A Review of the Labrid Fish Genus *Labroides*, with Descriptions of Two New Species and Notes on Ecology[1]

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AN INDO-PACIFIC genus of small labrid fishes (wrasses), *Labroides* Bleeker, is here restricted to four species, two of which are described as new from islands of the tropical central Pacific. Underwater observations of all of the species have revealed the unusual food habit of removal of ectoparasites from other fishes. This is discussed for each species in the accounts following taxonomic considerations.

Günther (1862: 120) and Fowler (1949: 117) considered *Diproctacanthus xanthurus* Bleeker in the genus *Labroides*. I am in agreement with de Beaufort (1940: 19, 151, fig. 26) that the monotypic *Diproctacanthus* Bleeker is a valid genus. *D. xanthurus* lacks the characteristic bilobed lower lip of *Labroides* and has two instead of three anal spines.

Smith (1957: 100, 104) established a new genus, *Fowlerella*, for *Labroides bicolor*, principally on the basis of fewer lateral line scales than *dimidiatus*. In view of the similarity of *bicolor* to *dimidiatus* in other respects than number of scales, I refer *Fowlerella* to the synonymy of *Labroides*

Smith included *Labrus quadrilineatus* Rüppell (1835: 6, pl. 2, fig. 1) from the Red Sea with *dimidiatus* in the genus *Labroides* even though its scale counts would seem to ally it with *bicolor*. Actually *quadrilineatus* probably does not belong in *Labroides*, for this species has a completely scaled head (whereas in *Labroides* the head is naked except for suborbital, postorbital, and opercular regions), a slightly emarginate caudal fin, eight instead of nine dorsal spines, and in Rüppell's moderately detailed description there is no mention of a bilobed condition of the lower lip. Fowler (1928: 331) (after Schmeltz) also placed *quadrilineatus* in *Labroides* and listed it from Samoa. I am dubious of this record. Possibly Schmeltz obtained the young of *Labrichthys cyanotaenia* Bleeker which have two lengthwise pale bands on the body (although these are lower on the body of *cyanotaenia* than they are on *quadrilineatus* and the more ventral band is not as distinct). *Labrichthys unilineata* (Guichenot) from Guam is probably a synonym of *Labrichthys cyanotaenia*, based on this juvenile color pattern.

Saville-Kent (1893: 308, col. pl. 16, figs. 4, 9) described two species of *Labroides*, *L. bicincta* and *L. auropinna*, after seeing them in coral pools of Lady Elliot Island reef in the Great Barrier Reef of Australia. He obtained no specimens, but preferred to "provisionally" give the fishes new names. Although the color drawings on which these names are based are crude, it seems very likely that the blue and black *L. bicincta* is a juvenile *L. dimidiatus*. Saville-Kent mentioned its "resemblance to the white and black banded *L. dimidiatus*, C. and V." Obviously he was not aware that the true life color of *L. dimidiatus* is blue and black. The figure of *L. auropinna*, a blue fish with yellow fins, fits no known species of *Labroides*. Until a more complete description with necessary meristic, measurement, and detailed descriptive data on the species is available, I prefer not to recognize this name. It is possible that *L. auropinna* is not a species of *Labroides*, and perhaps not even a labrid.

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The genus *Labroides* is distinguished from other genera of the Labridae in having a small mouth with thick lips, the upper with a shallow median groove and the lower divided into two prominent, anteriorly projecting lobes. The inner surface of the lips has fleshy folds. There is a single pair of large, curved, canine teeth anteriorly in each jaw, the upper pair fitting inside the widely-spaced lower pair when the mouth is closed. There is a large, anteriorly directed, canine tooth at the extreme posterior part of the upper jaw, separated by a gap from anterior teeth. The remaining teeth are small, those in the lower jaw in several close-set rows between the canines and those in the upper jaw forming a large mass just behind the anterior canines, this mass with a marked indentation anteriorly in the mid-line. The body is compressed, its width contained about 2.5 to 3 times in the head length, and moderately elongate, its depth contained about 3.5 to 4 times in the standard length. The caudal fin is truncate or slightly rounded. The preopercle is entire, its margin smooth. The gill membranes are attached to the isthmus. The snout is pointed. The snout, entire dorsal surface of the head, chin, and throat are scaleless. The lateral line is continuous, and the lateral line scales number 28 or 52 to 54. Fin ray counts are as follows: D IX, 11 or 12; A III, 10; P 13 (uppermost two rays unbranched). The species are small, individual fish usually being less than 100 mm. in standard length.

KEY TO THE SPECIES OF LABROIDES

(Applicable primarily to adults; see discussion below concerning juveniles)

1a. Lateral line scales 52 to 54; color light blue with a median lateral black band from snout to end of caudal fin (this band broadening as it passes posteriorly on body) (Indo-Pacific) . . . . . **Labroides dimidiatus**

1b. Lateral line scales 28; color not as above (although a median lateral black band is often distinct anteriorly on body and on head) 2

2a. Snout long, diameter of eye contained 2.1 to 2.5 times in snout length; caudal peduncle and caudal fin pale with a prominent black crescent posteriorly in fin, the attenuate ends of which extend to margins of caudal peduncle (tropical Pacific) . . . . . **Labroides bicolor**

2b. Snout not long, diameter of eye contained 1.5 to 1.9 times in snout length; caudal peduncle and caudal fin black with upper and lower edges of fin pale 3

3a. Median lateral black band which extends posteriorly from snout continuous with black posterior half of body; no dusky streak on cheek below eye; pale edges of caudal fin magenta in life; maximum standard length in excess of 80 mm. (Hawaiian Islands) . . . . . **Labroides phthirophagus,** n. sp.

3b. Median lateral black band which extends posteriorly from snout merges gradually to broad, pale-brown (dull-orange in life) area in center of body; a narrow dusky streak on cheek below eye running from chin to base of pectoral (may be faint in small adults); pale edges of caudal fin light lavender in life; maximum standard length about 60 mm. (Society Islands and Tuamotu Archipelago) . . . . . **Labroides rubrolabiatus,** n. sp.

Juvenile specimens for all species are unavailable to me; however, all have been viewed underwater, frequently in the proximity of adults. Juveniles of all four species appear to have the same basic color pattern, namely black with a broad band of color along the back which extends and narrows on to snout. On *L. dimidiatus* and *L. rubrolabiatus* this band is brilliant deep blue (these species are readily separable by scale counts; see key above); on *L. bicolor* it is bright yellow; on *L. phthirophagus* it is bright purple.

Labroides dimidiatus
(Cuvier and Valenciennes)
Fig. 1

Labrus latovittatus Rüppell, (*non* Lacépède), 1835, Neue Wirbelth., Fische . . . , p. 2.
Cossyphus dimidiatus Cuvier and Valenciennes, 1839, Hist. Nat. des Poiss., vol. 13, p. 136.
Labroides paradiseus Bleeker, 1851, Natuurk. Tijdschr. v. Nederland. Indië, vol. 2, p. 249.
Labroides bicincta Saville-Kent, 1893, The Great Barrier Reef of Australia, p. 308, pl. 16, fig. 4.
Labroides caeruleo-lineatus Fowler, 1945, Acad. Nat. Sci. Phila., Proc., vol. 97, p. 65, fig. 7.

TYPE LOCALITY: Mauritius.

This blue and black species is the most common and widespread of the genus, ranging from Africa to the tropical Pacific (where it is recorded from most major island groups).

Labroides paradiseus Bleeker differs from *dimidiatus* in having a hooklike ventroanterior extension of the broad black band in the caudal fin. I have observed various degrees of intermediacy between typical *dimidiatus* and the *paradiseus* form, and I regard the latter as a color variety, as did Günther (1881: 243). In the Society Islands and Tuamotu Archipelago I have seen no specimens of the *paradiseus* variety, although collections are not extensive. In large collections from the Marshall Islands and the Philippines in the United States National Museum the *paradiseus* form predominates.

At Makatea and Takaroa in the Tuamotu Archipelago, and to a lesser extent at Tahiti and Moorea, another color variant was observed. Occasional adults have a dull red-orange region in the middle of the body below and adjacent to the median black band. In the Marquesas *L. dimidiatus* were seen with a red-orange area which was longer and occurred above as well as below the black band.

Barnard (1927: 749) described two color varieties of the species at Natal, East Africa, one with a dark stripe across the base of the pectoral fin and one without. He stated that the color of the species in Africa is blue or yellow with a black longitudinal band. Smith (1949: 291), also reporting on the species from East Africa, described the color as varying rapidly from light pink through straw yellow to dark blue, apparently at will and according to the emotional state of the fish. I have never seen *L. dimidiatus* in the Pacific pink or yellow instead of blue, nor have I observed any rapid color changes. With age there is a loss of brilliance and a lightening of the blue color. Below the median black band large adults are nearly white.

