

On the Sociobiology of some Hermaphroditic Serranid Fishes, the Hamlets, in

Puerto Rico

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ABSTRACT

Three species of hamlets, Hypoplectrus chlorurus, H. unicolor, and H. puella (Pisces: Serranidae) were observed underwater off the west coast of Puerto Rico. They are predaceous fishes, feeding on small benthic organisms, and live in close association with the coral reef. Hamlets are highly aggressive and defend large territories, excluding all species of hamlets. They are synchronous hermaphrodites. In spawning, which occurs around sunset, one member of the pair ascends, the other joins it, each clasps the nape of the other with its tail, and gametes are released. Little color change occurs. But the black marking before the eye of H. unicolor fades when fixing on prey, proving it is not used as a sighting line. The all-black nominal species H. nigricans spawns with the yellow-tailed H. chlorurus, so it becomes a synonym of H. chlorurus.

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INTRODUCTION

The numerous serranid fishes inhabiting coral reefs offer a wealth of material for the curious naturalist. They exist in a wide variety of species, many of which are small, yet they are among the least specialized perciform fishes. Since they tend to utilize the interstices of the reef as ambush sites or places of refuge, their behavior can be more readily related to the type of substrate inhabited, and they can be more easily followed and observed. But most attractive is that the sexual biology of serranids and related families is so flexible (see Fishelson, 1970; Smith 1965). At least one species, Serranus subligarius, has been shown to be a synchronous hermaphrodite (Clark, 1959, 1965). Judging from anatomy, this condition appears to prevail in yet other serranids (Smith, 1965; Randall, 1968) including the genus Hypoplectrus, a group called the hamlets.

Other than Clark's original brief reports, nothing is known about the behavior of synchronously hermaphroditic fishes. And Clark's articles dealt almost entirely with aquarium observations. Field observations are needed, particularly if we are to understand the adaptive significance of such an unusual mode of reproduction among vertebrate animals (see review by Ghiselin, 1969).

STUDY SITE

The opportunity arose in February, 1973, to spend two weeks working out of an undersea habitat, La Chalupa, where hamlets could be observed. Operated by the Marine Resources Development Foundation, the Puerto Rico International Underwater Laboratory (PRINUL) was sited in water 18 m deep about 10 km seaward from Punta Ostiones. There the outer edge of Negro Bank drops sharply from four to six to about fifteen to twenty meters deep (see illustration in Barlow, 1975). The upper excursion limit was eight to ten meters. The appear-

ance of the site is that of a sand plain with a thin carpet of algae bounded by the steep face of the coral reef on the landward or east side. In the northern sector of the study site the reef descends more gently and further out into the plain, tapering off into patches of low reef. It was mostly there that the hamlets were observed.

METHODS

The main objective was to study parrotfishes, but often none was present. Also, I noted behavior of hamlets while seeking parrotfish to follow. No record was kept, consequently, of the actual time spent observing hamlets, but I estimate it to have been about 25 hours. Observations were for the most part opportunistic, although the most productive hours occurred around sunset. When a hamlet was found I simply watched it and made terse notes; these were tape recorded in fuller form after each excursion.

Four nominal species were present, the yellowtail hamlet (H. chlorurus), the black hamlet (H. nigricans), the butter hamlet (H. unicolor), and the barred hamlet (H. puella). For reasons that will follow, H. nigricans is treated as a junior synonym of H. chlorurus.

OBSERVATIONS

THE INDIVIDUALS

Hamlets are among the smaller serranids. The four adult H. chlorurus (Fig. 1) that were measured ranged from 75 to 95 mm standard length; all had both ovaries and testes. The H. unicolor (Fig. 2) seen while diving were about the same size, but the largest H. puella (Fig. 3) exceeded the largest H. chlorurus by about ten to twenty percent. Randall (1968) stated that H. chlorurus is generally the largest species. The smallest hamlets seen were about half the length of the largest and were presumed to be immature.

GROUPING

All of the immature hamlets and most of the adults were solitary when encountered. In all three species, however, distinct pairs of adults were seen. These were most obvious in H. unicolor. Pairs of these were tracked for up to 30 minutes. They stayed mostly within 20 to 30 cm of each other, sometimes opening the distance to around 80 cm. Such pairs occasionally became separated as much as 5 m. But then one would suddenly seek out and swim rapidly to the other.

