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Reexamination on the Aggressive Mimicry of the Cleaner Wrasse *Labroides dimidiatus* by the Blenny *Aspidontus taeniatus* (Pisces; Perciformes)

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Abstract—Field observations on feeding and related behavior of the mimic blenny *Aspidontus taeniatus* and 3 species closely related to it, and the cleaner fish (model) *Labroides dimidiatus* were made at the coral reef of Sesoko Island, Okinawa, Japan, along with analysis of gut contents. The mimic blenny fed mostly on demersal eggs of fishes and tentacles of polychaetes, but it rarely tore pieces from the fins of host fishes even when they were posing for cleaning. The feeding habits of the mimic blenny are compared with those in other localities and with those of related species. It is concluded that the mimicry can hardly be regarded as an aggressive one: posing by host fishes seems to be a secondary result of the resemblance which may have developed because of the benefit for immunity from predation, and the resemblance itself prevents the blenny from becoming a specialized fin-eater because it can be easily recognized by host fishes.

The Indo-pacific labrid *Labroides dimidiatus* (Valenciennes) is well known as an obligate cleaner. It takes food such as ectoparasites and mucus from the body surface of host fishes, which visit it to solicit cleaning by posing (Randall 1958; Okuno 1969a, 1969b; Potts 1973; Losey 1974a; Kuwamura 1976, 1980). The sympatric blenny *Aspidontus taeniatus* Quoy & Gaimard resembles the cleaner in size, shape, and color and swimming patterns. From the resemblance, the blenny is thought to receive benefits in 2 ways: (1) it may be protected from predation, as the cleaner is because of its cleaning habit, and (2) it can easily take food such as pieces of the fins of other fishes being deceived and posing for it (i. e. "aggressive mimicry") (Eibl-Eibesfeldt 1959; Randall & Randall 1960; Wickler 1968; Springer & Smith-Vaniz 1972).

Wickler (1960, 1961, 1963, 1968) studied the origin and evolution of aggressive mimicry by detailed aquarium observations on the behavior of *A. taeniatus* in comparison with those of related blennies such as *Plagiotremus* spp. However, *Aspidontus dussumieri* (Valenciennes), the only congener of *A. taeniatus*, was not dealt with in his study, and field observations were extremely limited. A few observations on the feeding behavior and gut contents of *A. taeniatus* in the field show that it feeds on demersal eggs of fishes (Randall & Randall 1960; Losey 1974b, 1978; Smith-Vaniz 1976) and tentacles of tube worms (Polychaeta) (Randall & Randall 1960; Kuwamura 1981b) rather than fish fins or ectoparasites (Eibl-Eibesfeldt 1959), and that it rarely attacks posing fishes to tear pieces of their fins (Losey 1978; Kuwamura 1981b). From these facts, it is suggested that immunity from predation may be the primary basis for the mimicry, with exploitation of fins a secondary benefit (Smith-Vaniz 1976), or that the blenny may rely on aggressive mimicry only when other foods are rare (Losey 1978), or that the unexpectedly low utilizing rate of posing fish by the blenny may be a strategy to prevent host fishes from learning its disguise (Kuwamura 1981b).

The present paper aims to reexamine the aggressive mimicry by quantitative field observations on the feeding behavior of *A. taeniatus*, the closely related *A. dussumieri* and *Plagiotremus* spp., and the cleaner.

Study Area, Materials and Methods

During July and August 1982, field observations and collections were made using scuba or by snorkelling at the fringing reef near the Sesoko Marine Science Center of University of the Ryukyus, on the southeast coast of Sesoko Island (127°54′E; 26°38′N), Okinawa, Japan. About 100 m from the seashore, the outer reef slope or cliff changes to the continuous sandy area (about 5 m deep) where small coral patches or patch reefs are scattered sparsely (see Fig. 1). Most field work was carried out in an area about 50 m

