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NOTES FROM THE PLYMOUTH AQUARIUM. III.

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(Plates I and II)

CONTENTS

The present notes (see also Wilson, 1949, 1953) are mainly concerned with the breeding habits of two fishes commonly kept in marine aquaria. These habits may be familiar to keepers of other large marine aquaria, but I have failed to find any account of them in scientific literature other than a very brief and inadequate description by Raffaele (1898, p. 328) of the nesting of *Cantharus vulgaris* (= *Spondyliosoma cantharus*) in the aquarium at Naples. The scientific names of species mentioned follow the *Plymouth Marine Fauna*, third edition (Marine Biological Association, 1957).

THE BREEDING OF *SPONDYLIOSOMA CANTHARUS* (GMELIN)

The Black Sea-bream or Old Wife (*Spondyliosoma cantharus*) has never been common in the Plymouth sea area, but since 1951 occasional specimens have been obtained throughout the year. Earlier records are not numerous, and certainly for 25 years prior to 1951 no specimens were kept in the aquarium. Since that year a varying number, at present seven, have lived in the largest tank ($31 \times 9 \times 4\frac{1}{2}$ ft. deep) in company with more numerous *Pagellus centrodontus* with which they shoal, and with a variety of other fishes and with *Palinurus vulgaris* and *Homarus vulgaris*. Some of them have been in the tank for several years and since 1953 they have bred regularly. The present account is based on observations made over several years.

From early in the year onwards the males, from time to time, make nests until breeding is over, and occasionally afterwards. When nest-making begins the water is often at about its coldest (8–10° C); spawning takes place when the water is about 12–14° C. May is the usual month for spawning, but in 1957 the first spawning took place on 17 April, to be followed by others late in May. The winter had been mild and the water temperature of about 13° C was two to four degrees higher than usual for mid-April. In 1956 spawning was delayed to mid-June, although temperature during the earlier months of

that year had not been abnormal and spawning temperatures had been reached in May.

The nest is simply an area of the slate floor of the tank cleared of its usual covering of small pebbles. The male makes the clearing by swimming close above the bottom and exerting vigorous side-to-side movements of the tail, thus creating a backward current that sweeps away the pebbles. He remains upright, head more or less towards the centre of the patch as he clears it and travels thus around the edge of the clearing, not necessarily continuously but usually with pauses. In the early part of the year these nests, which are roughly circular, may be only a foot or so across, but as the breeding season approaches the bared patch reaches a larger size and may have a diameter of 3 or 4 ft. (roughly 1 m). Two or more males may each make a nest at the same time, a few feet apart. They will threaten and chase one another, sometimes facing mouth to mouth, nearly touching, fins erect and bodies flushed almost black with vertical white stripes. Little actual fighting between males has been seen.

Out of the breeding season males and females are practically indistinguishable. In the well-lit tank they are silvery, very pale violet on their upper sides and back, with broken horizontal stripes. It is only in the excitements of nest-making, threatening other males, mating and guarding the eggs that the males justify the common name of 'black'. In almost an instant they can when excited change from the normal pale coloration to an intensely dark violet, almost black, with a very prominent vertical white stripe on each side, just in advance of the anal fin (see Pl. I, fig. 1). There are often similar but paler vertical stripes before and behind the main one; another occurs about the level of the pectoral, and yet another at the base of the caudal fin. There are horizontal dashes of white along the lateral line and small whitish blotches more or less all over, but especially on head and shoulders. Broad horizontal banding may occur on the snout and gill-cover, below eye level. There is much variation between individuals, some never become as dark as others, and the same individual may vary from time to time. All individuals exhibiting this dark coloration and this colour pattern are judged by their actions to be male.

As the combined shoal of *Spondyliosoma* and *Pagellus* swim up and down the long tank, males with nests swim after and dart at others of their own species, assumed to be female, as they pass by. During the early months of the year there is no response from them and the males do not stay long on the nests they have made, soon leaving to shoal up again with the other fish. But every now and then the urge to nest-making drives them to repeat the performance.

When a female is ready to spawn she will accompany a soliciting male down to his nest. Spawning has always taken place very late in the evening or very early in the morning, possibly even at night though there is no evidence for

this. The actual spawning has rarely been seen; it has been watched once or twice at about 10 p.m., though not by a scientific observer and details are vague. I have seen, during the daytime, a female accompany a male, which had approached her, to the nest and stay there for some minutes testing the bared slate with her mouth and body. Meanwhile the male swam actively about her, not attacking but now and then nuzzling her ventral fin and her anal region. He was intensely black with prominent white stripes, and he repeatedly erected his dorsal fin. The female bore normal pale coloration. Unfortunately, there was no spawning and as the female swam away she was immediately followed by the male, fussing about her, though as far as could be seen she was not bitten by him.