Pairs of H. chlorurus sometimes maintained a similarly close relationship, especially if stationary. In some pairs, however, the individuals would separate and travel up to 20 m away before returning to the starting point. Each fish of such pairs made periodic forays. Sometimes they returned simultaneously, displayed reciprocally, moved briefly as a pair, then separated. Other times they returned to the starting point out of phase and then went forth alone again. The important conclusion is that when a solitary H. chlorurus is seen it does not necessarily mean it is unpaired. The same reservation must apply to the other species.

The barred hamlet, H. puella, was also seen travelling in well coordinated pairs, but none was observed closely.

SPACING

Compared to the herbivores such as the surgeonfishes and some of the parrotfishes and damselfishes, the hamlets are widely spaced on the reef. In a transect census of all four of these types of fishes (Barlow, 1975) I hardly encountered any hamlets. One transect (four replications) indicated one butter hamlet per 250 m^2 , and the other transect one barred hamlet per 166 m^2 and one yellowtail hamlet per 500 m^2 .

The apparent abundance of hamlets varied radically. I suspect that they

remained in the area but hid within the reef at times (see below). They were usually most abundant within an hour or two before sunset. The transect censuses were carried out in the early afternoon in areas where hamlets were relatively common at other times.

During an excursion lasting about 60 to 90 minutes I usually encountered from three to ten hamlets, though occasionally fewer. After following hamlets, I estimated that an individual or a pair moves within an area of up to 150 to 200 m² in an hour, which is appreciable for so small a fish. Most hamlets moved less, however, some staying within 10 m².

Spacing between hamlets is achieved through aggressive behavior (see below). The result is territories defended by individuals or pairs. Their boundaries seem to be poorly defined. The focus of territorial behavior, moreover, may shift from day to day, and territories appear to broadly overlap. Obviously, careful observation with tagged fish is needed here.

USE OF SURROUNDINGS

Hamlets appear to know their surroundings well. They progress appreciable distances across the reef at times, moving from one lair to another. Upon reaching a small cave they often take cover for a while, peering out from one exit or another. They use the lair as a refuge, alternately moving around nearby then retiring. At some point instead of returning to the cave they slowly work their way to another which becomes the new center of activity. In this fashion they travel considerable distances. The hamlets seemed to know where to find the next hiding place, as though proceeding along familiar routes.

The foregoing describes in particular the behavior of H. chlorurus. The behavior of H. puella was similar. But H. unicolor tended to be slightly more out in the open, and did not make such overt use of hiding places as it moved

about. Some H. chlorurus were similarly bold, seldom taking cover, especially toward dusk.

FEEDING

All three hamlet species feed primarily on benthic invertebrates. They move along slowly, fixing on the substrate while posing motionless with tautly spread median fins. Then they suddenly strike forward while biting at the substrate with their large and protrusible gulping type of mouth. Occasionally they slam their mouth into a pocket of sand or detritus. This is followed by exhausting inedible debris out through the gill slits or even by coughing. More often they strike at the surface of corals or filamentous algae. A favorite surface is that of a sea fan or sea whip. Here they position themselves down current. Frequently, right after lunging into this substrate, they instantly spin around and engulf something dislodged, most likely a small invertebrate.

Often I saw a hamlet moving along with other fishes that forage from the surface of the reef, as has been noted by Ogden and Buckman (1973). Small groups of parrotfishes, surgeonfishes and wrasses seem particularly attractive. The hamlet typically stands a few body lengths down stream from the group, its head pointed slightly down and toward the center of the area from which the others are feeding. The hamlet occasionally jerks around, tracking a small animal (once a goby) that was disturbed by the herbivores. Now and then the hamlet plunges into the midst of the group and engulfs something. Once an H. unicolor briefly accompanied a spotted goatfish (Pseudupeneus maculatus).

On a number of occasions I observed what appeared to be a more profitable feeding relationship with another species. Each time an H. unicolor accompanied the same but unidentified species of wrasse (probably Halichoeres garnoti) and always when the wrasse fed from a sea fan. The wrasse was gleaning

invertebrates from the down-current side of the sea fan. The butter hamlet stationed itself one to two body lengths directly downstream from the wrasse. Now and then the wrasse dislodged an invertebrate and turned around to capture it. Invariably, however, the hamlet took the prey. While the wrasse's pointed snout and forceps-like dentition is nicely adapted to picking, the capacious mouth of the hamlet is ideally suited to gulping up such small dislodged prey.