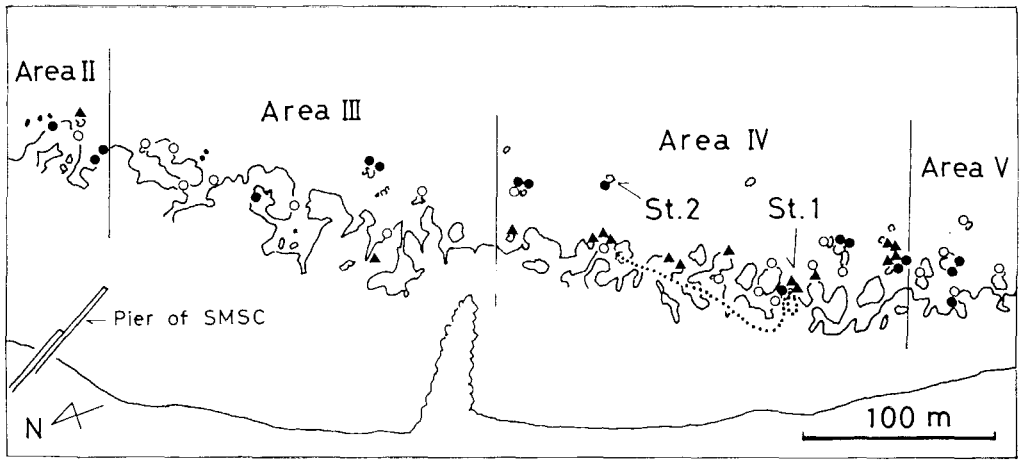

Fig. 1. Distribution of the cleaner *L. dimidiatus* (open circle for juvenile and solid one for adult) and the mimic blenny *A. taeniatus* (solid triangle), observed on August 15 (Areas IV and V) and 16 (Areas II and III), 1982. SMSC: Sesoko Marine Science Center. The shoreline (below) and the outer reef margin and coral patches are illustrated with unbroken lines. An example of the trace of movement of a mimic blenny (9 cm TL), observed from 11:27 to 11:43 on August 29, is also illustrated by the dotted line. After it roamed around St. 1 for several minutes, the blenny began to swim northward and entered into the nest hole at about 100 m distance from St. 1.

x 1000 m along the reef margin, i.e. Areas I, II, III, IV, and V (each 50 x 200 m^2) from north to south, and at a patch reef (Patch Reef A: about 30 x 40 m^2) which is located about 100 m offshore from Area I and is composed of numerous small coral heads mostly of *Porites*. The topography and oceanographic condition around Sesoko Island were described elsewhere (Nishihira 1974; Yamamoto 1979; etc.); the fish fauna around the island was reported by Yoshino & Nishijima (1981).

The fishes studied were: *Labroides dimidiatus* (cleaner: model), *Aspidontus taeniatus* (mimic), *A. dussumieri, Plagiotremus rhinorhyncos* (Bleeker), and *P. tapeinosoma* (Bleeker). The genus *Aspidontus* is composed of only the 2 species given above; it is closely related to the genus *Plagiotremus,* both belonging to the tribe Nemophini in the family Blenniidae (Smith-Vaniz 1976). Another species of *Plagiotremus, P. laudandus,* and 2 other cleaner fishes, *Labroides bicolor* and juvenile *Labropsis manabei,* were also found in the study area, but they were not studied in detail as they were few in number.

Underwater observations were made between 10:00 and 18:00. Distribution of the 5 species was surveyed several times, and the position of each fish was recorded on a map of the study area along with its body color and estimated total length. In these surveys, the characteristic behavior of each species was also recorded, sometimes by underwater 35 mm still and 8 mm movie cameras. Continuous tracing of an individual, recording its feeding and other behavior in detail for 15 min on the average (5 to 70 min), was carried out in 113 cases for 1664 min for a total of 5 species: i. e. "All Events Recording (AER)". Most data of AER were collected at Area IV, but about half of the data of *A. dussumieri* were collected at Patch Reef A. At the end of the study period, collection of 33 specimens was made by dip net and screen net or the anesthetic quinaldine. The specimens were preserved in 10 % formaldehyde solution just after collection; later their gut contents were examined by stereoscopic microscope.

Results

Distribution, Abundance and Movement

During the preliminary observations individuals of all the 5 species except for juvenile *L. dimidiatus* were rarely found in the inshore areas. Therefore, their populations were censused in detail in the area along the reef margin and patch reefs (Table 1). The smallest individuals of *L. dimidiatus* observed were 1 cm in total length (TL), while most of other species were larger than 5 cm TL; a result of the difference in settling size (Smith-Vaniz 1976; Kuwamura 1981a, 1981b). Juveniles ($\leq$ 5 cm TL) of *L. dimidiatus* have different color pattern from adults (Randall 1958; Potts 1973; Kuwamura 1981a); *A. taeniatus* usually mimics the adult color pattern of the cleaner (Randall & Randall 1960; Kuwamura 1981b). Therefore, when numbers of the cleaner and the mimic are compared, those of adults ($>$ 5 cm TL) must be compared.

The cleaner *L. dimidiatus* was the most abundant and was almost evenly distributed along the reef margin (Table 1 and Fig. 1) probably

Table 1. Distribution and abundance of *A. taeniatus* and 4 other species at Sesoko Island, observed in the middle of August 1982. Numbers of juveniles (J: ≦ 5 cm TL) and adults (A: > 5 cm TL) observed in each study area are shown for each species, respectively.

	L. dimidiatus		*A. taeniatus*		*A. dussumieri*		*P. rhinorhynchos*		*P. tapeinosoma*	
	J	A	J	A	J	A	J	A	J	A
Patch Reef A	1		0		0		0		0	
		0		0		4		0		1
Area I	2		0		0		0		0	
		4		1		0		1		2
Area II	4		0		0		1		0	
		8		1		0		3		1
Area III	7		0		0		0		0	
		3		1		0		1		2
Area IV	9		0		0		1		0	
		8		14		3		1		5
Area V	12		0		0		0		0	
		8		0		0		0		1
Total	35		0		0		2		0	
		31		17		7		6		12

because it has haremic social structure (Robertson 1972; Kuwamura in press). In contrast to this, *A. taeniatus* was concentrated in Area IV, where it was more abundant than adults of *L. dimidiatus* (14:8, Table 1). Such a concentrated distribution was also found in *A. dussumieri* (Area IV and Patch Reef A).