A juvenile specimen, 24 mm. in standard length, collected by the author in Tahiti, was colored in life as follows: black with a band of deep blue about a pupil diameter in width beginning at upper lip and passing backward through upper part of eye (lower edge of band at upper edge of pupil) on to nape, where it is nearly two pupil diameters in width, and thence on to back, where it gradually narrows until it terminates dorsally on caudal peduncle; the black middorsal region, which is bordered by a blue band on each side, is broadest on the head and narrows as

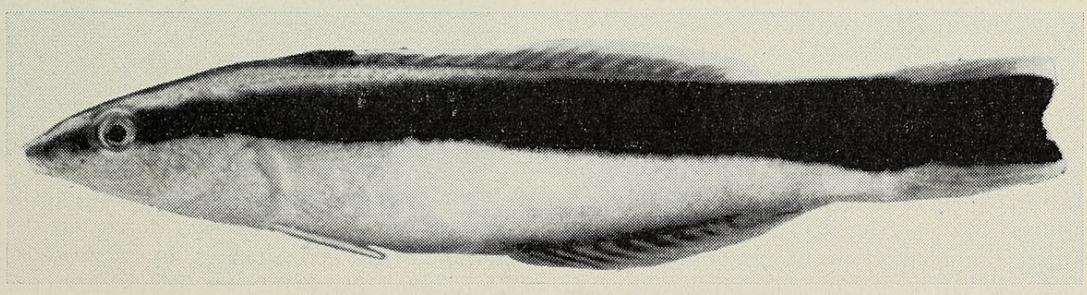


FIG. 1. *Labroides dimidiatus*, 83 mm., Society Islands. Caudal fin not expanded, hence emarginate appearance.

it passes posteriorly until it ends at rear of dorsal fin; head and thorax below level of lower edge of eye are pale; caudal fin black with narrow pale-violet edges; dorsal and anal fins dusky basally and hyaline distally, the dorsal blackish anteriorly, the anal darker posteriorly; paired fins pale.

Labroides caeruleo-lineatus Fowler (1945: 65, fig. 7) (1946: 159) is a young *L. dimidiatus*. The description was based on a 28 mm. specimen, and the figure clearly shows the typical juvenile color pattern as described above.

L. dimidiatus occurs most commonly in coral or coral-sand areas which are protected from wave action. Around atolls individuals are most often seen in lagoons rather than outside the peripheral reefs. I have observed them in water as shallow as 2 feet and as deep as 120 feet, but they appear to be more abundant in shallow water. Regan (1908: 230) has recorded the species from 34 fathoms in the Maldives.

Of this species de Beaufort (1940: 148) wrote, "In the aquarium of Amsterdam I observed that *Labroides dimidiatus* cleans the surrounding of the mouth and the gill openings of large fishes (Het Aquarium IV, 1936: 153) in the same way as has been observed by Beebe for the Atlantic species *Iridio bivittatus*." Smith (1949: 291) stated that *L. dimidiatus* "Feeds on minute organisms on rocks and has been observed to nibble over the mouth parts and gill covers of large Rock-cods." Doty and Morrison (1954: 24) observed what they termed an interesting association between a parrot fish and a fish which is undoubtedly *L. dimidiatus*.[2] The latter "cleans off its larger companion's beaklike jaws, teeth and head area." They implied that this unusual association is limited to just these two species; however, I have observed (Figs. 2, 3, 5) *L. dimidiatus* picking at the heads, bodies, and fins of numerous species of reef fishes representing many different families, including the carangids and serranids, members of which habitually prey upon small reef fishes.

None of the above authors mentioned the removal of ectoparasites; the use of the term cleansing gives the connotation of removal of debris or particles of food.

The stomach contents of two specimens from the Gilbert Islands and three from the Marshall Islands consisted of calagoid copepods which are ectoparasitic on fishes; two more specimens from the Gilberts had eaten small isopods (also fish parasites) along with a few fish scales (Randall, 1955*b*: 144). Subsequently, a specimen, 72 mm. in standard length, from Hull Atoll, Phoenix Islands, was found to contain three caligid copepods

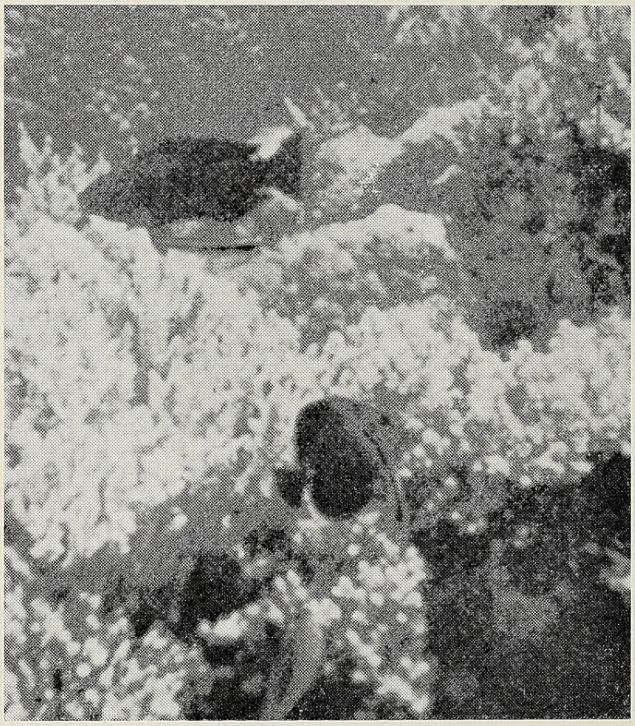


FIG. 2. A parrot fish, *Scarus* sp. (upper fish), and a surgeon fish, *Zebrasoma scopas* (lower fish), each being examined for ectoparasites by *Labroides dimidiatus*. Reproduced from 16 mm. movie film taken in the lagoon of Takaroa, Tuamotus.

[2] These authors erroneously refer to this species as a blenny—probably because of the confusion that results from the similarity in color pattern of *L. dimidiatus* to the blenny *Aspidontus taeniatus* Quoy and Gaimard, a similarity so striking that Barnard (1927: 749) suggested that mimicry might be involved, with perhaps one or the other species being poisonous. R. W. Hiatt and D. W. Strasburg observed the resemblance at Arno Atoll in the Marshall Islands and suspected mimicry. Randall (1955*b*: 144), noting it in the Gilbert Islands, proposed that the blenny might be mimicking the labrid, since the latter might gain protection from predaceous fishes by virtue of its food habits.

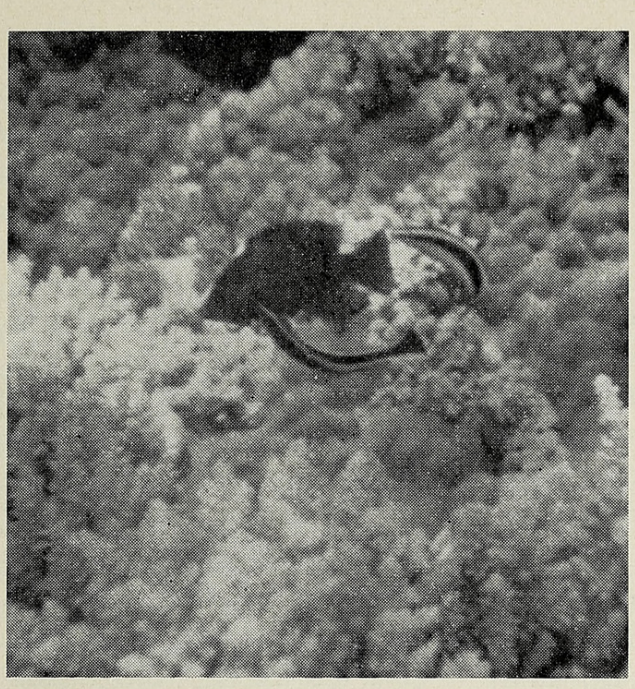


FIG. 3. A pair of *Labroides dimidiatus* picking at the wrasse *Epibulis insidiator*. Reproduced from 16 mm. movie film taken in the lagoon of Takaroa, Tuamotus.

and three small fish scales in the stomach and the digested remains of numerous calagoid copepods in the intestine. A 71 mm. specimen from the Society Islands had two calagoids in the stomach and four calagoids and one larval gnathiid isopod in the intestine. One section of the intestine had a bit of soft bottom debris including a few fragments of algae. A 65 mm. specimen from the Society Islands had an empty stomach and the remains of 13 calagoid copepods and 1 lernaeid copepod in the intestine. A 24 mm. juvenile had eaten five small larval gnathiid isopods and three immature calagoid copepods. Nonparasitic crustaceans were not found in any of the specimens examined. The bottom debris in the one specimen may indicate occasional feeding on free-living forms, however, the species appears to be at least dominantly a feeder on crustacean ectoparasites of fishes.

Although Doty and Morrison (*op. cit.*) stated that parrot fish were feeding when the labrid cleansed them, host fishes are generally not so oblivious to having their parasites removed. Usually the fishes display some distinctive behavior during the process. Often they remain completely motionless in the water, although they may swim slowly. Usually their fins are fully erected (this may be associated with the high percentage of crustacean parasites which occur on the fins as compared with the rest of the body epidermis), and there may be a disorientation of the body to a position out of the vertical plane (i.e., tilted to one side) or with the anterior part of the body elevated. At times color changes are apparent. The black-hued surgeon fish *Acanthurus achilles* Shaw, for example, may become bright blue when picked over by *Labroides*.

