified protective ensembles, the components of which can be isolated and shown to be characteristically distinct from analogous components in other life strategies.

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