Some individuals of *A. taeniatus* could be recognized by color variation and size. At least some used the same nest hole throughout the study period. During each AER, individuals of *A. taeniatus* continuously rested in nest holes, foraged only around one *Porites* head (2–5 m in diameter), roamed over several *Porites* patches, or extended their ranges over the reef flat. The largest movement observed during an AER was about 150 m for 10 min (Fig. 1). Individuals of *A. taeniatus* in Area IV had largely overlapping home ranges. This blenny sometimes formed a small aggregation of up to 7 fish: e.g. the number of the fish observed at St. 1 (see Fig. 1) varied from 1 to 7 from time to time. In such an aggregation, a frontal display was often seen: two fish stopped to face each other in a tail-hanging position for several seconds, and then one of the two swam forward by the side of the other, beating its tail strongly. The members of the aggregation repeated such displays changing the partners. Similar display and gregarious behavior were also seen in *A. dussumieri*.

Feeding Behavior and Food

Subjects of feeding behavior observed during AER and gut contents of collected specimens are shown in Tables 2 and 3 respectively. *A. taeniatus* fed mostly on tentacles of tube worms and eggs of fishes, but rarely on pieces of the fins of other fishes.

Two species of tube worms, *Spirobranchus giganteus* and *Sabellastarte indica*, which were usually found on *Porites* heads, were observed to be attacked by the mimic blenny. It fed on the former species far more frequently than the latter, probably because the former was much more abundant than the latter in the study area. In its feeding on tube worms, the blenny slowly approached one of the tube worms, stopped 10–20 cm above it, and suddenly darted downward to tear off a tip of a tentacle before the worm could withdraw its tentacular crown. Once attacked by the blenny, the tube worm did not came out from the tube for several minutes. The blenny fed upon tube worms one after another around one or more *Porites* heads, foraging solitarily or in a small groups of up to 4 fish.

Demersal eggs of fishes were frequently found in gut contents of *A. taeniatus* (Table 3), though its egg-feeding behavior was observed only 1 time during AER (Table 2). Egg-feeding behavior was observed 4 times during other observations. In these 5 cases, eggs of the damselfish *Poma-*

centrus moluccensis (2 cases), *Abudefduf coelestinus* (once), *Glyphidodontops cyaneus* (once), and the blenny *Exallias brevis* (once; observed by Y. Hirose in September 1982) were eaten by the mimic blenny. The blenny approached the nest of an egg-caring fish solitarily or in a small group of up to 6 fish, and though it was repeatedly attacked by the nest-owner, it succeeded in darting into the nest. In spite of vigorous attacks also in the nest, the blenny continued feeding on the adhesive eggs for 30 to 60 s. When it came out of the nest, its abdomen was swollen: as many as 1500 eggs were found in the stomach of a specimen.

The cleaner *L. dimidiatus* mostly picked (cleaned) at the body surface of other fishes (Table 2); ectoparasitic copepods and isopods, and fish scales and mucus, etc. were found in its gut (Table 3).

A. dussumieri fed on tentacles of the tube worm *S. giganteus* by the same method as *A. taeniatus*, but it more often picked at bottom substrata, mostly feeding on filamentous algae (Tables 2 and 3).

P. rhinorhynchos and *P. tapeinosoma* fed only on pieces of the body surface of other fish by sudden attacks (Tables 2 and 3).

Table 2. Feeding behavior of *A. taeniatus* and 4 other species at Sesoko Island. Bouts of picking at each material observed during All Events Recording (AER) of each species are shown. The ratios (%) of those to total picking bouts of each species are given in parentheses.

	L. dimidiatus	*A. taeniatus*	*A. dussumieri*	*P. rhinorhynchos*	*P. tapeinosoma*
Number of observations (individuals)	20 (7)	50 (15)	22 (7)	10 (3)	11 (7)
Total observation time (min)	169	863	327	156	149
Fish body surface	206 (97.6)	15 (2.3)	0	14 (100.0)	19 (100.0)
Fish egg	0	1[a] (0.2)	0	0	0
Polychaete tentacle	0	605 (93.8)	77 (26.3)	0	0
Other substrata	4 (1.9)	22 (3.4)	216 (73.7)	0	0
Plankter	1 (0.5)	2 (0.3)	0	0	0
Total picking	211	645	293	14	19
Bouts per 100 min	124.9	74.7	89.6	9.0	12.8

[a] In this case egg-feeding continued for about 30 s in the nest of a damselfish, but total bouts of picking could not be counted; for convenience sake, it was counted as 1 time in this table.

Table 3. Gut contents of *A. taeniatus* and 4 other species collected at Sesoko Island in the late August 1982. Number of specimens which had taken each food item and its ratio (%, in parentheses) to total number of specimens are shown for each species.