I examined the gut contents of four H. chlorurus. They contained little. But I found the remains of two crustaceans, one clearly an isopod, part of a polychaete worm, and what appeared to be a plug of mud.

AGGRESSION

One of the most impressive aspects of hamlet behavior is aggression. They attacked any other Hypoplectrus, not just their own species. Since they are so extraspecifically aggressive, I expected to observe hostile interactions with other potential trophic competitors, e.g., small serranids. None, however, was seen. Further observation might reveal such interactions.

A particular relationship merits description in this context. The dusky damselfish (Eupomacentrus fuscus) is one of the most extraspecifically aggressive species on the reef. It is of about the same size and coloration as H. chlorurus, and both take refuge in small caves where I sometimes saw them within one body length of one another. No sign of aggression was detected. Note that the dusky damselfish is an herbivore. Also, the mouths of the carnivorous hamlets seem poorly adapted to scraping up the sessile eggs of damselfishes.

When two apparently unpaired hamlets met, and an appreciable size difference existed, the larger fish attacked. Attack consisted of swimming at high speed straight at the other fish. The smaller hamlet invariably fled. The larger would then stop, stand briefly with fully spread median fins, then resume its normal activities.

When equally matched pairs or individuals met they usually displayed toward one another, then slowly moved apart. Occasionally one hamlet would suddenly swim at the other, as if to chase, but then turn back, briefly chased by the other. This led either to a back and forth swimming, or to one hamlet fleeing, briefly pursued by the other.

The displays are elaborate and drawn out, judging from experience with other reef fishes. More observations and films are needed for an adequate description of them, but their major features are as follows:

In all three species the main display consists of presenting the side to the opponent, often while head down about 45° . The body may be flexed laterally in an S-shape with the head away from the other fish, the tail toward it. The ample median fins are fully spread. The large pelvic fins are maximally extended and pressed together in the midline, giving the display a uniquely hamlet appearance. The head may be twitched to the side. Two mutually displaying fish may suddenly swim ahead, side by side, as in the parallel run of Badis badis (Barlow, 1962). One H. chlorurus was seen to roll onto its side, directing its back and erect dorsal fin toward its opponent; holding that position, it moved toward the other hamlet.

Nearly all the encounters between hamlets never went further than this display phase, except for the sudden chase that sometimes terminated it. Once, however, I saw a prolonged and damaging fight between an H. chlorurus and an H. puella. Since reports of such fights between fish in nature are rare, I report this one in some detail.

When the two fish were encountered they were already in the display phase, which continued about six to eight minutes. The H. puella was about ten percent longer than the yellow tailed H. chlorurus, and its displaying was less developed, perhaps as a consequence. The H. chlorurus did more head-down

posturing and twitching and in general took the initiative. Bouts of reciprocal displaying were interspersed with periods when one fish swam rapidly around the small coral head and basin, where the fight was centered, with the other following closely. Sometimes one led, sometimes the other. No tailbeating occurred during this display phase, nor did either hamlet attempt to bite the other or show the intention to do so.

Then the character of the encounter rapidly changed. The H. chlorurus became overtly aggressive. It performed shallow, poorly developed tailbeats and directed incomplete rams toward the H. puella. Then it rammed the H. puella in the side. This seemed to trigger a different set of behaviors, the contact phase.

The H. puella moved closer to the H. chlorurus and overt fighting began. Each directed short rams, culminating in bites, at the head of the other, and these could start from nearly any orientation. Often, however, the rammings had a ritualized prelude: The fish faced off with their heads overlapping, thus with the left side of the face of one against the right side of the face of the other. Then each seemed to swing its head against that of its opponent and the large mouth could be seen to flare open and bite; it was difficult to observe in detail because of its speed. The objective apparently is to bite the face or eye of the opponent. (We see here an interesting parallel with another teleost fish that has a large protrusible mouth: Polycentrus also avoids mouth wrestling, which could severely damage the structure of its relatively delicate jaw (Barlow, 1967).)

