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Batesian Mimicry between a Cardinalfish (Apogonidae) and a Venomous Scorpionfish (Scorpaenidae) from the Philippine Islands[1]

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ABSTRACT: An apparent case of Batesian mimicry involving the cardinalfish *Fowleria* sp. and the venomous scorpionfish *Scorpaenodes guamensis* is described. Classical definitions of Batesian systems require that the mimic be less common than the model. The present data do not suggest a classical Batesian mimetic system. However, if the model is considered to be the generalized scorpaenid morph characteristic of *S. guamensis* and other Philippine scorpaenids, then the mimetic association between *Fowleria* sp. and *Scorpaenodes guamensis* is a classical Batesian system.

OF THE REPORTED OBSERVATIONS of interspecific mimicry in fishes (e.g., Whitley 1935, Randall and Randall 1960, Tyler 1966, Wickler 1968, Hobson 1969, Starck 1969, Losey 1972, Springer and Smith-Vaniz 1972, Russel, Allen, and Lubbock 1976, Thresher 1978, Ormond 1980), there is only Whitley's (1935) record of a mimetic association involving a species of venomous scorpaenid and a nonvenomous mimic. Whitely described several specimens of the serranid *Centrogenys vaigensis* and the scorpaenid *Sebastapistes bynoensis laotale* collected from North Queensland, Australia, noting that the former, a percoid, was a mimic of the latter in both form and coloration. He remarked that scorpaenoids are "sluggish creatures with venomous spines on the head or in the dorsal fin, so that the harmless *Centrogenys* may derive some fortuitous benefit from resembling them."

Russel, Allen, and Lubbock (1976) noted that most reported cases of interspecific mimicry in fishes can be classified as either Batesian, Müllerian, or aggressive mimicry. Batesian mimicry typically includes three elements: one or more predator species; a model that is dangerous or unpalatable to the predator; and a mimic species that obtains some protection from predation by resembling the model (Nur 1970, Greene and McDiarmid 1981).

We report a new case of apparent Batesian mimicry between a species of apogonid, *Fowleria* sp.,[4] and a venomous scorpaenid, *Scorpaenodes guamensis*, from the Philippine Islands. Material is deposited in the Natural History Museum of Los Angeles County (LACM). All measurements are standard length (SL).

In July of 1981, while diving at Puerto Galera, Oriental Mindoro, Republic of the Philippines, one of us (Seigel) observed a mimetic association involving the cardinalfish *Fowleria* sp. and the scorpionfish *Scorpaenodes guamensis*. Two stations (PI81-36, 37, Table 1) were particularly noteworthy, for in 5 or 6 separate localities, it was observed that when ichthyocide was applied to small caves or to interstices in large rock boulders, a small *S. guamensis* (sizes ranged 15.0–68.0 mm SL) swam away from the rocks (usually 5 to 10 min after application of ichthyocide) closely followed by at least one *Fowleria* of nearly the same size; in some instances more than

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[4] Identification is tentative, since the genus *Fowleria* is in need of revision. There are seven nominal species (Fraser 1972) of which *F. variegatus* most closely resembles the *Fowleria* figured in this paper.