	L. dimidiatus	*A. taeniatus*	*A. dussumieri*	*P. rhinorhynchos*	*P. tapeinosoma*
Total number of specimens (SL mm)	7 (21.0–75.1)	11 (50.4–94.5)	5 (48.3–77.7)	3 (38.6–73.8)	7 (53.0–74.3)
Fish scale, fin, skin and mucus	7(100.0)	0	0	3(100.0)	7(100.0)
Ectoparasite on fish[a]	4 (57.1)	0	0	0	0
Fish egg[b]	0	7 (63.6)	0	0	0
Polychaete tentacle[c]	0	5 (45.5)	4 (80.0)	0	0
Copepoda associating with invertebrate[d]	1 (14.3)	0	1 (20.0)	0	0
Filamentous algae	0	0	4 (80.0)	0	0
Sand grain	1 (14.3)	1 (9.1)	2 (40.0)	0	0

[a] *Caligus cordiventris* and Taeniacanthidae sp. (Copepoda) and Gnathiidae spp. (Isopoda).
[b] Oval eggs, 1.1–1.2 mm x 0.5–0.55 mm, with adhesive threads; perhaps of Pomacentridae.
[c] *Spirobranchus giganteus* and a few *Sabellastarte indica*.
[d] Sabelliphilidae sp. (?).

Table 4. Interactions between host fishes and *A. taeniatus* and 4 other species at Sesoko Island. Bouts of posing by host fish, picking at the posing fish, approaching nonposing fish and picking at the nonposing fish, observed during AER of each species, are shown. Bouts per 100 min are represented in Italics. Number of host species posing or being picked at is given in parentheses. *: could not be counted in detail because of too many occurrence and long duration of posing.

	L. dimidiatus	*A. taeniatus*	*A. dussumieri*	*P. rhinorhynchos*	*P. tapeinosoma*
Posing by host fish [A]	*	13 (8) *1.5*	0	0	0
Picking at posing fish [B]	173 (44) *102.4*	3 (3) *0.3*	0	0	0
Utilizing ratio of posing fish [B/A %]	–	23.1	–	–	–
Approaching nonposing fish [C]	*	29 (15) *3.4*	0	18 (10) *11.5*	25 (12) *16.8*
Picking at nonposing fish [D]	33 (15) *19.5*	12 (9) *1.4*	0	14 (7) *9.0*	19 (11) *12.8*
Success ratio of picking at nonposing fish [D/C %]	–	41.4	–	77.8	76.0
Ratio of posing fish to total picking [B/(B+D) %]	84.0	20.0	–	0.0	0.0

Interactions with Host Fishes

Host fishes exhibited posing to solicit cleaning for the mimic *A. taeniatus* as well as the cleaner *L. dimidiatus*, but not for the remaining 3 species (Table 4).

During AER, 44 species of Pomacentridae, Labridae, Chaetodontidae, etc. were observed posing for and being cleaned by *L. dimidiatus* (Appendix 1). The cleaner also cleaned nonposing fishes, but most (84.0 %) of its cleaning was directed to posing fishes (Table 4).

Eight species of Pomacentridae, Labridae, etc. displayed posing to the mimic *A. taeniatus* (Appendix 2). Five of these host species are common hosts for *L. dimidiatus*, and there was no difference in the body size of hosts between the cleaner and the mimic: both juveniles and adults posed (Appendices 1 and 2). However, the cleaner cleaned some other larger species which were not seen posing for the mimic. The frequency of posing for the mimic (1.5 bouts per 100 min) was much lower than that for the cleaner (>102; Table 4). The mimic utilized (tore a tip of the fin of) posing fish only in 3 out of 13 cases. It attacked nonposing fish more often (12 times, Table 4 and Appendix 3). The blenny slowly approached to the distance of 20–30 cm from the nonposing fish, and suddenly darted to tear off a piece of its fin. The success ratio of such attacks was 41.4 % (Table 4).

Out of 13 cases of posing exhibited to *A. taeniatus*, as many as 10 cases were observed for a small adult (6 cm TL), which appeared on a coral patch (4 m in diameter: St. 2 in Fig. 1) on August 5 and disappeared after 10 days (probably it moved onshore to the outer reef margin in about 30 m distance, for a similar sized fish appeared there on August 16). The frequency of posing for this individual was 8.0 bouts per 100 min (based on 6 observations for 125 min in total), which was lower than that observed for a coexisting *L. dimidiatus* (6 cm TL; 33.3 per 100 min), but much higher than the average (0.5) of other individuals of *A. taeniatus*. The small adult tore pieces of fins of the posing fish only in 2 out of 10 cases, and more often (5 cases) attacked nonposing fishes. Seven cases of tearing fish fins observed in this individual account for about half of all the cases (15) seen in *A. taeniatus*. Though the ratio of tearing fish fins to total feeding (7.8 % of 90 feedings) in the small adult was much higher than that in average (1.4 %) of other individuals, most (88.9 %) of feeding behavior was directed to the tentacles of tube worms.