Of all of the species of *Labroides*, *L. dimidiatus* is the least wary and will often swim up to a human observer, sculling along by pectoral fins alone in typical wrasse fashion, as if to investigate the possibility of human ectoparasites. I have experienced a picking at the hairs of my legs by this species and on one occasion a persistent and vigorous nipping at a small mole on my chest.

Randall (*op. cit.*) noted a peculair mode of swimming often displayed by *L. dimidiatus* when near other fishes, describing it as an oscillation of the posterior part of the body during slow progression. Doty and Morrison wrote that this species swam "in an odd leaping fashion, somewhat like a finch in flight." I presume that this "dancing" about other fishes by this and other species of *Labroides*, coupled with their remarkable color, serves to enhance their recognition by the other fishes. Further, I noted in the Society Islands that *L. dimidiatus*, when near other fishes, often elevates its dorsal fin, especially anteriorly, such that the black forward part of the fin appears like a conspicuous black triangle.

On several occasions I have seen *Labroides dimidiatus* enter the buccal and gill cavities of larger fishes, ostensibly to remove parasites. Probably this occurs more often than these few observations suggest, for the proximity of a swimmer appears to frighten the host fishes sufficiently to preclude their entering

into this more complex symbiotic association. In Papetoai Bay, Moorea, at a depth of 20 feet, about a 200 mm. *Parupeneus trifasciatus* (Lacépède) approached an adult *L. dimidiatus*. As it neared the latter, it changed its color rapidly from light tan to mottled pink. The *Labroides* picked over the body and fins of this goatfish, moving anteriorly. When it reached the forward part of the head, the goatfish opened its mouth and the wrasse inserted more than half of its body into the mouth and remained there several seconds. Subsequently two adult goatfish of the species *Mulloidichthys samoensis* (Günther) interrupted the pair and received the attention of the *Labroides*. D. W. Strasburg has written that he made the same observation with *L. dimidiatus* and *P. trifasciatus* at Eniwetok Atoll in the Marshall Islands. In Teavenui Pass, Bora Bora, Society Islands, at a depth of about seven feet, I saw a 1240 mm. moray eel (*Gymnothorax javanicus* Bleeker) with its head and anterior third of its body projecting from beneath a coral ledge. It was being picked over by a *L. dimidiatus* about 50 mm. long. After about 30 seconds the wrasse devoted its attention to the eel's head, whereupon the latter opened its mouth widely, maintaining it in this position for about eight seconds while the labrid picked inside the upper and lower jaws and then disappeared back into the pharynx. A sharp lateral jerk of the eel's head preceded the departure of the wrasse. The eel was then speared to permit positive identification. A similar observation was made at Takaroa in the Tuamotus. The eel appeared to be the same species and the *L. dimidiatus* was a juvenile about 20 mm. in length. At Caroline Atoll (10° S., 150°14′ W.) I saw an adult *L. dimidiatus* slip the anterior third of its body into the gill cavity of the chaetodontid *Hemitaurichthys thompsoni* Fowler by way of the gill opening. The latter held its opercula open without respiring for several seconds to accommodate the labrid. In the Tuamotus individual *L. dimidiatus* were observed to enter the gill cavities of the wrasse *Epibulis insidiator* (Pallas), the grouper *Variola louti* (Forskål), and the goatfish *Parupeneus barberinus* (Lacépède) via the gill openings.

Labroides dimidiatus are frequently seen in pairs. Also it has been noted that individual fish or pairs of fish appear to remain around the same small coral head or small section of a larger reef. The fish described above in association with *Parupeneus trifasciatus* is one of a pair which has been sighted in the same area over a period of six months. Other pairs or individual fish have been observed to be restricted to small areas.

If a parasite-feeding fish is resident to a small section of bottom and other fishes in the area are nonmigratory (probably true for the majority of coral reef fishes), its food supply would be insufficient, for it would be limited to the ectoparasites of fishes in its immediate surroundings. Therefore, it was not surprising to note that fishes come from beyond the range of vision to a *Labroides* site. A school of subadult *Mulloidichthys samoensis* was consistently seen to occupy a region of sandy bottom over 50 feet from the shore reef where the pair of *L. dimidiatus* mentioned above could be found. As I watched, small groups of about eight of the goatfish moved toward the *Labroides* site and remained in the area until they had been picked over; then they would return to their usual place. Their swimming back and forth from where the school congregated to where the *Labroides* were resident was not haphazard but directional, even though the water was not clear enough for me to see the reef from where the school was situated. Another species which swam to these two labrids from a locality previously known to me was a large adult *Abudefduf septemfasciatus* (Cuvier and Valenciennes), the only one of its size in the area. The rocks along the shore where it habitually hid are 45 feet from the labrid locale. *Caranx melampygus* Cuvier and Valenciennes, a foot or more in length, were other visitors which came to be "serviced" and left when the service had been finished. These fish are what

might be termed roving carnivores and appear to move over considerable distances. Yet they seemed to know the *Labroides* site, for they would come up to it from deeper water of the bay. At the atoll of Takaroa in the Tuamotus a four-foot moray eel (*Gymnothorax javanicus*) was seen to leave a hole in the coral, swim 15 feet over the bottom to a small coral head where a *Labroides dimidiatus* was located. There it was picked over the head and body by the labrid, after which it returned to the hole. Other fishes, such as *Ctenochaetus striatus* (Quoy and Gaimard), which were commonly seen being nibbled at by *L. dimidiatus*, could not be distinguished from one another or identified as having come from a certain area; nevertheless, it is expected that some means of marking many such fishes in the area, such as with different colored tags, would demonstrate that these fish are aware of the place where the *Labroides* can be found and swim there, perhaps under the stimulation of being irritated by ectoparasites. Individual *L. dimidiatus* are not wholly dependent on fishes bearing parasites coming directly to them. Often the species has been observed swimming over the reef for distances as great as 60 feet "servicing" fishes on the way. This was especially true in areas where the highly territorial damsel fish *Pomacentrus nigricans* (Lacépède) was common. As one damsel fish was being tended, another nearby would assume a stationary pose with fins erect and the *Labroides* would move on to the latter with little hesitation. For further discussion of the subject of restricted "home" sites of *Labroides*, as applicable to *L. phthirophagus*, see the account of this species.

The habit of feeding on ectoparasites is not unique to the genus *Labroides*, as might be surmised from the reference above to the labrid *Iridio* (=*Halichoeres*) *bivittatus* of the Atlantic. Longley (in Longley and Hildebrand, 1941: 129) reported that small porkfish, *Anisotremus virginicus* (Linnaeus), nibble and peck at the surfaces of larger fishes at Tortugas. I was fortunate to observe one individual of this species pecking at the body of the Nassau grouper, *Epinephelus striatus* (Bloch), in Florida, and can thus corroborate Longley's observation. In addition, I saw a juvenile of the pomacentrid *Microspathodon chrysyrus* (Cuvier and Valenciennes) picking over the fins and body of an angel fish, *Pomacanthus arcuatus* (Linnaeus), which remained nearly motionless during the process. Also suspected of feeding on ectoparasites of fishes by Longley are the goby *Elacatinus oceanops* Jordan (p. 226) and the young of the labrid *Thalassoma bifasciatum* (Bloch) (p. 198). Of the former he wrote, "Wherever found, these small fish slip out from shelter, attach themselves by their ventral disks to other fishes, and 'creep' over them, presumably to look for parasites. As many as 6 have been seen together on a *Mycteroperca venenosa* about ¾ yard long. . . . The boldness of these tiny fish is almost incredible. They will creep over the teeth of the great *Pseudoscarus*, or enter the mouths of grunts and groupers and explore them with unhurried movements. . . . Their attentions usually continue until the larger fishes grow restless, start up abruptly, or move away and leave them, whereupon they return to their original stations."

Interestingly, the color of this goby is similar to that of *Labroides dimidiatus*. *E. oceanops* which I observed in Florida were blue with a black longitudinal band running from the snout through the lower part of the eye, broadening on the body, and ending on ventral half of caudal fin.

A recent paper by Eibl-Eibesfeldt (1955) is devoted in a large part to the detailed observation of the behavior of fishes which "cleanse" larger fishes. He observed the following species in the Caribbean in symbiotic association with larger fishes: *Elacatinus oceanops*, young *Thalassoma bifasciatum*, young *Anisotremus virginicus*, young *Bodianus rufus* (Linnaeus) (Labridae), and *Gramma hemichrysos* Mowbray (Pseudochromidae). He noted that the larger fishes do not merely accept the cleansing but invite it by taking special posi-

tions. Furthermore he observed that the larger fish seek out the stations of the "cleaners." He made the following observation of *Elacatinus oceanops* and *Epinephelus striatus*. As soon as the grouper came close to the coral where the gobies were located, the little fish swam immediately in his direction and started to clean his body. Sometimes the grouper lay on his side. He allowed the gobies to enter and leave the buccal cavity through his mouth and gill openings which he held rigidly open. After about 30 seconds he respired once or twice and then opened his mouth and elevated his gill covers again. When he wanted to leave, he made a signal by closing his mouth sharply, although not completely, and then opening it widely. At this signal the gobies came out. Before leaving the grouper shook his body. Even if frightened (as by a diver) he still took time to make the signal to the gobies. Of the small fishes listed above which cleanse larger fishes, only *Elacatinus oceanops* and young *Bodianus rufus* were seen to enter the buccal cavity of larger fishes. Large fish were never observed trying to catch any of the little fish. Eibl-Eibesfeldt suggests that it be ascertained whether the appetite of predaceous fishes is first appeased before they allow themselves to be picked over by the smaller fishes. No mention was made of the examination of stomach contents for ectoparasites by this author.