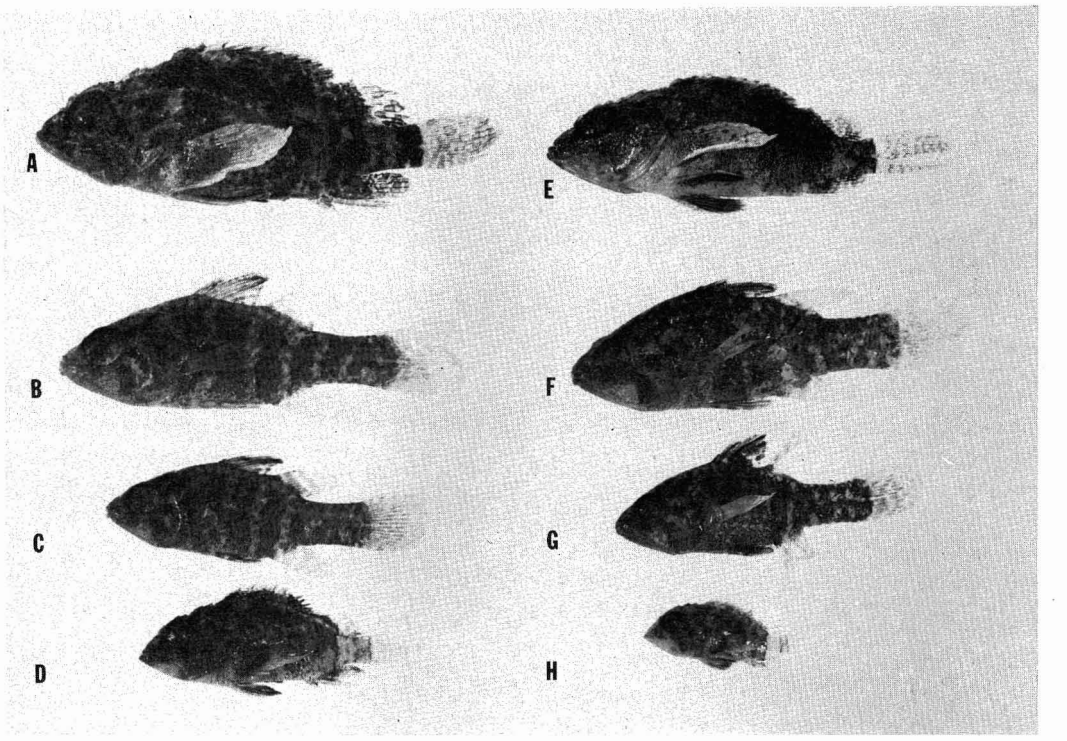

FIGURE 1. *Scorpaenodes guamensis* (*A*, *D*, *E*, *H*) and its mimic *Fowleria* sp. (*B*, *C*, *F*, *G*). Lateral view of *A*, LACM 42490-56, 1 of 3, 39.0 mm; *B*, LACM 42490-51, 1 of 10, 34.0 mm; *C*, LACM 42490-51, 1 of 10, 27.0 mm; *D*, LACM 42490-56, 1 of 3, 23.0 mm; *E*, LACM 42491-52, 1 of 6, 33.0 mm; *F*, LACM 42491-49, 1 of 5, 33.0 mm; *G*, LACM 42491-49, 1 of 5, 26.0 mm; *H*, LACM 42491-52, 1 of 5, 15.0 mm.

TABLE 1

PHILIPPINE ISLAND STATIONS THAT YIELDED *Fowleria* SP. AND *S. guamensis* INCLUDING NUMBER OF EACH SPECIES

STATION	LOCALITY	*Fowleria* SP.	*S. guamensis*
PI81-2	Hundred Islands	10	2
PI81-7	Hundred Islands	6	3
PI81-13	Lingayen Gulf	6	1
PI81-35	Puerto Galera	5	1
PI81-36	Puerto Galera	10	3
PI81-37	Puerto Galera	5	6

one *Fowleria* was taken along with a small *S. guamensis*.

Both species are strikingly similar in coloration, the live-color patterns consisting of dark-reddish brown mottled bands alternating with light-colored bands flecked with small reddish brown spots (Figure 1). The dorsal, anal, and caudal fins are variably banded, the pelvic fins dark, and there are two or more oblique bars extending ventrally and posteriorly from the rim of the orbit to the maxillary and the posterior margin of the preopercle, respectively (Figure 1). Body shape is remarkably similar in the two species. Both appear as rather robust fishes, and the dorsal and ventral profiles of the head and body are nearly identical (Figure 1). The mouth is upturned at an angle of approximately 25–30° and the eye is large (30–40 percent head length).

The Scorpaenoidei is renowned for including the world's most venomous fishes (Halstead and Mitchell 1963, Halstead 1970, Nelson 1976). Halstead and Mitchell (1963) recognized the genus *Scorpaenodes* as a venomous scorpionfish, a statement subsequently corroborated by Halstead (1970), who listed two venomous species of *Scorpaenodes*, *S. guamensis* and *S. parvipinnis*. There are at least