P. rhinorhynchos and *P. tapeinosoma* always attacked nonposing fish from as far away as 1 to 2 m, and they succeeded in tearing off a piece of the body surface from the hosts in more than 70 % of the trials (Table 4, Appendices 4 and 5). Their success ratios were much higher than that of *A. taeniatus* (Table 4; $\chi^2 = 4.57$ for *P. rhinorhynchos* and 5.24 for *P. tapeinosoma*, $0.02<P<0.05$ in both cases). *Plagiotremus* spp. attacked larger host species than those of *A. taeniatus* (Appendices 3, 4 and 5).

A. dussumieri was never observed attacking other fishes (Table 4).

When approached by *A. taeniatus*, nonposing fishes attacked it before being attacked in 6 (20.7 %) of 29 approaches (Appendix 3). Also, host fishes sometimes attacked the blenny just after the latter tore their fins. Such attacks were

observed more often against *A. taeniatus* (5 out of 15 successful attacks [33.3 %]: Appendices 2 and 3) than against *L. dimidiatus* (14 out of 206 cleanings [6.8 %]: Appendix 1) ($\chi^2 = 9.38$, $0.001<P<0.01$). *Plagiotremus spp.* were rarely attacked by host fishes after feeding (only once [5.3 %] for *P. tapeinosoma*: Appendices 4 and 5), probably because they can rapidly swim away from the hosts after contacts.

Even in other cases except for those shown above, which were related to feeding, other fishes sometimes attacked *A. taeniatus* (8.5 bouts per 100 min) and *L. dimidiatus* (3.0) passing near by them (Appendices 6 and 7). The damselfishes often attacked *A. taeniatus*, probably because the latter was a predator on eggs of the former.

Interactions between the Mimic and the Cleaner

During AER of *A. taeniatus*, 49 encounters (within 30 cm distance) between it and *L. dimidiatus* were observed (Table 5). In about half of these encounters no active displays were seen between the 2. In most encounters the mimic was larger than the cleaner, but attacks by the cleaner against the mimic were often observed (24.5 %). The cleaner, however, also often cleaned the posing mimic (20.4 %).

A. taeniatus was sometimes found in the vicinity of other blennies, but usually no active displays were seen between them. It once attacked *A. dussumieri*, and was attacked twice by *P. tapeinosoma*.

The cleaner *L. dimidiatus* rarely had interactions with other blennies: it once attacked *P. tepeinosoma*, and twice cleaned posing *A. dussumieri*.

Discussion

Plasticity and Specialization of the Feeding Habit

At Sesoko Island, *Aspidontus taeniatus* fed mainly upon fish eggs, which were taken in low frequency in regard to foraging time but could be taken in a large volume at a time, and polychaete tentacles, which though frequently taken could be obtained only in small pieces at a single feeding. Other food items such as fish fins were rarely taken (Tables 2 and 3). Quantitative field data on the feeding habits of the mimic blenny in other localities are relatively few (Table 6).

Among the 4 localities given in the table, egg-feeding was not observed at Shirahama. Attacks on the blenny by damselfishes, which were frequently seen at Sesoko Island and Enewetak Atoll (Losey 1978), were not observed at Shirahama. There may have been no or few demersal eggs of fish at the period of observations (mainly in autumn), since breeding of most damselfishes occurs during late spring and summer at Shirahama (Kuwamura observations). Tentacles of polychaetes were not observed to be taken at Enewetak Atoll (Losey 1978); it is unknown whether there were tube worms or not at the study area. Fish fins were never or only rarely fed upon in all the localities except for Tahiti and Moorea, where nearly half of the specimens contained fish fins (Randall & Randall 1960). However, no quantitative observation on feeding behavior was made in that locality.

Beside the data given in Table 6, Eibl-Eibesfeldt (1959) observed fin-eating and cleaning behavior (picking of ectoparasites of a large fish) of the mimic blenny at Maldive and Nicobar Islands, but no quantitative data are available. He also reported that 1 specimen examined contained fish fins in the stomach. Hiatt & Strasburg (1960) described the gut contents of 3 specimens collected at Marshall Islands: one contained shrimp fragments, another had consumed fish eggs, and the third contained only gurry in its stomach.

Judging from the field data available at present, it is suggested that where fish eggs and/or tube worms are present, *A. taeniatus* can live feeding only upon them. If such foods are not present, e.g. cases in aquarium, the blenny may be obliged to rely on the other food, fish fins, but such situations have not been known from the sea.

The feeding habit of *A. taeniatus* is described as a compromise between those of *A. dussumieri* (benthic omnivore: present study; Smith-Vaniz 1976; Randall personal communication) and

Table 5. Interactions between the mimic *A. taeniatus* and its model *L. dimidiatus* at Sesoko Island. Bouts of each interaction observed during AER of the mimic (863 min) are shown for each case in which the mimic was larger than the model or vice versa, respectively. The ratios (%) to the total number of encounters are given in parentheses. *A.t.*: *A. taeniatus*; *L.d.* : *L. dimidiatus*.