Head-on ramming and biting was also observed. Sometimes the two hamlets stood in a T or L-formation, one facing the other, before biting. Occasionally their bodies were pressed against one another; especially then, when they broke apart, could I detect signs of tailbeating.

The contact phase lasted two or three minutes. Shortly before it ended, and right after a particularly vigorous bout of ramming and biting, the coloration of the H. puella suddenly blanched, which I thought signalled defeat. But the colors quickly returned, and shortly thereafter the H. chlorurus abruptly fled. It swam off at a steady speed a distance of about ten meters with the H. puella about one meter behind. Then each stopped and hid. The H. puella appeared uninjured. But there were numerous horizontal cut marks behind each eye of the H. chlorurus, plus a cut across its nape.

Evidently the H. chlorurus was defending its territory against the intruding H. puella. Because of its wounds I was able to identify the H. chlorurus for several days. It was often found where the fight had occurred, but no H. puella was seen. Being the territory holder might also explain why the H. chlorurus took the initiative in the fight rather than fleeing from its larger opponent. It is strange, however, that the H. puella invested so much effort in winning the fight but then did not keep the territory, i.e., did not exclude the H. chlorurus.

REPRODUCTION

As already noted, distinct pairs were seen in all three species of hamlets. My limited observations suggest that spawning normally occurs at dusk.

A pair of H. chlorurus was seen spawning. The slightly larger of the two had a bright yellow tail whereas the smaller had a black tail (thus the smaller was nominally H. nigricans). Prior to spawning they moved to the highest point of ^a nearby reef while they displayed continuously to one another. The displays were mostly the same as those used in aggression, the central one being the head-down fin-spread posture. Unlike aggressive behavior, head twitching often developed into quivering. Displaying came in bouts: first one hamlet performed, then the other.

From time to time I heard distinct knocks that sounded like a wood block being struck. These coincided with twitches. Twitching also occurred in the absence of sounds, but no sounds were detected in the absence of twitches. I heard no sounds from other pairs of displaying hamlets, so I cannot be sure the sounds heard were made by the hamlets.

Spawning was initiated by one hamlet slowly ascending about 20 cm. The mate followed. The initiator cupped the posterior third of its body into a U. The follower swam into the U such that the tail of the initiator clasped it firmly around its nape. Simultaneously the follower wrapped its tail around the nape of the initiator. The spawning position was therefore symmetrical, the long axes of the two hamlets forming a depressed X. By this time the pair had usually rotated onto one side. They drifted over the bottom while trembling; the face of each became pale blue, and the corners of the mouth could sometimes be seen to be extended, indicating clenched jaws. After about two seconds, having drifted about 20 cm, the pair separated, returned to the starting point, and resumed displaying.

Because these fish are synchronously hermaphroditic it is of interest to determine whether the members of a pair have different roles. I could detect none. Both fish were initiators, although the larger may have done more of the initiating. (Note that the two fish of a pair, in all three species of hamlets, were usually of slightly different sizes.)

I also saw two H. unicolor spawn, but in a way that suggests aberrant behavior. My attention was drawn to the two butter hamlets because they seemed to be fighting. First one then the other chased its opponent about one meter. Then the much smaller one fled about five meters with the larger hamlet in pursuit.

The smaller butter hamlet stopped and displayed. The larger displayed

back and quivered, paused, then quivered again. The smaller drifted up about 30 cm and was joined by the other. They stood facing, but offset, face against face, just as in the prelude to biting described under the section on aggression. But then each moved forward a little, tilted down $30-45^{\circ}$, and with its tail loosely clasped the nape of its partner. Holding their vertical orientation, and still not tightly clasped, they drifted upward another 20 cm while trembling. Then they separated, and the larger swam off in the direction from which it had come.

The behavior seemed atypical for a number of reasons. First, pairs of butter hamlets seem to be the best coordinated of the three species, but these two fish did not move about as a pair. Second, the size difference was unusually large. Third, the overtly aggressive behavior suggested something more akin to rape (see Clark, 1965). And fourth, there were so many differences from the spawning behavior of H. chlorurus, especially the absence of well synchronized, cooperative, repetitive clasping. For these reasons it is difficult to reach a general conclusion about the differences in spawning between the two species.

While no other spawnings were witnessed I observed prespawning behavior in the three species. Reciprocal displaying occurred throughout the day but increased in frequency and intensity toward sunset. Displaying seemed most likely when a pair reunited after a separation.