Eibl-Eibesfeldt has informed me in a letter that he has since observed "*Coris giofredi* Risso cleaning a *Crenilabris*" in the Mediterranean south of Naples.

Szidal and Nani (1951: 412) examined the stomach contents of a *Remora remora* (Linnaeus) from the coast of Argentina and found four parasitic copepods of the family Caligidae, three of them males of *Achteinus dentatus* Wilson and the other a female *Pandarus;* both forms are known to parasitize sharks.

Hubbs and Hubbs (1954: 194) stated that the embiotocid *Brachyistius frenatus* Gill and the labrid *Oxyjulis californica* (Günther) have at times been observed feeding on ectoparasites of other California fishes.

The food habit of removal of ectoparasites from other fishes represents a distinct biological niche. It is interesting to note how different species, often from totally different families, have filled this niche in different areas of the world; however, more of them are species of Labridae than of any other family. It should be added that primarily tropical and subtropical areas, where labrids are usually numerous, have been investigated.

In addition to fishes like *Labroides*, certain shrimps have been observed removing ectoparasites from fishes. In Papetoai Bay and the lagoon of Moorea at depths of about 70 feet the author watched a shrimp picking at fishes. The shrimp was identified as *Hippolysmata grabhami* by Dr. F. A. Chace, Jr. The adult shrimp are about 40 to 50 mm. in total body length, have a brilliant red band along the back which is bisected by a white middorsal line, and long white antennae and antennules. They were seen on the surface of isolated blocks of coral. When fish approached they waved their antennae and antennules as if to attract the fish. Among the fishes seen to enter into symbiotic association with this shrimp were: *Apogon exostigma* (Jordan and Starks), *Apogon* sp., *Anthias* sp., juvenile *Acanthurus mata* (Cuvier), and *Gymnothorax flavimarginata* (Rüppell). A shrimp climbed on to a two-foot specimen of the latter species and busily picked over the dorsal part of the eel's head.

Labroides bicolor Fowler and Bean
Fig. 4

Labroides bicolor Fowler and Bean, 1928, U. S. Natl. Mus., Bul. 100, vol. 8: 224, pl. 18.

TYPE LOCALITY: Port Maricaban, Philippine Islands.

Judging from the few locality records of the species (Philippines, Java (Hardenberg, 1936), Japan (Kamohara, 1952), the Gilbert Islands (Randall, 1955*b*), Aldabra, Indian Ocean (Smith, 1955)), *L. bicolor* would ap-

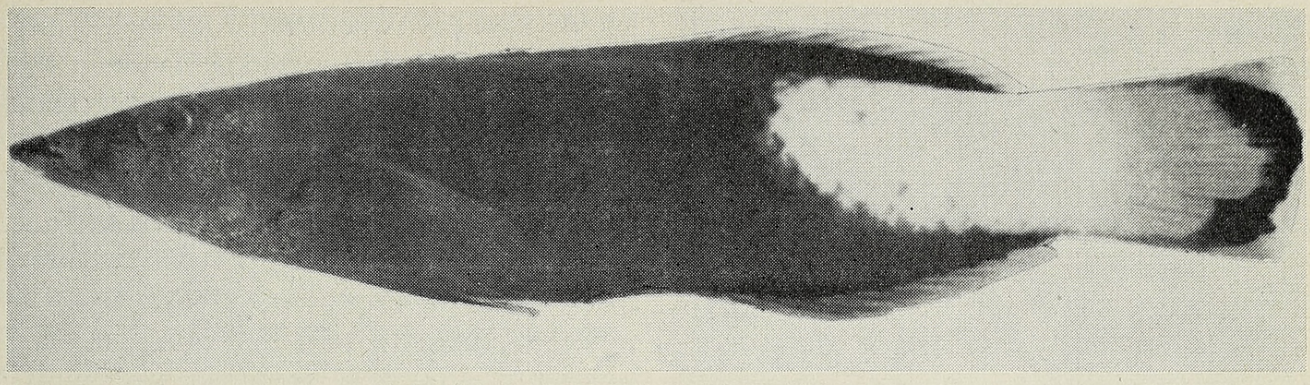


FIG. 4. *Labroides bicolor*, 81 mm., Gilbert Islands.

pear to be rare, although wide-ranging in the Indo-Pacific. I can attest to its rarity at Onotoa Atoll in the Gilbert Islands, where two months of field work resulted in the sighting of only two individuals. Subsequently in the Society Islands and Tuamotu Archipelago I have found the species surprisingly common for the genus. The two fish at Onotoa were observed in clear water beyond the windward reef of the atoll. Dr. Leonard P. Schultz of the United States National Museum has informed me that he will record the species from the northern Marshall Islands in volume II of *Fishes of the Marshall and Marianas Islands*. His specimens were taken on reefs exposed to severe wave action. In the Society Islands and Tuamotus, however, the species has rarely been observed outside of the barrier reefs but occurs more often around reefs in protected lagoon and bay areas. The apparent difference in habitat between this fish in the Gilbert and Marshall islands and the Society Islands may be a manifestation of possible subspecific differentiation. Further collections and observations are needed to elucidate the problem. Specimens from the Society Islands and Tuamotus have been sent to the United States National Museum and the Natural History Museum, Stanford University. *L. bicolor* was observed but not taken from the Marquesas Islands.

Although only adults were collected, the abundance of *L. bicolor* at the island of Moorea enabled me to perceive marked color changes which take place from the juvenile to the adult stage. In the following account, the color of juveniles is based on underwater observation. Juveniles as small as about 15 mm. in standard length have been observed. From this size to about 30 mm. the fish appear entirely black except for a brilliant yellow band along the back above the midlateral line of the body (this band confluent with one on other side dorsally on caudal peduncle and caudal fin) which extends on to head, including upper edge of eye and narrows as it terminates on snout. At a length of about 30 mm. the same general color obtains but the caudal fin and posterior part of caudal peduncle become pale yellow or almost white; subsequently, at the posterior part of the caudal fin, a trace of the black crescent so typical of adults appears. Then the yellow band along the back is replaced by light gray (the brilliant yellow color persisting longest on the head), and a light-gray area appears ventrally, thus restricting the black body color to a broad band along the middle of the body and head. Concomitant with the appearance of gray color is the development of the black crescent in the caudal fin. Anterior to the crescent a greenish tinge appears, replacing the pale-yellow color. Curiously, the next trend is a darkening of the light gray above and below the black band on the head and body and an intensification and enlargement of the yellow area posteriorly on the body. At about 60 mm. the yellow area is defined but scales anterior to the caudal peduncle have blackish centers. It is not until a standard length of nearly

75 mm. is reached that this large elliptical region is bright yellow, free or nearly so of scales with dusky centers. The green on the caudal fin also intensifies and blue appears posterior to the crescent and on the outer part of the dorsal and anal fins. On large fish (the species is the largest of the genus, attaining a standard length slightly in excess of 100 mm.) a suffusion of dark blue becomes apparent anteriorly.

A 98 mm. specimen speared in Moorea provided the following color description: body black except for a broad yellow area posteriorly, the forward end of which is rounded and reaches a vertical through base of fourth soft ray of dorsal fin; head dark blue and lacking the prominent black lateral band; lips dark blue, shading to light blue on inner surfaces; caudal fin with a subterminal black crescent, bright green anterior to and blue posterior to this marking; dorsal and anal fins black with broad light blue edges; pectorals hyaline; pelvics black.

This specimen and another 94 mm. one with the same color are males. On other individuals as large as blue-headed ones seen underwater the dark midlateral band is visible on the head and the deep-blue color is lacking, although the head and anterior part of the body above and below the band are dark grayish blue. The largest of the latter color variety collected in the Society Islands is 80 mm. in standard length, and it is a female. It is believed that others may consistently prove to be females too. At times one of each color variety are seen together as a pair. The above-mentioned color differences, if conclusively demonstrated to be sexual, are slight compared to the degree of sexual dichromatism known in some of the Labridae (Randall, 1955*a*).

On numerous occasions in the Society Islands and Tuamotus individuals of this species, both juvenile and adult, have been observed picking at the bodies, heads, and fins of other fishes. The contents of the gut of eight specimens, 60 to 98 mm. in standard length, have been examined. Four were empty save for a mucuslike substance and, in the case of two of the specimens, tiny digenetic flukes in the intestine, which were probably internal parasites of these fish. A 69 mm. specimen had two calagoid copepods and one fish scale in the stomach; 65 and 80 mm. specimens were empty except for a few fish scales in the stomach and intestine. The stomach of a 60 mm. specimen was empty, but three small larval isopods of the family Gnathiidae (larvae of this family consist exclusively of fish parasites) were found in the intestine.

