

## Aggressive Mimicry between Juveniles of the Snapper *Lutjanus bohar* and Species of the Damselfish Genus *Chromis* from Japan

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Russell et al. (1976) briefly listed the most important papers on mimetic relationships of marine fish species. Ten new cases of mimicry were described, including apparent aggressive mimicry between juveniles of the snapper, *Lutjanus bohar* (Forsskål) and the damselfish *Chromis ternatensis* (Bleeker). A similar mimetic relationship of the same lutjanid juvenile and four additional species of the genus *Chromis* has been observed annually since 1973 at Miyake-jima, Japan (34°05'N, 139°30'E). The present paper reports these observations and a similar record from the Ryukyu Islands.

### Observations

In the course of several hundred dives at Miyake-jima, I have frequently observed *Lutjanus bohar* juveniles seeming to mimic the following *Chromis* species; *Chromis flavomaculata* Kamohara, *C. weberi* Fowler at Bean, *C. miyakeensis* Moyer et Ida, and *C. lepidolepis* Bleeker. In addition, I observed a similar relationship between *L. bohar* and *C. weberi* in Nakagusuku Bay, Okinawa Island, in February, 1976. In all observations, the mimic aggregated in the water column near coral outcroppings or volcanic cliffs with the *Chromis* model or in heterotypic schools that included from one to three of the model species as well as *Anthias squamipinnis* (Peters) and juvenile *Caesio* spp. From a distance of 8 m or more, it was often difficult for the observer to distinguish the mimic from the model, particularly when visibility was somewhat limited.

*Lutjanus bohar's* mimetic relationship with *Chromis* species in Miyake-jima waters was most frequently observed between the lutjanid juvenile and *Chromis flavomaculata*, less often with *C. weberi* and *C. miyakeensis*, and rarely with *C. lepidolepis*. In every observation the mimic represented the same size class as the

Table 1. Comparative abundance of mimic and model species along selected courses at two sites at Miyake-jima, Japan.

Association	Toga Bay	Igaya Bay
Mimic		
<i>Lutjanus bohar</i>	5	6
Models		
<i>Chromis flavomaculata</i>	> 300	> 1000
<i>C. weberi</i>	> 50	> 150
<i>C. miyakeensis</i>	> 10	> 80
<i>C. lepidolepis</i>	0	> 50

model, the smallest being *L. bohar* juveniles of about 20 mm in total length with *C. weberi* and *C. lepidolepis* of the same size. The largest mimics observed were in excess of 100 mm in standard length in company with models of comparable size. In all cases, the model species greatly outnumbered the mimic. Usually only a single mimic appeared in the *Chromis* aggregation under observation. The single exception was noted on Jan. 2, 1977, when two *L. bohar* juveniles of greater than 100 mm in standard length were seen in company with 16 *C. flavomaculata* of similar size. Table 1 shows the comparative abundance of the mimic and model species resulting from a census taken over two specific courses at Miyake-jima in November, 1976.

The possibility was considered that the lutjanid might gain protection from predators by its habit of joining heterotypic schools (Ehrlich and Ehrlich, 1973). To test this hypothesis, I pursued numerous aggregations, varying the intensity of the chases. When pursued rather slowly, aggregations of *C. flavomaculata* quickly grouped together into tight, compact schools. The lutjanid remained at the fringe of such schools, only loosely associated with them. When the intensity of the chase increased, *Lutjanus bohar* individuals quickly left the *Chromis* aggregation to seek cover solitarily. Mixed schools of *Chromis* were less likely to segregate by species when pursued than was the lutjanid.

### Discussion

Russell et al. (1976) attribute the relationship between *Lutjanus bohar* juveniles and *Chromis ternatensis* to aggressive mimicry,

Table 2. Similarities of *Lutjanus bohar* juvenile mimics and *Chromis* models.

\*, not always present on model; \*\*, 30 mm SL.

Species of <i>Chromis</i>	Light postdorsal spot	Dark pectoral spot	Dark edges to caudal fin	Similar body color	Similar body depth	Similar habits
<i>C. ternatensis</i>			+	+		+
<i>C. flavomaculata</i>	+*	+		+	+	+
<i>C. miyakeensis</i>	+	+	+	+	+	+
<i>C. weberi</i>				+		+
<i>C. lepidolepis</i>				+	+	+**



Fig. 1. Top: Juvenile *Lutjanus bohar* mimic. TMBS 760905-1. Bottom: Most common model at Miyake-jima, *Chromis flavomaculata*, TMBS 761221-1. Bloches on body of *L. bohar* appear under stress condition.

similar to that of the serrinid genus *Hypoplectrus* and various Caribbean damselfishes (Randall and Randall, 1960, Ehrlich, 1975). Similarities between *L. bohar* juveniles and the plankton-eating *Chromis* apparently enable the lutjanid to closely approach unsuspecting prey who mistake it for the harmless *Chromis*. This view is supported by the fact that the gut contents of my single specimen of *L. bohar*, a juvenile of 55 mm in standard length, included numerous fish remains, with scales of two sizes, possibly those of small glastic juvenile apogonids that abound at the collecting site.