	A.t. > *L.d.*	*A.t.* ≦ *L.d.*	Total
A.t. attack *L.d.*	1	0	1 (2.0)
L.d. attack *A.t.*	10	2	12(24.5)
L.d. lateral display *A.t.*	0	1	1 (2.0)
L.d. clean *A.t.* posing	10	0	10(20.4)
No active display	21	4	25(51.0)
Total	42	7	49

Table 6. A comparison of the feeding habit of *A. taeniatus* among different localities. For each locality, percentages of each food item are shown based on the data from field observation (above) and gut contents analysis (below: in Italics). The method for calculation of the ratios is the same as in Table 2 (field observation) or Table 3 (gut contents). Utilizing ratio of posing fish is also shown, calculated as in Table 4. –: no data available; +: no quantitative data.

Locality (Author)	Food item				Utilizing ratio of posing fish	Observation time (min) / Number of specimens
	Fish egg	Polychaete tentacle	Fish fin	Others (substrata)		
Sesoko Island, Okinawa, Japan	0.2	93.8	2.3	3.7	23.1	863
(Present study)	*63.6*	*45.5*	*0*	*9.1*		*11*
Shirahama, Honshu Is., Japan	0	72.5	13.7	13.7	7.7	200
(Kuwamura·1981b)	–	–		–		–
Enewetak Atoll, Micronesia	100	0	0	0	0[a]	150
(Losey 1978)	*100*	*0*	*0*	*0*		*4*
Tahiti and Moorea, Polynesia	+	+	+	+	–	–
(Randall & Randall 1960)	*30.0*	*30.0*	*40.0*	*10.0*		*10*

[a] Posing was observed 12 time during 150 min observations of 5 blennies (Losey personal communication).

Plagiotremus spp. (specialized fish-body-surface-eater: present study; reviewed in Smith-Vaniz 1976). The fin-eating habit of *A. taeniatus* is not so specialized as *Plagiotremus* spp. (also see Wickler 1968; Smith-Vaniz 1976), for such foods account for only a small part of the diet of the former (Tables 2 and 3), and the success ratio of attacking nonposing fish was much lower in the former than the latter (Table 4). The method of attacking host fishes is also different between them: *A. taeniatus* tears fins, while *Plagiotremus* pick scales and skin, and the latter can attack host fishes from more distant position than the former (also see Wickler 1960, 1961, 1963, 1968).

Function of the Resemblance

As the blenny *A. taeniatus* resembles the cleaner *L. dimidiatus,* host fishes of the cleaner are deceived by the resemblance and exhibit posing for the blenny as well as the cleaner. Such posing for the mimic by host fishes was observed in all the localities in Table 6. However, the blenny utilized (ate) fins of the posing hosts only in low frequency (0–23.1 %, Table 6); moreover, fins were taken more frequently from nonposing fishes (Table 4; Kuwamura 1981b).

In usual cases of "aggressive mimicry" in fishes, (1) the prey is attracted, then killed and eaten by a mimic predator such as angler fish (Wickler 1968), or (2) the prey is suddenly attacked but not killed (only a part of it is taken) by a non-attractive (cryptic) predator such as some *Plagiotremus* spp. (Russell et al. 1976; Smith-Vaniz 1976). In both cases, prey fishes can not (in the former case) or rarely (in the latter) learn the disguise of the mimic. Different from these cases, in the case of "aggressive mimicry" of *A. taeniatus,* host fishes can easily learn the mimic when they are attacked by it, because the blenny attacks them but does not kill them. Rapid learning of the mimic by other fishes has been confirmed in aquarium (Wickler 1961, 1963, 1968; Okuno unpublished). This is also suggested in the sea by the facts that the frequency of posing by host fishes was much lower for the mimic than the cleaner (Kuwamura 1981b; present study), and that mainly young fishes were deceived by the mimic (Randall & Randall 1960) though some adult fish of small species were also deceived in the present study, and that attacks by host fishes (and also the cleaner) were often seen against the mimic (Losey 1978; present study).

Kuwamura (1981b) suggested that the low utilizing rate of posing fish by the blenny is a strategy to prevent them from learning its disguise. In the present study, the mimic blenny was observed to show rather stable residence, aggregating in an area (Area IV), where it was even more abundant than adult cleaners. If the blenny relies on posing fish for food, it should choose habitats with as low a density as possible compared to the model (cleaner), to prevent hosts from learning. The concentrated distribution of the mimic blenny may be the result of intraspecific social (and mating (?)) relationships common to the congener *A. dussumieri.* This intraspecific relationship probably prevents an individual mimic from adopting any strategy that relies on "aggressive mimicry".

As Losey (1978) suggested, it is supposed that the mimic blenny may rely on "aggressive mimicry" in certain situations such as when fish eggs and tube worms are rare. However, the blenny can move into more suitable habitat by pelagic floating behavior (Losey 1974b; Kuwamura 1981b) if the settling site is not suit-

able. Therefore, it seems that the blenny need not rely on "aggressive mimicry" even in such situations. When a mimic blenny newly settled in an area where no or a few resident blennies were present, the frequency of posing by host fishes was rather high: e.g. at Shirahama, near the northern limit of the range of the blenny (Kuwamura 1981b), and a case of a small adult at St. 2 in the present study. Even in these cases, however, posing fishes were rarely utilized and other foods were mainly eaten.