The presence of fish scales in the gut is comprehensible when the stout, curved, canine teeth and the vigor with which the little labrids nip the host fishes are considered. A medium-sized *L. bicolor* was seen to actually lift a piece of skin of an adult puffer, *Arothron meleagris* Bloch and Schneider, into a pronounced peak in its apparent effort to dislodge an ectoparasite.

The host fishes do not always tolerate such ardent pecking. Often they move their bodies sharply or swim away when the pecking becomes vigorous.

Adult *L. bicolor* do not display the oscillatory swimming movement as previously described for *L. dimidiatus*. The brilliant yellow and black young do, however. A further distinction between the behavior of young and adults lies in the tendency of the former to remain in a very restricted region, frequently a small cave or under a ledge. Adults are almost constantly on the move and appear to cover a larger area than other species of *Labroides*. Still, they seem to remain in the same general region. In addition to seeing what appeared to be the same individuals day after day at a certain reef, several which were wounded with a spear and could be positively identified were repeatedly sighted at approximately the same place.

As might be surmised from the above, adults of this species are more prone to seek out fishes from which to remove parasites

than the other species of the genus. They have been observed to follow individual fishes closely for 30 feet or more, frequently making contact with the dorsal fin or the dorsal part of the body of these fishes.

I have never observed *L. bicolor* enter the mouth or gill cavities of larger fishes as has been observed for *L. dimidiatus*, *L. phthirophagus*, and *L. rubrolabiatus*. *L. bicolor* is noticeably shyer than the other species, however, and individual fish usually swim away as a swimmer approaches; thus it is possible that such behavior occurs.

The three species of *Labroides* which are found in the Society Islands, Tuamotus, and Marquesas, *L. dimidiatus*, *L. bicolor*, and *L. rubrolabiatus*, are frequently seen near one another and rarely exhibit territoriality. On one occasion I observed all three together around a single small coral head. At Takaroa in the Tuamotus *L. dimidiatus* and *L. rubrolabiatus* were both seen to pick at the body of the parrot fish, *Scarus harid* Forskål, at the same time. In Moorea a five-foot moray eel of the species *Gymnothorax javanicus* was observed lying nearly motionless entirely in the open beside a small head of coral and being picked over simultaneously by two adult *Labroides*, one *L. dimidiatus* and the other *L. bicolor*. Until the small labrids were seen, the eel's position was perplexing, for morays are rarely seen free from their holes in the coral during the day unless in rapid transit from one hole to another. *L. dimidiatus* has thrice been observed to peck briefly at the bodies of adult *L. bicolor;* twice the *dimidiatus* were of about equal size as the *bicolor* (Fig. 5), and the remaining time definitely smaller.

Generally, individuals of the species of *Labroides* tend fishes larger than themselves, juveniles "taking care" of the smaller reef fishes. It is by no means rare, however, to see species of *Labroides* picking at fishes smaller than themselves. Conversely, tiny juveniles have been frequently seen busily working over the surface of fishes ten times or more their size. Several times *L. dimidiatus* 20 mm. or less in standard length have been seen in association with adult groupers (*Cephalopholis argus* Bloch and Schneider) 200 to 300 mm. in standard length and *L. bicolor* of about the same small size with full-grown squirrel fishes (*Myripristis* spp.).

FIG. 5. *Labroides bicolor*, (on right) being "serviced" by *L. dimidiatus*. Reproduced from 16 mm. movie film taken in the lagoon of Takaroa, Tuamotus.

At Takaroa an adult *L. bicolor* was observed to swim after a six-foot shark of the species *Triaenodon obesus* (Rüppell) and to make a few hasty pecks at the dorsal part of the body.

Labroides phthirophagus, new species
Pl. 1A

HOLOTYPE: U. S. Natl. Mus. No. 164466, a male specimen, 68.0 mm. in standard length and 84.0 mm. in total length, collected by J. Randall with a spear in 7 feet of water, about 100 yards offshore from the Waikiki branch of the Hawaii Marine Laboratory, Honolulu, Territory of Hawaii, on March 1, 1955.

PARATYPES: U. S. Natl. Mus. No. 164469, 69.0 mm. in standard length, collected by J. Randall with a spear in 5 feet of water in

Kealakekua Bay, Hawaii, on June 15, 1954; U. S. Natl. Mus. No. 164467, 83.5 mm. in standard length, collected with rotenone by W. Gosline and class at Diamond Head, Oahu, on Dec. 22, 1951; U. S. Natl. Mus. No. 164468, 18.8 mm. in standard length, collected with rotenone by W. Gosline and class at Diamond Head, Oahu, on Dec. 23, 1953; Stanford Univ. Mus. No. SU48445, 2 specimens, 64.5 and 69.0 mm. in standard length, collected by J. Randall with a spear in 18 feet of water at Waianae, Oahu, on Oct. 14, 1955; British Mus. No. 1955.12.12.1, 60.0 mm. in standard length, collected by J. Randall with a spear in 35 feet of water at Manana Island (Rabbit Island), Oahu, on Sept. 29, 1955.

In addition to the above, there is a series of 12 specimens, 19 to 76 mm. in standard length, in the collection of the University of Hawaii.

DESCRIPTION: Based on the holotype and the smallest (18.8 mm. in standard length, 23.2 mm. in total length) and the largest (83.5 mm. in standard length, 103 mm. in total length) paratypes. Counts and measurements are recorded for the holotype, followed in parentheses by data for the small and large paratypes, respectively. When counts of the two paratypes are the same as the holotype, only a single number is given.

Dorsal fin rays IX, 11; anal fin rays III, 10; pectoral fin rays 13 (the uppermost rudimentary, the next unbranched); pelvic fin rays I, 5; principal caudal rays 14. Lateral line scales 28, the last slightly enlarged and with a prominent lateral line tube; lateral line partially interrupted in adults (the lateral line in the 20th and 21st scales, the two which contain that part of the line which angles sharply downward at the level of the posterior part of the dorsal fin, is poorly developed; no degeneration in the lateral line at this location is apparent in the 18.8 mm. juvenile specimen, however). Scale rows above lateral line to base of first soft dorsal rays 3; scale rows below lateral line to base of first anal soft rays 8; median predorsal scales 8 (9 or 10 in large paratype and none in the juvenile specimen). Snout, chin, throat, and dorsal part of head naked. Gill rakers (including rudiments) on first gill arch 14 (large paratype only).

Head length 2.77 (2.22–2.80); depth of body 3.64 (3.69–3.50); snout to anus 1.59 (1.60–1.61); snout to origin of pelvic fins 2.72 (2.77–2.74); snout to origin of dorsal fin 2.86 (2.51–2.95); length of dorsal fin base 2.06 (2.09–1.95); length of anal fin base 3.54 (3.76–3.76)—all in standard length.

Width of body at gill opening 2.34 (3.12–2.64); least depth of caudal peduncle 1.92 (2.62–2.04); snout length 3.46 (3.73–3.21); diameter of eye 5.16 (4.20–5.97); width of interorbital 3.64 (4.65–3.59); length of pectoral fin 1.61 (1.87–1.65); length of pelvic fin 2.31 (2.80–2.29); width of mouth (rictus to rictus) 5.39 (5.25–5.98); mid-center of upper lip to rictus 6.13 (5.80–6.15)—all in head length.

Dorsal spines progressively longer, the ninth 3.50 (3.90–3.59) in head length; first dorsal soft ray 2.45 (2.89–2.54) in head length; second anal spine twice as long as first; third anal spine twice as long as second; third anal spine 3.36 (3.72–3.32) in head length; first anal soft ray 2.29 (2.80–2.56) in head length. Caudal fin slightly rounded.

A pair of large curved canine teeth in upper jaw, each nearly a pupil diameter in length and separated by a distance about equal to the diameter of one of the teeth at the base. A similar pair of canine teeth in lower jaw, lateral to but nearly touching upper teeth when mouth is closed. Remaining teeth small, except one at angle of jaw, those at the symphysis of upper jaw in numerous close-set rows, forming a semicircular mass between the two canine teeth.

Color in alcohol: posterior half of body and caudal fin black except upper and lower edges of caudal fin and dorsal edge of caudal peduncle which are white (magenta in life); anterior half of body light tan (yellow in life) with a median dorsal black band (beginning in a small spot on median upper portion of

upper lip) and a median lateral black band running posteriorly from lower corner of upper lip and tips of lobes of lower lip through eye to merge with black posterior part of body; dorsal and anal fins pale (light blue in life), except for basal part of spinous portion of dorsal fin which is black (this color continuous with that of median dorsal black band) and a narrow horizontal dark line extending from ends of last few dorsal spines posteriorly into the anterior half of the soft portion of the fin about three-fourths the distance from the base of the fin; paired fins pale. The body of the 18.8 mm. juvenile specimen is black except for a broad light-brown band along the back, this band continuing on to top of caudal fin; the remainder of the caudal fin is black like the body except for lower distal corner which is pale; the head is brown with median dorsal and median lateral black bands. In life the band along the dorsal part of the head and body is bright purple. No yellow color is visible on juveniles. The first indication of the yellow coloration is a suffusion of tan over the head and anterior part of the body. This occurs at a length of about 50 mm. (based on estimates of the size of individuals seen underwater).

