The gut wall was less active than were the liquid contents, the gut solid extracts, or the combined gut contents and gut wall, containing approximately the same concentration of homogenate. The most rapid digestion of algin occurred with a lyophilized gut-wall-plus-gut-contents preparation. This extract decreased the viscosity of the polysaccharide by more than one-half in 7½ min, and the reduction in viscosity was complete in 50 min (Fig. 1).

Figure 2 shows the *p*H activity curve for the alginase of the gut wall compared with that of the pooled gut wall and gut contents. Although both have optima in the range of the intestinal *p*H (7.2 to 7.3) (*11*), the alginase from the gut wall has an additional optimum toward *p*H 4 (*p*H values below 4 were not used because of the increase in algin viscosity at low *p*H).

Different *p*H activity curves, obtained for the alginase of the gut wall and of the gut contents, respectively, suggest that there may be two alginases involved. Because the gut contents of this animal are known to contain microorganisms capable of degrading whole brown algal blades (*5*), it is possible that these may be a source of alginase in the gut. On the other hand, precursors of alginase in the gut wall could contribute to the alginase found in the gut contents. Clarification of the role of intestinal bacteria in algin digestion by *Strongylocentrotus purpuratus* is needed. It would also be of interest to characterize the products of algin digestion by these preparations and to determine their usefulness to the sea urchin.

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Functional Hermaphroditism and Self-fertilization in a Serranid Fish

Abstract. Each mature individual of *Serranellus subligarius,* regardless of size, has at the same time both motile sperm and eggs. Embryos and larvae were produced from artificial fertilizations and from isolated fish kept in aquaria. Mating behavior of pairs and groups of hermaphrodites shows two types of behavioral patterns involving different color changes.

Although teratological hermaphroditism has been reported in a wide variety of teleosts, only two groups, the serranids and the sparids, have been seriously considered to have members which are regularly and functionally hermaphroditic. Evidence for this has been based on purely anatomical and similar evidence. A recent review of this situation is given by Bertin (*1*). The present report presents data on the reproductive behavior, including self-fertilization, of the serranid *Serranellus subligarius* (Cope) (*2*). Such observations were possible because this species is small enough to be kept conveniently in the usual laboratory aquaria.

During July, August, and early September of 1958, all of the mature individuals of this species appeared to have slightly to greatly distended abdomens. They are common in depths of from 8 to 65 ft on rocky bottoms in areas of the Gulf of Mexico near the Cape Haze Marine Laboratory, off Sarasota and Madeira Beach, Florida, where I have observed thousands of these fish while skin diving. Over two hundred specimens have been collected by steering them into glass jars by hand (*3*). Individuals over 28 mm in standard length which were examined had sizable ovaries with a thin winding patch of white tissue, on the ventral surface, from which motile sperm smears can be made. Within 1 or 2 days after they have been collected, greatly distended individuals can be made to release quantities of mature sperm and hundreds of ovulated eggs simultaneously by means of very slight pressure on the abdomen. If this pressure is applied while the genital area of the fish is being viewed under a dissecting scope it can be seen clearly that the eggs are released from a separate exit of the oviduct into a small vestibule under a flap with a bilobed edge, just posterior to the anus. Posterior to the exit for the ova is a pigmented genital papilla which erects slightly when sperm is released from a small opening at the tip of the papilla. A clear fluid is sometimes released with the cloud of sperm. Eggs have been artificially fertilized by sperm from the same individual by washing both eggs and sperm from the genital area into a fingerbowl with sea water. Ovulated eggs in good condition taken from live or recently dead fish are readily fertilized by sperm from the same or another fish.

In cases of both self- and cross- artificial fertilizations, embryonic development has been followed through to the hatching of the larvae (18 to 22 hours at 82 to 88°F). The egg is buoyant and nonadhesive and has a single oil drop. The developing embryo and newly hatched larva have a distinctive set of round dark pigmented areas (two on the head, two just anterior to the anus, and four forming a ring around the tail, halfway along its length).

I have observed spawning activity in nature while diving with an Aqualung, and also in laboratory aquaria. Studies so far indicate that spawning activity usually takes place between two individuals in the late afternoon between 4 and 7 P.M. It seems to be initiated by a fish with a distended abdomen, who puts its body into an "S" curve, spreading its fins and sometimes quivering in this position directly before or near the head end of another fish. During S-curving the white area of the abdominal region stands out conspicuously. The other fish may be obviously carrying ripe ova as well as sperm, or it may be comparatively slim, carrying only immature ova but with sperm which can be squeezed out easily. A fish with only mature sperm will often ignore an S-curving fish or nip it and show aggressive behavior toward it. In other cases it will start to follow an S-curving fish until both fish are swimming with slow jerky movements, often upwards to the surface of the aquarium, and the pairing fish may separate momentarily or for long periods after a splash at the surface. In nature, however, the fish stayed within a few inches of the bottom on the occasions when they showed spawning behavior. The fish that is following often touches with its mouth the dorsal region of the S-curving fish, or it may follow from below and gently mouth the abdominal region. Sometimes the S-curving fish will lie down on its side with the other fish curved over it.