COLORATION

I observed little change in coloration among the hamlets. I mentioned that in H. chlorurus the face became pale blue at the moment of spawning, but no other alteration was seen. I also reported that an H. puella blanched momentarily during a fight.

Color changes in H. unicolor were more apparent, however, belying its

species name. Most of the time the butter hamlet appears creamy white with a small blue-black splotch before the eye and another ahead of the tail (Fig. 2). The presence or absence, size, and shape of these spots, especially the preorbital, vary among individuals and between the two sides of the same individual.

In social interactions, for instance while being chased, the back of H. unicolor may become grey, extending ventrally, as in H. aberrans (Fig. 83 in Randall, 1968). This change may progress further until shaddy grey bars emerge. The basic pattern then is as that of the dark markings on the barred hamlet, H. puella (Fig. 3).

The butter hamlet also changed color pattern while feeding. Hunting H. unicolor sometimes darkened their bars so much that they resembled H. puella. They lacked the brown and yellow tinting of H. puella, however, and the barring was never pronounced.

Another aspect of coloration calls for comment. It is the polychromatism (color polymorphism) of H. chlorurus. The nominal species H. nigricans differs from the older species H. chlorurus only in that it has a black tail--H. chlorurus has a yellow one. Yet I observed a black tailed and a yellow tailed hamlet spawning together. I also saw pairs in all combinations, i.e., both with yellow tail, both with black, and one with black and the other with yellow. Evidently they are two color morphs of H. chlorurus. The yellow tailed form was the less common. No census was done, but I estimate that about twenty-five percent of the H. chlorurus had yellow tails.

DISCUSSION AND CONCLUSIONS

These admittedly incomplete, but intensive, observations demonstrate that hamlets are accessible for close study in the field. They are small enough to follow, and they should be comparatively easy to capture. That would permit marking and tracking individuals, which is so important to understanding their sociobiology.

We need to know, for example, just how stable the pairs are. Also, do they have sexual roles, in spite of being hermaphrodites, as described for Serranus subligarius by Clark (1959, 1965)? Are the territories completely shared between mates, or do they merely overlap?

Such information would provide insights into the adaptive significance of hermaphroditism in hamlets. Does it relate to the sparsity of these predaceous fishes on the reef? And, when hermaphroditic, why form pairs? Is it to assure outcrossing? Or is it a tactic to maximize fertilization? Even if hamlets can self, they may have to release eggs and spermatozoa separately. That could well lower the probability of fertilizing all the eggs.

Whatever the situation, the interaction between hamlets in pairs provokes comparisons with other, non-hermaphroditic vertebrates. For example, the displaying that accompanies reunions of pairs is reminiscent of the so-called greeting ceremonies of geese. And the sustained high level of displaying deserves comment. Given that these are such aggressive species, it is not surprising that displaying is so prominent between pairs, nor that the displays are essentially the same as those used in aggression. The reason pairs display so much to one another, and especially when reuniting, is probably to inhibit aggression in the mate (this argument is developed in more detail in Barlow, 1968, 1970, and in Barlow and Green, 1970).

Because intrapair relationships in a synchronously hermaphroditic species are so inherently intriguing, it is easy to lose sight of what may prove to be an important aspect of their territoriality. This is the possibility that

individuals in pairs of H. chlorurus may patrol the perimeter of the territory alone. Only man is said to show such sentinel behavior (Hamilton and Watt, 1970). In other animals, the members of the pair or group move together, patrolling the territory as a social unit.

Assume that when two individuals combine to defined a territory, taking a circular configuration for simplicity of argumentation, the potential area (A) is doubled, although the area per individual is unchanged. The circumference (C) increases by a little less than one and a half ($\sqrt{2}$), since the new $C = 2\pi\sqrt{2A}$. Consequently if the pair moves as a unit, each fish now has a much larger perimeter to maintain (Smith, 1968). If individuals in a pair of H. chlorurus manage to patrol the boundary independently, and if each patrols a different sector, then they have made a bioenergetic gain. They will have reduced the amount of perimeter to maintain while keeping the same amount of territory.