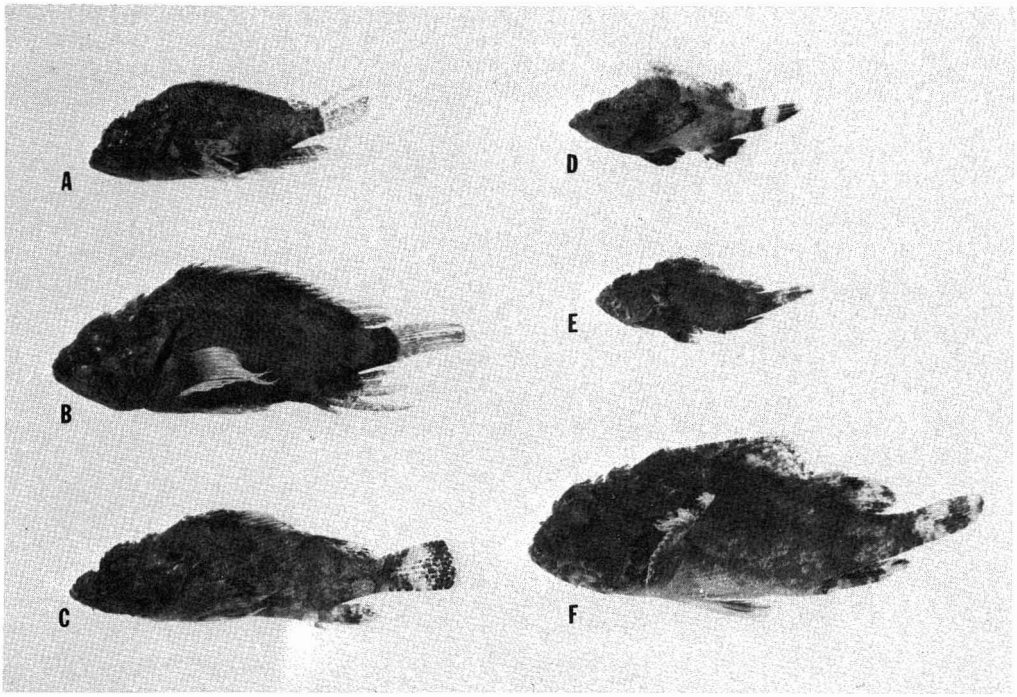

FIGURE 2. Morphologically similar Philippine scorpaenids. Lateral view of *A*, *Scorpaenodes guamensis*, LACM 42491-52, 1 of 6, 45.0 mm; *B*, *Scorpaenodes scabra*, LACM 42456-41, 67.0 mm; *C*, *Scorpaenopsis cirrhosa*, LACM 42479-37, 61.0 mm; *D*, *Scorpaenopsis diabolus*, LACM 35977-30, 36.0 mm; *E*, *Sebastapistes tristis*, LACM 42467-42, 34.0 mm; *F*, *Parascorpaena aurita*, LACM 42461-58, 72.0 mm.

seven common Philippine scorpaenids that resemble *Scorpaenodes guamensis* in overall body shape and coloration: *Scorpaenodes scabra*, *Hypomacrus albaiensis*, *Scorpaenopsis cirrhosa*, *Scorpaenopsis diabolus*, *Sebastapistes tristis*, and *Parascorpaena aurita* (Figure 2, *Hypomacrus albaiensis* not figured). Most of these are known to be venomous (Halstead 1970).

There are no known venomous cardinalfishes. The Apogonidae contains about 200 species representing 24 to 26 diverse genera, most of which are small (less than 100 mm), secretive coral reef fishes (Fraser 1972).

Randall and Randall (1960) noted that evidence for mimicry should follow other lines in addition to the similarity of the two species in form and color: "a mimic occupies the same habitat as the model, and its distribution frequently coincides with that of the model." The geographic ranges of *Fowleria* sp. and *Scorpaenodes guamensis* are broadly overlapping. *S. guamensis* is found along rocky and coral reefs throughout the tropical Indo-west Pacific (Eschmeyer 1969, Allen and Steene 1979) and *Fowleria* (with seven nominal species, see footnote 4) is widely distributed in the Indo-west Pacific from east Africa to Samoa, the Philippine Islands, and northward to Japan (Fraser 1972, Masuda, Araga, and Yoshino 1975, Yoshino and Nishijima 1981).

The present observations are based on material collected during June and July 1981 from 39 stations in 3 separate regions of the Philippine Islands: Hundred Islands and adjacent areas, Lingayen Gulf, northwest Luzon; Honda Bay and adjacent areas, and Sombrero Island, Palawan; and Puerto Galera, Oriental Mindoro. A review of species lists from each station revealed that *Fowleria* sp. and *S. guamensis* were collected in 6 of 39 stations (3 stations in Hundred Islands/Lingayen Gulf; 3 stations in Puerto Galera), and except for

1 station in Honda Bay, Palawan, neither species was taken in a collection without the other.

DISCUSSION

The numbers of both species collected at each station do not suggest the classical Batesian complex in which the mimic is less common than the model (Table 1). The present data indicate that in collections made at stations where *Fowleria* sp. and *S. guamensis* were present, the mimic-to-model ratios ranged from 1 : 1 to 6 : 1 (Table 1). Previous authors have discussed mimic-to-model ratios in Batesian systems, noting that there are numerous situations in which Batesian mimics occur in equal or greater numbers relative to models (Fisher 1930, Springer and Smith-Vaniz 1972, Russel, Allen, and Lubbock 1976, Greene and McDiarmid 1981).

Innate avoidance, as described by Springer and Smith-Vaniz (and subsequently by Smith 1975 and Greene and McDiarmid 1981) is an individually variable, genetically based response whereby predators innately recognize a particular morphology or behavior as belonging to an unpalatable prey species. By mimicking *Scorpaenodes guamensis*, the nonvenomous cardinalfish *Fowleria* sp. may gain protection from predation because it closely resembles a generalized, venomous scorpaenid morph innately avoided by potential predators. There are a number of very similar venomous scorpaenids (see above and Figure 2) that provide, along with *S. guamensis*, a "model morph" for the cardinalfish *Fowleria* sp. It is possible that the mimic, *Fowleria* sp., is in fact less abundant than its model, if the model is considered to be the generalized, venomous scorpaenid morphology characteristic of *S. guamensis* and many other Philippine scorpionfishes.

Greene and McDiarmid (1981) stated that Batesian and Müllerian mimicry are rare phenomena among vertebrates. Conversely, Russel, Allen, and Lubbock (1976) noted that mimicry, at least among marine fishes, may actually be relatively general and widespread; they stated that previous descriptions of mimicry centered around the more spectacular and specialized mimics, those that are most striking to the observer. The description of a new case of Batesian mimicry involving a venomous scorpionfish and a nonvenomous cardinalfish presents evidence that mimicry may in fact be a relatively widespread, though often unobserved or unrecognized, phenomenon in marine fishes.

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