The relationship between *Lutjanus bohar* juveniles and four species of *Chromis* in Japan brings to five the number of *Chromis* species reported as models for the lutjanid. *Lutjanus bohar* is a wide-ranging species in the tropical Indo-West Pacific. Its similarities in body depth and fin contours to several species of *Chromis* and local variation in abundance of different *Chromis* in specific geographical locations throughout the vast tropical Indo-West Pacific suggest that the relationship between *L. bohar* and *Chromis* may be a universal adaptation of the lutjanid, and that further model species will be discovered. In addition to shape and color similar to numerous *Chromis*, *L. bohar* juveniles display a light spot at the base of the soft dorsal fin, resembling, for example, *Chromis elerae* Fowler et Bean, *C. hypsilepis* (Günther), *C. acares* Randall et Swardloff, *C. notata* Temminck et Schlegel, and the known models, *C. miyakeensis* and *C. flavomaculata* (see Allen, 1975). Russell et al. (1976) list the criteria for facultative mimicry as follows: (a) the mimic may only superficially resemble the model, (b) the mimic aggregates with the model, (c) the model far outnumbers the mimic, (d) the relationship is opportunistic, involving more than one species of model, (e) only juveniles mimic, (f) mimicry occurs during only part of the life history of the mimic, and (g) usually elements of only one type of mimicry are involved in the relationship. That *L. bohar* meets criteria (a)~(f) has been shown above, i.e., the lutjanid superficially resembles the various *Chromis* models, it aggregates with them and is far outnumbered by the *Chromis*

(Table 1), and the lutjanid mimics only as a juvenile. Hobson (1973) and others have shown that aggregating fishes group together into compact schools at the approach of danger. The departure of *L. bohar* juveniles from *Chromis* aggregations when vigorously pursued negates the possibility of protective mimicry. Aggressive mimicry is therefore the only type of mimicry involved in the relationship, thus meeting criterion (g). *Lutjanus bohar* appears to be a facultative mimic of *Chromis*.

Russell et al. (1976) suggest the possibility that attributes of facultative mimics may, in some cases, represent "incipient" stages in the evolution of eventual obligative mimicry relationships. Wickler (1965) had previously theorized, that in its early stages, mimicry could not have evolved under the selective pressures of mimicking, but rather as the result of convergent similarities in morphology, coloration, and behavior. With this in mind, it is of interest to compare *Lutjanus bohar* juveniles with the five known models.

It would appear that *C. miyakeensis* displays the most attributes of an acceptable model (Table 2), but, in fact, *C. flavomaculata* and *C. weberi* are more common models in Miyakejima waters, in spite of their rather superficial resemblance to the mimic. Apparent preference for specific models may be only partly due to the relative abundance of the various *Chromis* species (Table 1). As Hobson (1968, 1969) has noted for the aggressive mimic blenny, *Plagiotremus azaleus* (Jordan et Bollman), only a superficial resemblance may serve to make the mimic inconspicuous to its prey as it swims in aggregations with the model species. Observations at Miyakejima suggest that rather than a close physical resemblance, subtle behavioral differences may be more important in determining the most ideal model. Although all of the model species and the mimic feed in the water column, the lutjanid mimic and the models *C. flavomaculata* and *C. weberi* exhibit very limited home ranges, e.g., around a specific coral head or a fairly restricted section of volcanic cliff. *Chromis miyakeensis* utilizes a somewhat wider home range, increasing the possibility of "losing" its mimic as it strays too far for

the lutjanid to follow. This possibility is further suggested by the fact that neither *Chromis albomaculata* Kamohara nor *C. chrysur* (Bliss) have been observed in relationship with *L. bohar*, although both are locally common at Miyake-jima. Both of these damselfishes are known to range over extremely wide areas of the reef (personal observation).

As shown above, *Lutjanus bohar* juveniles share many similarities in color and shape with a variety of *Chromis* species, thus pre-adapting the lutjanid for potential mimicry. Whether the diurnal mid-water feeding habits of *L. bohar* were preadaptations or whether they evolved secondarily under the selective pressures of mimicking cannot be said with certainty. Although substantial information is available on the feeding behavior of the Lutjanidea in general (Randall and Brock, 1960; Hobson, 1965, 1974; Stark and Davis, 1966; Randall, 1967), virtually nothing has been reported on the food habits of juvenile lutjanids. My observations of the juveniles of *L. bohar*, *L. fulvus* (Bloch et Schneider), *L. monostigma* (Cuvier), *L. sp.* (see Masuda et al, 1975, fig. D on p. 64), and *L. kasmira* (Forsskål) at Miyake-jima indicate that only *L. bohar* and *L. fulvus* are primarily diurnal feeders. All of these species except *L. bohar* feed near the substrate as juveniles, with *L. fulvus* seeming to occupy a very limited home range, similar in area to that of *L. bohar*. Diurnal feeding by *L. bohar* and *L. fulvus* juveniles may be relatively late evolutionary specializations (Hobson, 1974: 1019) with the mid-water feeding habit of *L. bohar* juveniles possibly co-evolving under the selective pressures of mimicking.

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#### Postscript

At Seragaki Beach, Okinawa Island, Oct. 7, 1977, after completion of the manuscript, the author observed a single juvenile *Lutjanus bohar* in association with a large heterotypic aggregate consisting of approximately 200 *Pomachromis richardsoni* (Snyder) and about 50 *Chromis flavomaculata*. All members of the aggregate including the lutjanid ranged in size from about 80~90 mm in total length. The pomacentrids were actively feeding on plankton in upwelling waters along a reef patch. The mimic lutjanid closely resembled *P. richardsoni* in body depth and shape, and by the presence of a white post-dorsal spot, black borders to the caudal fin, and a dark pectoral spot, making species distinction difficult from a distance of 5~6 m in the relatively turbid water.

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#### スズメダイ属とその擬態種パラフェダイ幼魚について

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東京都下三宅島及び沖縄の潜水観察でパラフェダイ *Lutjanus bohar* の幼魚がスズメダイ属4種の aggressive な擬態種として生活していることが明らかとなった。三宅島では *Chromis flavomaculata*, *C. weberi* との関係が顕著であった。

擬態種であるパラフェダイは多くの場合1尾で、モデル種の数がそれより多いこと、擬態種の形態が外見上モデル種に似ていること、擬態種が幼魚であること、さらに両者の関係が機会的であることなどから、facultative な擬態と考えられる。

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