Labroides phthirophagus is known only from the Hawaiian Islands, where it is a common species. That it escaped being described in Jordan and Evermann's time is probably due mainly to its small size. It is too small to be caught in the usual fish traps or hook and line. An indication of its abundance is its listing [as *L. dimidiatus* by Brock (1954: 307)] among the species consistently tabulated in his underwater transects of Hawaiian reef fishes.

The record of *Labroides dimidiatus* by Günther (1881: 243) from the Hawaiian Islands is open to question. It seems possible that he might have obtained *L. phthirophagus* and confused it with *L. dimidiatus*, for the latter, if it occurs in Hawaii at all, is certainly rare. On one occasion I observed a small individual of what I believe to be this species underwater in Kaneohe Bay, Oahu.

Although generally seen around rock or coral, *Labroides phthirophagus* does not appear restricted to any special habitat. I have observed it in clear water of high coral cover such as Kealakekua Bay and turbid, at times brackish, water lacking living coral such as the Ala Wai Yacht Basin, Honolulu (it is, however, uncommon in the latter area). It occurs in water at least as shallow as 2 feet and has been seen at a depth as great as 90 feet (it may occur deeper—there have been few observations beyond 90 feet).

L. phthirophagus (Greek: *phtheiros*, louse; *phagous*, eat) is named for its habit of feeding on external parasites of fishes.

The food habits of *L. phthirophagus* were suspected from observation of its picking at the surface of other fishes (Fig. 6) and from the knowledge that *L. dimidiatus* feeds on parasitic copepods and isopods from fishes.

In order to obtain more positive evidence of such a mode of feeding, the contents of the alimentary tract of 11 specimens of *L. phthirophagus* in the collection of the University of Hawaii were examined. None of the specimens represent type material. They were

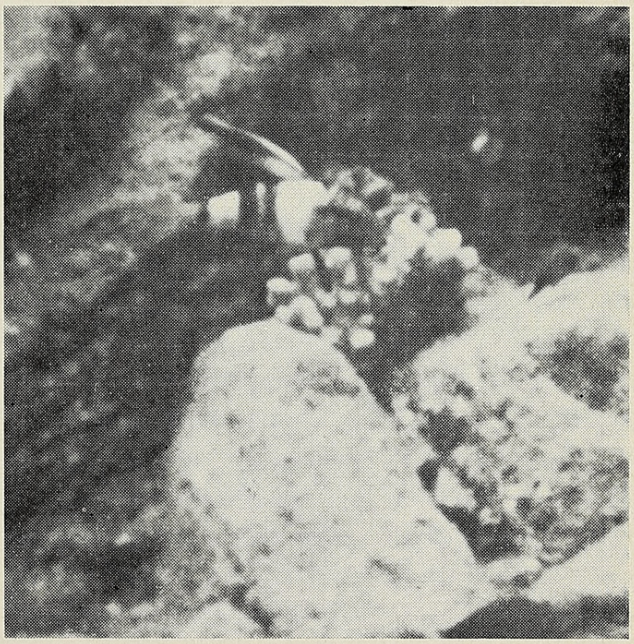


FIG. 6. *Labroides phthirophagus* picking at the body of a goatfish, *Parupeneus multifasciatus*. Reproduced from 16 mm. movie film taken off Manana Island, Oahu.

collected with rotenone from the islands of Oahu, Molokai, Maui, and Hawaii. The results of the examination of the gut contents of these specimens are given below in Table 1, along with the date of collection and the standard length and sex of the specimens.

It seems evident from Table 1 that *L. phthirophagus* feeds primarily on parasitic copepods and isopods from fishes. The fish scales and fragment of fin membrane were probably accidentally ingested in the process of picking at parasites. The cyclopoid copepods (lichomolgids and harpacticoids) do not appear parasitic. They are tiny, and when present in the gut, they are usually numerous, suggesting that they may have been encountered by the labrid in a convenient concentration. That parasites are not the sole diet was further shown by the following observation in Kealakekua Bay, Hawaii. Several nests of the pomacentrid fish *Abudefduf abdominalis* (Quoy and Gaimard) were seen at a depth of 90 feet. When the guarding adult was frightened from one of the nests, a number of other fishes commenced to feed avidly on the eggs, among them an adult *L. phthirophagus*.

Like *Labroides dimidiatus* and *L. bicolor*, *L. phthirophagus* is nonspecific in the fishes which it "services." Among the groups of reef fishes commonly seen participating in symbiotic relationship with *L. phthirophagus* are acanthurids, pomacentrids, scarids, labrids, chaetodontids, mullids, and plectognaths.

Species of *Caranx* are not abundant in the Hawaiian Islands and none were observed in association with *L. phthirophagus*. Only one carangid, *Decapterus pinnulatus* (Eydoux and Souleyet), was seen to associate with the labrid. As a school of this species swam over the bottom off Waikiki, Oahu, a single *Labroides phthirophagus* swam upward to the school. One of the carangids left the school, swam slowly in a small circle, and quivered slightly as the *Labroides* pecked at its body surface.

On one occasion when a *Labroides* was tending a large butterfly fish of the species *Chaetodon lunula* (Lacépède), the latter ceased its gill movements and elevated its operculum. The labrid inserted the anterior half of its body into the gill cavity through the gill opening, where, for several seconds, it presumably searched for parasites.[3] The same behavior was observed for the goatfish *Parupeneus prophyreus* (Jenkins). With the use of self-contained breathing apparatus in clear water of about 40 feet in depth off Manana Island (Rabbit Island), Oahu, an individual *Labroides phthirophagus* was seen to enter the buccal cavity of an adult goatfish, *Mulloidichthys samoensis* (Günther), by way of the mouth, such that the majority of the body of the labrid was lost from view. About five seconds elapsed before the *Labroides* emerged.

Frequently the act of removal of parasites by *Labroides phthirophagus* occurs beneath a ledge or in an interstice in the reef, making observation difficult. Furthermore, the approach of a swimmer usually interrupts the proceedings. For these reasons an effort was made to bring living specimens of *Labroides* into large aquaria where it was hoped detailed observations of behavior could be made.

A total of three were caught underwater with dip nets in Kaneohe Bay and brought to the Honolulu Aquarium. None were maintained in the aquaria long enough for normal feeding behavior to manifest itself; however the reactions of the resident fishes of the aquaria bear mentioning. When placed in a tank containing many moorish idols (*Zanclus cornutus* (Linnaeus)), one balistid (*Rhinecanthus aculeatus* (Linnaeus)), and an unidentified large scorpaenid, the *Labroides* swam about the aquarium, paying little attention to the other fishes. It was evident, however, that the

[3] I suspect that the parasites removed from the gill cavity by *Labroides* are still principally calagoid copepods. In a study of the parasites of the surgeon fish *Acanthurus triostegus sandvicensis* Streets (MS data), I observed individuals of the most common parasitic copepod of this fish, an undescribed species of *Lepeophtheirus*, freely enter and leave the gill and buccal cavities of the fish. The genus *Lepeophtheirus* is the most abundant of the calagoids listed in Table 1.

TABLE 1
GUT CONTENTS OF SPECIMENS OF *Labroides phthirophagus*

DATE COLLECTED	STANDARD LENGTH (MM.)	SEX	GUT CONTENTS
Apr. 10, '50	58	F(ripe)	2 calagoid copepods, 4 larval gnathiid isopods, fish scales
Sept. 21, '51	53	F	4 calagoid copepods, 25 harpacticoid copepods*
May 11, '52	60	F	3 calagoid copepods, 1 lernaeid copepod†, 88 lichomolgid copepods‡
Dec. 31, '52	42	M	2 calagoid copepods, 1 lernaeid copepod†
	49	F	14 calagoid copepods, 1 lernaeid copepod†, 4 larval gnathiid isopods
	55	F	10 calagoid copepods, 1 lernaeid copepod†, 6 larval gnathiid isopods, fragment of fin membrane
	76	M	2 calagoid copepods, 14 digenetic trematodes§
Jan. 21, '53	39	F?	1 calagoid copepod, 8 larval gnathiid isopods
June 19, '53	60	F	1 calagoid copepod, 19 harpacticoid copepods*
July 25, '55	58	F	6 calagoid copepods, fish scales
Aug. 7, '55	63	F	14 calagoid copepods

* *Tisbe* sp.; most species are free-living but at least one is commensal (in a pelecypod).
† *Peniculus* sp., generally attached to fins.
‡ Many members of this family of cyclopoid copepods live commensally with tunicates, pelecypods, flatworms, etc.; however, according to Dr. Paul L. Illg, this species of copepod does not fit well into any genus so far proposed. Although no lichomolgid has turned up as parasitic on a vertebrate, this one is sufficiently distinctive anatomically (the arrangement of the maxillary suggests its use as a substitute masticatory appendage) that it might have developed a divergent feeding mechanism.
§ Undigested, probably a gut parasite of the *Labroides*.

moorish idols and the trigger fish were immediately aware of the new arrival, for they reacted as in the normal environment. As the *Labroides* swam past individual fish, many were observed to cease swimming, and occasional moorish idols stopped their respiratory movements and raised their gill covers. The following morning the *Labroides* could not be found in the aquarium.