As S-curving activity becomes more marked, being repeated at more frequent intervals, and while the fish are close together, there is a noticeable color-pattern change in the S-curving fish. The fish blanches, the usual dark vertical bands on the sides of the body completely disappear, and the large black spot at the base of the dorsal fin suddenly turns pale gray. In addition, the evenly rounded profile of the abdomen changes, and the front half is pulled up flatter while the posterior part of the abdomen is lowered conspicuously and sharply just anterior to the genital area, forming approximately a right angle with the genital area. The other fish of the pair stays in the normal darker-banded color phase, and only in a few instances is there noticeable blanching of the dorsal-fin spot, although, if this is also a distended fish, it may show the same change in the abdominal profile.

In some observations on group behavior in large aquaria a blanched, S-curving fish has aroused a response from as many as five other banded individuals. Although usually only one or two banded fish are able to hold a position close to the S-curving fish, in several instances all six of these fish rushed to the surface in a tight group and made a splash, the body of the blanched fish being strongly arched. Occasionally a rotund but banded fish, especially in a group showing this behavior, will suddenly reverse its role, blanch, and start S-curving and behaving like a typically blanched fish. This may last for only a few seconds or continue into typical spawning behavior with a banded fish. On some occasions both fish of a spawning pair may reverse roles for short periods, with intervals when both fish are blanched and S-curving. Usually the more distended fish will S-curve more strongly and more continuously, in an aggressive manner, blocking off and cornering the other blanched fish until it returns to the banded condition.

Spawning activity among pairs or groups may keep up for more than an hour, and water-surface samples taken afterwards show hundreds of fertilized eggs in various stages of early cleavage. However, the exact moment when eggs and sperm are released has yet to be determined with certainty, as there appear to be no special times when the genital areas of the fish are very close together. Also, it is not known which fish releases eggs and which sperm, or if eggs and sperm are released together from one or both fish. It was at first suspected that the blanched fish was releasing eggs and the banded fish, sperm, but subsequent observations have shown that an obviously gravid fish will blanch and go through S-curving and quivering movements and, without any response from another fish, release eggs and sperm that produce embryos and larvae even when such a fish is kept in isolation. In two instances the eggs could be seen coming out of the fish shortly after some quivering movements and a lowering of the post-abdominal region; the fish then seemed to rest on the bottom. There is also evidence that the mere sight of another fish in an adjacent aquarium could stimulate this release. Greatly distended fish caught in the morning and kept isolated will often release nonfertile or self-fertilized eggs the same or the following day. This may well be an artificial response brought about by laboratory conditions and the separation of natural pairs just before they are ready to spawn. A comparison of the sizes of these fish with the state of their gonads has given no evidence, so far, of a protandric condition with an intermediate stage to explain individuals capable of self-fertilization.

In nature these fish are strongly territorial. Before June, skin-diving observations indicated that only one mature-sized fish of this species occupied a territory (usually a ledge or pathway among the rocks). But in June and more frequently in July, pairs and sometimes trios of large fish with distended abdomens shared the same pathways, indicating a tolerance to sharing the same territory. This is especially noticeable because of the manner in which we catch these fish. By chasing them a few times around the rocky ledges, a diver can soon estimate the extent of their territory and can determine what other fish share this territory (such as *Opsanus, Equetes, Pomacentrus* and various species of gobies and blennies, and *Hypleurocheilus geminatus,* the last of which forms a substantial part of the diet of *Serranellus*).

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Hemoglobin Patterns in American Indians

Abstract. Two populations of North Carolina have been analyzed for hemoglobin patterns by paper electrophoresis. Of 534 Cherokee Indians, both mixed and full bloods, all showed normal hemoglobin. Lumbee Indians of less certain ethnic status had 1.7 percent of hemoglobin S, an equal amount of hemoglobin C, and one possible hemoglobin D trait among 1332 bloods studied.

Bloods of Cherokee and Lumbee Indians of North Carolina have been analyzed for hemoglobin patterns by the rapid paper electrophoresis method (*1*). All abnormal patterns were verified by standard electrophoretic techniques and sickle-cell tests.

The Cherokee Indian sample consisted of school children on the reservation at Cherokee, N.C. Among this Eastern band of the tribe, descended from those who escaped the forced westward migration of 1838, there is, as is known from the tribal records, a wide range of degree of Indian ancestry. No abnormal hemoglobins were found among 534 bloods studied, including 136 "full bloods."

The Lumbee Indians are a population in the south-central part of the state, whose origins are uncertain. Considering themselves primarily a mixture of Indian and white, they have also been known as Croatans and Indians of Robeson County. The sample studied consisted of students in Pembroke College, High School, and Elementary School. Of 1332 bloods analyzed, 23 (1.7 percent) showed sickle-cell trait (A plus S), and an equal number exhibited hemoglobin C trait (A plus C). One possible case of hemoglobin D trait (A plus D) requires further study for verification. No other abnormal hemoglobins were encountered.

Previous studies of American Indians have revealed no abnormal hemoglobins (*2*), but the claim of Indian ancestry among many individuals with hemoglobin D suggested the likelihood of a reservoir of such abnormal hemoglobin among Indian populations (*3*). Furthermore, two non-Indian families in the same general geographic area as the Lumbee Indians had shown hemoglobin D (*4*). The present survey suggests the absence, or extremely low incidence, of abnormal hemoglobins among unmixed American Indians (*5*).

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