The mimic blenny may rely on "aggressive mimicry" in a different way from above: to deceive egg-caring fishes and then attacking their eggs. Egg-caring fishes such as damselfishes often chased out the blenny whether it was ready or not to attack their nests (Losey 1974b, 1978; present study). Therefore, it does not seem that the blenny has any benefit from mimicry in cases of egg-feeding.

It is therefore concluded that the principal function of the mimicry is immunity from predation. Though no quantitative field data, either positive or negative, have been obtained on the immunity from predation either for the cleaner or the mimic blenny (see Kuwamura 1981b), protection from predation seems probable because potential predators exhibit posing for the blenny. The resemblance between *A. taeniatus* and *L. dimidiatus* can hardly be regarded as aggressive mimicry; posing by various fishes for the blenny may be only a secondary result of the resemblance. The low utilizing rate of posing fish can be explained as a strategy to prevent them from learning and to facilitate the effect of protection. Furthermore, it seems that *A. taeniatus* is prevented from becoming a specialized fin-eater similar to *Plagiotremus* spp. by the resemblance itself, for it is easily learned by host fishes if it attacks them, because of the advertisement coloration.

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Appendix 1. Fishes cleaned by *L. dimidiatus* during AER (169 min). Bouts of cleaning at posing and nonposing fish are shown respectively. Bouts of attacks by host fish after being picked by the cleaner are given in parentheses.

Family	Species	TL(cm)	Posing	Nonposing
Pomacentridae	*Abudefduf coelestinus*	10–15	42	7
	Amblyglyphidodon curacao	7–12	10(1)	0
	Amphiprion frenatus	10	2	0
	Chromis bicolor	4–6	7(1)	1
	C. lepidolepis	6	1	0
	Glyphidodontops rex	6	1	0
	Pomacentrus amboinensis	8	0	1
	P. lepidogenys	5	1	0
	P. rhodonotus	8	1	0
Chaetodontidae	*Chaetodon auriga*	10	1	0
	C. kleini	6	1	0
	C. lunula	10–20	10(2)	2
	C. vagabundus	15	9	0
	Heniochus acuminatus	10	1	0
	H. chrysostomus	10	2	0
	H. monoceros	15	3	0
	H. varius	10–15	12	0
Labridae	*Coris aygula*	40	1	0
	C. gaimardi	20	3	0
	Halichoeres hoeveni	5–8	2	0
	H. melanochir	10–18	3	2
	H. prosopeion	10	1	0
	Labroides dimidiatus	7	1	1
	Thalassoma lunare	8–10	2	3
	Labridae sp.	15	1	0
Scaridae	*Scarops rubroviolaceus*	15	1	0
	Scarus sordidus	10–15	2(1)	0
	S. venosus	25–30	4	0
	Scarus sp.	30	1	0
Apogonidae	*Apogon cyanosoma*	3–7	3	1
	A. doederleini	6	0	1
	Cheilodipterus macrodon	10–12	0	5(2)
	C. quinquelineatus	8–10	0	2(1)
Serranidae	*Cephalopholis argus*	20	1	0
	C. urodelus	15	1	0
	Epinephelus merra	20	1	0
Mullidae	*Parupeneus fraterculus*	15–30	2	3
	P. trifasciatus	10–20	6(1)	0
Nemipteridae	*Scolopsis bilineatus*	15–20	13	0
	S. cancellatus	20	1	0
Pseudochromidae	*Dampieria spiloptera*	8	1	0
	Pseudochromis xanthochir	6	0	1
Acanthuridae	*Acanthurus nigrofuscus*	15–18	2	1
Aulostomidae	*Aulostomus chinensis*	40	1	0
Blenniidae	*Petroscirtes breviceps*	9	1	0
Ephippidae	*Platax orbicularis*	30	4	0
Holocentridae	*Myripristis adustus*	20	1(1)	0
Pomacanthidae	*Pomacanthus semicirculatus*	20–30	5	0
Scorpaenidae	*Pterois volitans*	30	0	2(1)
Zanclidae	*Zanclus cornutus*	8–15	4(3)	0
Total	50 spp. in 17 families		173(10)	33(4)
			44 spp.	15 spp.

Appendix 2. Fishes posing to *A. taeniatus*. Bouts of posing to and being picked by the mimic blenny observed during AER (863 min) are shown respectively for each host species. Bouts of attacks by host fish after being picked by the mimic are given in parentheses. Asterisks indicate species which are common hosts to *L. dimidiatus* (see Appendix 1).