The second *Labroides* was added to a tank containing two parrot fishes (*Scarus* sp.) about 250 mm. in length and seven surgeon fishes (*Acanthurus* spp.). Again the *Labroides* paid little heed to the other fishes, but they reacted characteristically. The surgeon fishes swam about nervously in a restricted area of the tank. The behavior of the parrot fish was almost ludicrous. They followed the *Labroides* around the aquarium, stopping occasionally to literally stand on their tails, waggle their pectoral fins, and seemingly to ogle the labrid, as if to entreat it to perform the expected services. The parrot fishes and surgeon fishes were recognized as ones which had been in the aquarium at least several months. This poses a question which is as yet unanswered. Do these fishes learn the role of *Labroides* through experience or is their behavior innate? The answer could be provided through observation of *Labroides phthirophagus* with aquarium-reared fishes or with fishes taken from an area where species of *Labroides* are known not to occur. If learned through experience, how long is the capacity for symbiotic association retained?

The second *Labroides* was left overnight in the aquarium, and it also was gone the next day. It is not known whether this and the first *Labroides* which disappeared were eaten by fish or whether they escaped down the drains (which, it was later noted, were not screened).

The third *Labroides* was placed in an aquarium containing only adult wrasses of many species. It was immediately chased about the tank by several individuals of different species and ultimately eaten by one of them. This was totally unexpected, for various wrasses were among the fishes which were observed being serviced by *Labroides phthirophagus* in the reef environment. The immediate

pursuit of the *Labroides* in the aquarium suggests that the wrasses might have been conditioned to rapid seizure of food items added to the surface of the tank, and that this reaction may have superseded the one which would occur in the normal habitat.

When in the proximity of other fishes, *Labroides phthirophagus* exhibits the same unusual oscillatory mode of swimming as seen in *L. dimidiatus*, although not as commonly.

As previously mentioned, the act of removal of ectoparasites by *L. phthirophagus* frequently takes place in a region of cover such as beneath a ledge. Repeated observations of one such ledge at Manana Island, Oahu, revealed that a pair of this species of *Labroides* could invariably be found at or near this site. These observations continued for a period of over three years. Other pairs or groups of three fish were similarly checked over long periods of time at the following locations: Waikiki, Kaneohe Bay, Hanauma Bay, and Kealakekua Bay, Hawaii. I conclude from these and lesser observations that adult *L. phthirophagus* tend to remain in a restricted area of the reef.

As with *Labroides dimidiatus*, it is believed that fishes seek out the area where *Labroides phthirophagus* occur in order to have their parasites removed. The first evidence that fishes might come to a *Labroides* site from beyond the immediate vicinity was the sighting at Manana Island of an adult manini, *Acanthurus triostegus sandvicensis* Streets, swimming from at least 40 feet away direct to the *Labroides* ledge where it stopped and erected its fins. As one of the *Labroides* swam up to this fish, the latter was speared and taken ashore. Macroscopic examination revealed the presence of three calagoid copepods. Seemingly purposeful swimming by other fishes to *Labroides* areas has been observed. Generally there is a concentration of reef fishes around a *Labroides* site. I have on several occasions located such a site by first noting a greater density of reef fishes in a restricted area than could be explained by any other reason.

Labroides sites are usually well separated from one another. This first became evident around the patch reefs in Kaneohe Bay. *Labroides phthirophagus* is generally found at a depth of about 5 to 20 feet at the steep margins of these reefs rather than their shallow, truncate tops. The spacing between sites, at times remarkably regular, is now linear and more readily perceived by an observer swimming around such a reef.

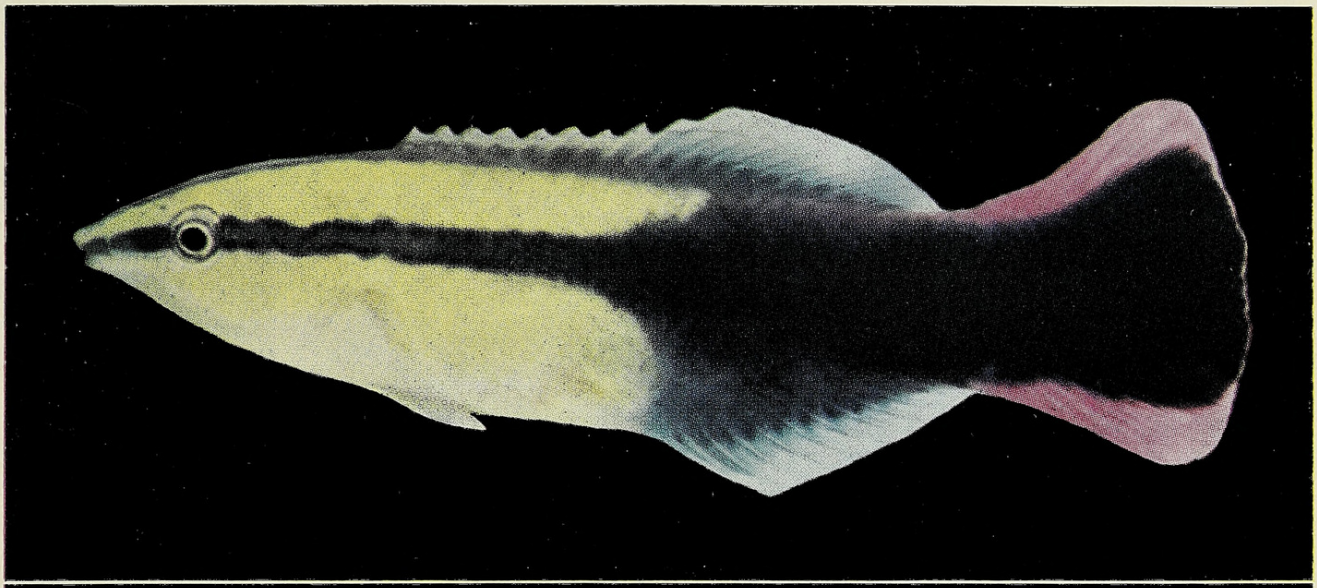
Although occurring singly or in groups of as many as five individuals, *Labroides phthirophagus* is most commonly seen in pairs. Often groups of three or more contain one or more juveniles in the company of a pair of adults. When a pair of adults is seen, it is natural to expect that one would be a male and the other a female. There is some evidence that this is the case. Of the four specimens shown in Table 1 which were collected at a poison station on December 31, 1952, two are males and two are females. One of the two paratypes which were speared on October 14, 1955, at Waianae, Oahu, is a ripe female (standard length 64 mm.; length of ovary *in situ* 12 mm.) and the other appears to be a male. These two fishes were found together and were the only two seen in the area surveyed.

Labroides rubrolabiatus, new species
Pl. 1 B

HOLOTYPE: U. S. Natl. Mus. No. 164603, a female specimen, 54 mm. in standard length and 66.5 mm. in total length, collected by J. Randall with rotenone in the lagoon at a depth of 20 feet next to a large coral head about 100 feet from shore one-fourth of a mile east of the entrance to Papetoai Bay, Moorea, Society Islands, on May 3, 1956.

PARATYPES: U. S. Natl. Mus. No. 164604, a female specimen, 51 mm. in standard length, collected by J. Randall with a spear 30 feet off the lee reef near the boat entrance of Caroline Atoll (10° S. 150° 14′ W.) at a depth of about 15 feet on February 12, 1956; Stanford Univ.