The holding of a territory may be facilitated by a fish's coloration (see especially Myrberg and Thresher, 1974). Lorenz (1966) proposed that color pattern plays a central role here in communication among coral-reef fishes. Their brilliant "poster" colors are thought to advertise the feeding guild of the territory holder. Further, they are interpreted as permanently "switched on" signals of aggression to ward off conspecific competitors. The community of fishes is said to have completely partitioned the trophic environment among themselves. The poster colors therefore should direct attach exclusively to conspecific intruders, the only trophic competitors.

Hamlets fit Lorenz's model well in some respects. They are decidedly aggressive and territorial, and they are not inclined to change colors when in aggressive display. On the other hand, they are not brilliantly colored compared to, say, wrasses or parrotfishes. Nor is their aggression directed only

to conspecific hamlets. In addition, the occurrence of color polymorphism is inconsistent with the idea that color patterns are tied to distinct, sharply partitioned, trophic niches. Of course, coloration is adaptive in other ways, as in the following on predator-prey interactions.

In a review article on the functional significance of eye stripes (Barlow, 1972) I pointed out that hamlets are among the few teleost fishes that have a prominent dark marking ahead of the eye. Usually such markings extend to the rear past the eye or occur only posterior to the eye. Recently Ficken et al. (1971) put forth the hypothesis that similar eye stripes in birds serve as sighting marks, aiding the bird to aim at prey. They suggested the same might apply to fishes. Thus information about the use of the preorbital eye mark in the predaceous hamlets is particularly germane.

The evidence is against Ficken's hypothesis. First, the marking is highly variable, even between the two sides of an individual. This suggests either that selection for a good sighting mark is weak, or that selection favors variation, perhaps for individual recognition in social interactions. Second, the color changes are inappropriate. I have seen butter hamlets move toward a sea fan, change colors, fix on a prey, and strike. The color change included assuming grey markings, as mentioned. Most significantly, the preorbital marking faded away. The marking is therefore either a hindrance to aiming, or something making the predator apparent to the prey. The preorbital marking in hamlets does not appear to serve as a sighting line.

Another issue, also involving coloration, is the species problem. There is little to separate the species of Hypoplectrus other than color differences (Bühlke and Chaplin, 1968). The morphometric differences provided by Randall (1968) did not lead to consistent separation of the species treated here.

Richard Robins (pers. comm.) suspects wide spread polychromatism and believes

that many hamlet species will be synonymized.

My observations indicate that H. chlorurus (Cuvier and Valenciennes) 1828 and H. nigricans (Poey) 1852 are the same species, i.e., H. chlorurus. The consistent pairing according to species in H. chlorurus, H. unicolor, and H. puella, however, make it difficult to imagine that they are all one species. There are also small behavioral differences between those species that reinforce the belief that they are valid. Information about the other species in Hypoplectrus would greatly aid systematists in evaluating the status of its species.

SUMMARY

1. While working for two weeks out of the PRINUL underwater habitat La Chalupa, off the west coast of Puerto Rico, I observed the behavior of three species of hamlets (Pisces: Serranide), the yellowtail (Hypoplectrus chlorurus), the butter (H. unicolor), and the barred hamlet (H. puella).
2. They are synchronously hermaphroditic. Some of the adults live as well coordinated pairs.
3. Hamlets are widely spaced on the reef and are intragenerically territorial. They live in intimate association with the reef, moving from refuge to refuge over what seem to be familiar routes.
4. Hamlets are predaceous, taking benthic organisms on, or dislodged from, the bottom. At times they accompany grazing herbivores or foraging wrasses, snapping up the prey they flush out.
5. Hamlets are aggressive toward all species in their genus. They chase those hamlets who yield and display to those who do not by posing with all fins spread, often head down with the body flexed laterally in a S-shape and while twitching the head to the side. One prolonged and damaging fight, between an

H. chlorurus and an H. puella, is described in detail.

6. Spawning occurs toward dusk. Displaying, which is like that of aggression except that quivering appears, is performed reciprocally in bouts. One hamlet of the pair, in H. chlorurus, initiates a symmetrical spawning act, in which each clasps with its tail the nape of the other. One spawning act by H. unicolor was observed; while sharing the major features of that of H. chlorurus, the behavior was judged to be atypical.

7. The hamlets showed little capacity for color change. However, H. unicolor sometimes darkened during social interactions and when feeding. But the prominent dark preorbital marking in H. unicolor often disappeared when it was fixing on prey, proving that it does not aid aiming.