Family	Species	TL(cm)	Posing	Picked
Pomacentridae	**Chromis bicolor*	5–6	4	1
	C. flavomaculata	8	1	0
	Pomacentrus moluccensis	6	2	1(1)
	**P. rhodonotus*	8	1	1
Labridae	**Halichoeres prosopeion*	12	1	0
	**Thalassoma lunare*	10	1	0
Acanthuridae	**Acanthurus nigrofuscus*	12	1	0
Balistidae	*Sufflamen chrysopterus*	20	2	0
Total	8 spp. in 4 families		13	3(1) 3 spp.

Appendix 3. Fishes approached and picked by *A. taeniatus* when they were not posing. Represented by the same methods as in Appendix 2.

Family	Species	TL(cm)	Approached	Picked
Pomacentridae	**Abudefduf coelestinus*	15	2(1)	0
	**Amblyglyphidodon curacao*	10	1	1(1)
	**Chromis bicolor*	6	10(2)	2(1)
	C. flavomaculata	4–6	2	1(1)
	**C. lepidolepis*	5	1	0
	**Pomacentrus amboinensis*	5–6	4(1)	3
	P. coelestis	7	1	1
	P. moluccensis	6	1(1)	0
Apogonidae	**Cheilodipterus quinquelineatus*	5	1	0
Blenniidae	*Atrosalarias fuscus*	10	1	1
Chaetodontidae	*Chaetodon argentatus*	5	1	1
Cirrhitidae	*Paracirrhites forsteri*	15	1	0
Labridae	**Halichoeres hoeveni*	10	1	1(1)
Mugiloididae	*Parapersis polyphthalma*	10	1	1
Pomacanthidae	*Centropyge ferrugatus*	10	1(1)	0
Total	15 spp. in 8 families		29(6)	12(4) 9 spp.

Appendix 4. Fishes approached and picked by *P. rhinorhynchos* during AER (156 min). No attacks by host fishes after being picked by the blenny were observed.

Family	Species	TL(cm)	Approached	Picked
Acanthuridae	*Acanthurus nigrofuscus*	15	1	1
	A. xanthopterus	12–20	2	2
Chaetodontidae	*Chaetodon lunura*	15	1	0
	C. vagabundus	10	1	0
Labridae	*Stethojulis strigiventer*	8	1	1
Lethrinidae	*Lethrinus nebulosus*	20	1	1
Nemipteridae	*Scolopsis bilineatus*	10–18	4	4
Pomacentridae	*Abudefduf coelestinus*	10–15	5	4
Scaridae	*Scarus* sp.	10	1	1
Synodontidae	*Saurida gracilis*	20	1	0
Total	10 spp. in 8 families		18(0)	14(0) 7 spp.

Appendix 5. Fishes approached and picked by *P. tapeinosoma* during AER (149 min).

Family	Species	TL(cm)	Approached	picked
Pomacentridae	*Abudefduf coelestinus*	8–15	5	4
	A. vaigiensis	8	1	1
	Amblyglyphidodon curacao	10	4	4
	Chromis flavomaculata	10–15	4	2
	Pomacentrus coelestis	6	1	1
Labridae	*Coris aygula*	40	1	1
	Hologymnosus semidiscus	12	1	1
Scaridae	*Scarops rubroviolaceus*	10–30	3	0
	Scarus sp.	6	1	1
Acanthuridae	*Acanthurus xanthopterus*	25–30	2	2
Balistidae	*Sufflamen chrysopterus*	20	1	1(1)
Mullidae	*Parupeneus trifasciatus*	12–20	1	1
Total	12 spp. in 6 families		25(0)	19(1) 11 spp.

Appendix 6. Fishes attacking *A. taeniatus* passing near by them. Bouts of attacks observed during AER of *A. taeniatus* (863 min) are shown for each species. Attacks apparently related to feeding behavior of the mimic blenny are omitted.

Family	Species	TL(cm)	Attacks
Pomacentridae	*Abudefduf coelestinus*	15	4
	Amblyglyphidodon curacao	10	4
	Chromis bicolor	5–6	2
	Dascyllus aruanus	6	1
	Eupomacentrus nigricans	8–10	10
	Pomacentrus amboinensis	7– 8	14
	P. alexanderae	6	3
	P. lepidogenys	6	1
	P. moluccensis	6	7
	P. rhodonotus	6– 8	10
	Pomacentrus sp.	6– 8	7
Labridae	*Cheilinus bimaculatus*	7	1
	Halichoeres hoeveni	8	1
Apogonidae	*Cheilodipterus quinquelineatus*	6–10	2
Pseudochromidae	*Dampieria spiloptera*	7	1
Blenniidae	*Plagiotremus tapeinosoma*	8	1
Total	16 spp. in 5 families		69

Appendix 7. Fishes attacking *L. dimidiatus* passing near by them, during AER of the cleaner (169 min). Represented by the same methods as in Appendix 6.

Family	Species	TL(cm)	Attacks
Pomacentridae	*Pomacentrus moluccensis*	6– 7	1
	P. rhodonotus	8	1
Apogonidae	*Cheilodipterus macrodon*	10	1
	C. quinquelineatus	7–10	2
Total	4 spp. in 2 families		5