A



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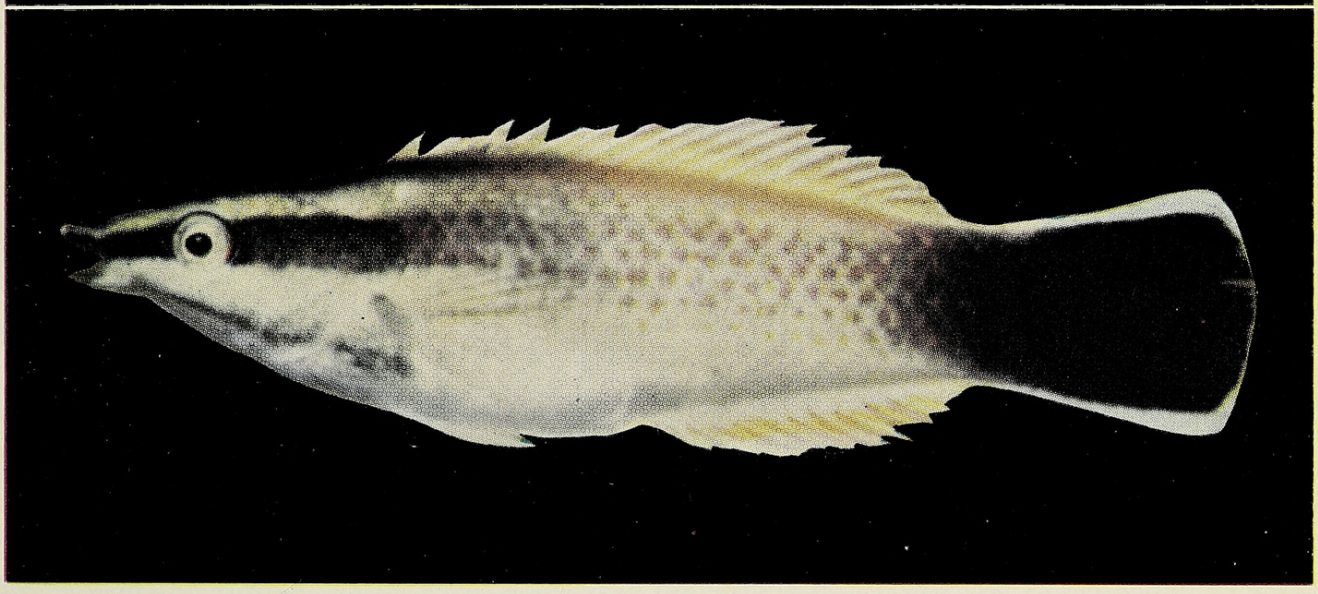

Plate 1

A. *Labroides phthirophagus*. Holotype, Oahu, Hawaiian Islands. Standard length, 68 mm.
B. *Labroides rubrolabiatus*. Holotype, Moorea, Society Islands. Standard length, 54 mm.

Mus. No. 48871, a female specimen, 48 mm. in standard length, collected by J. Randall with a spear in the Moorea lagoon just east of Tareu pass at a depth of 8 feet on May 22, 1956 (specimen was picking on the body of a female *Scarus sordidus* Forskål when speared); British Mus. No. 1956.8.14.1, a female specimen with mature gonad, 45 mm. in standard length, collected with a spear by J. Randall within 75 feet of the locality of the May 22 specimen at a depth of about 10 feet on March 29, 1956.

Two more specimens collected by the author, a male 46.5 mm. in standard length, from a depth of 7 feet in the Moorea lagoon near the entrance to Papetoai Bay on July 1, 1956, and a 54.5 mm. female from 15 feet in the pass at Takaroa, Tuamotu Archipelago, Nov. 9, 1956, have been placed in the collection of the University of Hawaii. Both specimens were speared, the former as it was picking at the dorsal fin of *Zebrasoma scopas* (Cuvier). No external differences could be ascertained between the one male specimen and the female specimens.

Some proportional measurements of the paratypes were difficult to make because of injury from spears.

DESCRIPTION: Based on the holotype and the smallest (45 mm. in standard length, 55.3 mm. in total length) and the largest (51 mm. in standard length, 62.5 mm. in total length) paratypes. Measurements are recorded for the holotype, followed in parentheses by data for the small and large paratypes, respectively. Meristic data are the same for the holotype and paratypes (with the possible exception of median predorsal scales which are obscure and difficult to count), hence only a single number is given for each count.

Dorsal fin rays IX, 11; anal fin rays III, 10; pectoral fin rays 13 (the uppermost rudimentary, the next unbranched); pelvic fin rays I, 5; principal caudal rays 14. Lateral line scales 28, the last enlarged and bearing a prominent lateral line tube (scales extend posterior to lateral line nearly half the remaining length of caudal fin); scale rows above lateral line to base of first soft dorsal rays 3 (the upper row extending on to base of dorsal fin); scale rows below lateral line to base of first anal soft rays 8 (two additional rows of moderately large scales on base of anal fin at this point); median predorsal scales 8 or 9; snout, chin, throat, and dorsal part of head naked. Gill rakers (including rudiments) on first gill arch of 48 mm. paratype 15.

Head length 2.78 (2.67–2.77); depth of body 3.48 (3.50–3.69); snout to anus 1.66 (1.70–1.69); snout to origin of pelvic fins 2.70 (2.59–2.66); snout to origin of dorsal fin 2.92 (2.74–2.91); length of dorsal fin base 1.99 (2.08–2.07); length of anal fin base 3.60 (3.89–3.90)—all in standard length.

Width of body at gill opening 2.70 (2.81–2.75); least depth of caudal peduncle 2.16 (2.33–2.32); snout length 2.85 (2.91–2.87); diameter of eye 5.11 (4.82–4.98); width of interorbital 3.81 (4.02–3.88); length of pectoral fin 1.50 (1.53 and 1.53); length of pelvic fin 1.96 (1.96–1.94)—all in head length.

First dorsal spine 8.64 (9.62–9.20) in head length; dorsal spines progressively longer (filaments of interspinous membranes extend beyond spine tips), the ninth 3.40 (3.75–3.58) in head length; first dorsal soft ray 2.43 (2.42–2.52) in head length; first anal spine nearly half as long as second; second anal spine about two-thirds as long as third; third anal spine 3.63 (3.47–3.57) in head length; first anal soft ray 2.18 (2.00–2.11) in head length. Caudal fin slightly rounded.

Width of mouth (rictus to rictus) equal to eye diameter. Center of upper lip to rictus about 5 in length of head. Distance between lobes of lower lip about one-third diameter of eye.

A pair of curved canine teeth (the uppers more curved than the lowers) anteriorly in each jaw, about one-fourth eye diameter in length. Upper canines fit inside lowers when jaws are closed (upper and lower canines on one side separated by a distance slightly less than diameter of base of one of the teeth). A

large semicircular mass of fused teeth in center of upper jaw just posterior to upper canines. This mass is as long as the upper canines with which it is in contact basally. It is indented anterocentrally. An inconspicuous band of small teeth may be seen anteriorly in the lower jaw. A canine tooth at angle of jaw.

Color in alcohol of Moorea specimens: light greenish brown, shading anteriorly on head to light bluish gray, with a black band running from mouth through eye on to body; on the body the band broadens as it passes posteriorly and becomes progressively indistinct until, in the median part of the body beyond the tip of the outstretched pectoral fin, it is barely discernible or absent; posteriorly it reappears, becoming black on caudal peduncle and caudal fin (which is completely black except for upper and lower edges and the posterior rounded corners which are white); a broad black middorsal band runs posteriorly from tip of snout and gradually lightens until it disappears at rear base of spinous portion of dorsal fin; a diagonal dusky streak from chin across cheek below eye to lower base of pectoral fin (obscure in 45 mm. paratype); spinous portion of dorsal fin dusky basally, pale distally; anal fin and soft portion of dorsal fin pale with a dark horizontal streak anteriorly located about two-thirds the distance from base to margin of fins; paired fins pale except for dark edges of pectoral fin rays.

The following color note from life was made of the holotype: body from region of end of pectoral fin to caudal peduncle orange; caudal peduncle and caudal fin (except for upper and lower edges which are pale-blue violet) jet black; a black band passing from snout through eye, broadening on to anterior portion of body and merging gradually with dusky orange on median part of body; a similar black band from snout to anterior third of back where it also merges with the orange; a narrow blackish line from slightly ventral and posterior to rictus to lower base of pectoral fin; narrow band on head between midlateral and middorsal bands chartreuse; head below midlateral band chartreuse, shading to pale blue ventrally; lips edged in bright red; abdomen pale blue shading to dull pale yellow posteriorly; dorsal fin orange basally, hyaline distally (only tips of interspinous membranes are hyaline whereas the outer half of the soft portion of the fin is clear); anal fin divisible by color into three lengthwise bands, light blue basally, orange in the middle, and hyaline distally; paired fins pale except for dark edges of pectoral rays.

The brightness of the life color of the holotype had already faded when the photograph of Plate 1 was taken. The orange of the body and especially the yellow green of the head were more brilliant when the fish was alive.

The specimen from Caroline Atoll, although exhibiting the same general color in alcohol, is more melanistic than the ones from Moorea. The median portion of the body is dusky, almost blackish, and the white margins of the caudal fin are narrower and restricted to the outer half of the fin.

The life colors were approximately the same. The color on the head was noted in life as dusky iridescent green; the middle of the body was dusky orange and the abdomen dusky yellow; the narrow band on the cheek was blackish orange; the edges of the caudal fin were hyaline violet; the lower lip was bright red and the upper mottled with red; the dorsal and anal fins were orange basally and hyaline distally, and the paired fins pale with a purplish hue.

One pair of *L. rubrolabiatus* at Caroline Atoll was seen in company with a juvenile which was iridescent blue with a broad midlateral black band. One of another pair showed intermediate coloration—the anterior half was bright blue with the black median band, and an orange-brown area was just appearing in the middle of the body.

L. rubrolabiatus is the smallest of the four species of *Labroides*. Individuals seen underwater rarely appear even slightly larger than the largest specimens collected. An excep-