8. H. chlorurus occurs as two color morphs. One is all black and the other, less common morph, is black with a yellow tail. Since the two morphs lived in pairs and spawned together, the black morph, nominally H. nigricans (Poey) 1852, is considered a junior synonym of H. chlorurus (Cuvier and Valenciennes) 1828.

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engineer. Especially appreciated was the confident reliance in my experienced diving partner, Goerge Losey.

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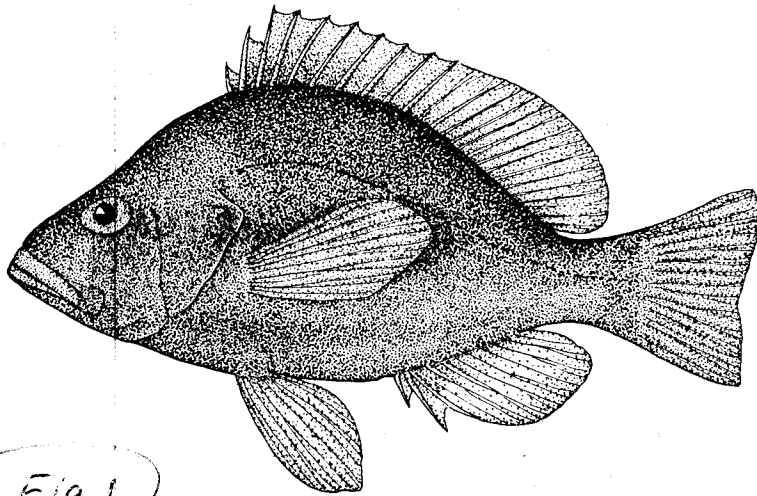


Fig. 1

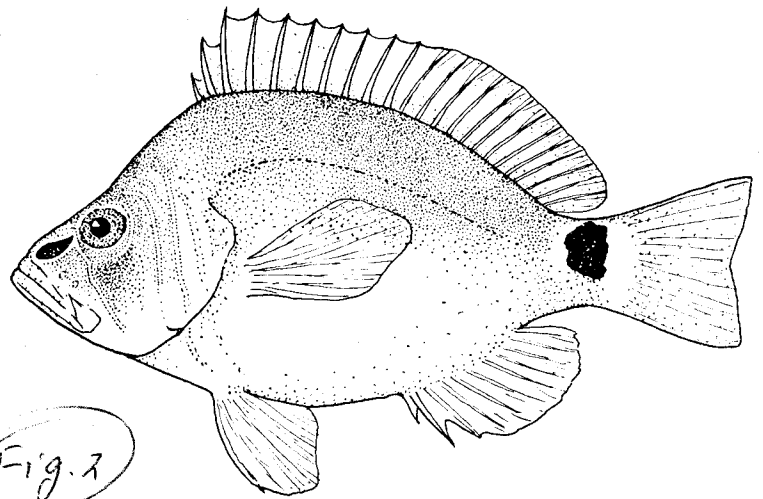


Fig. 2

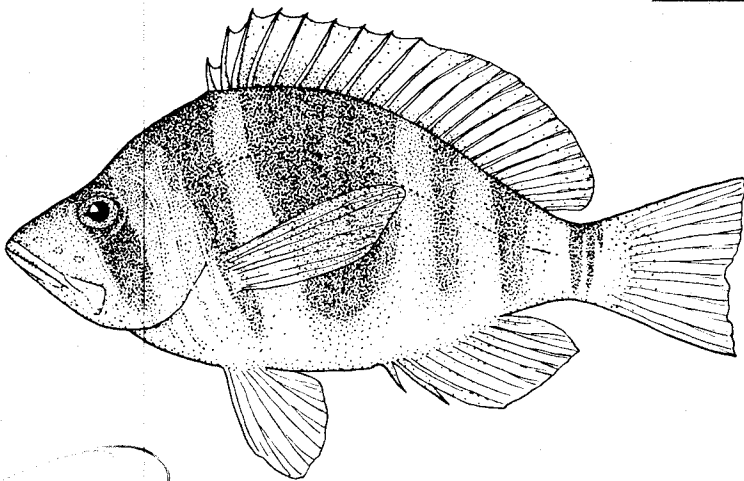


Fig. 3