On another occasion, the following year, a female which had accompanied a male to his nest darkened in colour, though not to the same extent as the male. On the side of her body, behind and above the insertion of the pectoral fin, there appeared a pale horizontal rectangular patch and there were a few irregular thin vertical stripes near the root of the tail. The horizontal pale patch on the female contrasted sharply with the vertical stripes in the same region of the almost black male. The latter became wildly excited and with all fins erect made rapid protrusions of the mouth. Unfortunately, the female stayed on the nest for only a minute or so and no eggs or milt were shed. The performance was repeated several times, for each time the female left she was chased by the male and induced to return, until finally she would go back no more.

The eggs are stuck in a single layer to the slate, although here and there a second layer covers the first. They form an irregular whitish patch a foot or so in diameter in the middle of the cleared area of slate, which is 3 ft. or so across. Each egg is about 1 mm in diameter, flattened underneath and flattened at the sides where it sticks to neighbouring eggs. The egg capsule is relatively tough. The developing embryo shows a single yellow oil globule about 0·25 mm in diameter. Hatching takes place in about 9 days at about 13° C. The larval fish retains the oil globule in its yolk sac and it swims right way up. The eye is darkly pigmented before hatching.

The eggs are guarded by the male until they have hatched. Whilst on guard he endeavours, especially during the first 2 or 3 days, to induce other females to add to them. In May 1954 a second spawning definitely took place on one nest within 24 hr. of the first, and presumably by a second female. There are less definite indications of double spawnings having taken place in other years. In May 1957 two males each had a nest with eggs at the same time, one lot of eggs being a day older than the other.

The first duty of the guarding male appears to be to keep the eggs clean and to prevent them from being silted over. At frequent intervals he swims slowly just above the eggs, wriggling his body and fanning vigorously with tail and fins. This action disperses silt, and also pebbles which have been scattered among them by such accidents as a ray, or flat-fish, settling down

close beside the nest and with flapping movements attempting to bury itself in the gravel. The male also goes around the borders of the nest, head towards the centre, and widens it by swishing with his tail, just as he does when making it originally. He also picks up pebbles in his mouth and drops them well to the side of the nest. This action is not pursued very effectively for the pebbles have never all been cleared away even when there were only a few on the eggs, and whilst swimming around with one in the mouth the fish occasionally let it fall back again on the eggs, especially when his attention was distracted by the approach of other fish.

The second duty of the male is to guard the eggs (Pl. I, fig. 1). In a tank with so many other fishes and invertebrates this is always an arduous task. Especially troublesome are the various species of *Raia*, the flat-fishes (*Pleuronectes platessa* and *Microstomus kitt*) and the rock-lobsters (*Palinurus vulgaris*). Large wrasses (*Labrus bergylta*), the shoals of common sea-bream (*Pagellus centrodontus*) and of mackerel (*Scomber scombrus*) give little trouble and neither do the pollack (*Gadus pollachius*), although if any kind of fish swims too low over the nest it is likely to be bitten. The most troublesome fish actually observed was a pout (*G. luscus*), of which more later. The reactions of a guarding male towards others of his own species varies with their sex. He attacks any male coming near and may chase after him for some distance; as already described he solicits any female and while following her deserts the nest for a short time.

With the exception of a small sting-ray (*Dasyatis pastinaca*) which on one occasion appeared to be feasting on the eggs (observation by Mr G. R. Forster) and was removed to another tank, none of the other fishes in the tank, not even the pout, were ever seen to attempt to eat the eggs. The offence of the rays and flat-fishes was to lie on the eggs, or on any part of the cleared area. They appeared to settle down on the nest just as they would on any part of the tank floor and seemed indifferent to the eggs. It was while the owner of the nest was away for a few minutes, chasing something else, that this was liable to happen. On his return the intruder was immediately attacked, often swooped down on from above and savagely bitten, on body, fins or even the eyes; this rarely failed to bring about a hurried departure. Once a small ray was seized beside the snout and towed away, not being released until well clear of the nest. Any fish approaching was rushed at and if it did not turn away, bitten. After a few days most offenders learned to avoid the nest and its immediate neighbourhood.

Encounters with rock-lobsters were always amusing to a human onlooker. When a *Palinurus* wandered over the nest the *Spondyliosoma* became very excited. There were several methods of dealing with it. One was to seize an antenna and pull the crustacean off the nest, small ones being lifted well clear of the ground and towed for several feet, until with a vigorous flap of its tail the *Palinurus* pulled itself free. Sometimes the *Spondyliosoma* approached

from behind and bit the upper surface of the abdomen, or the tail-fan, whereupon the rock-lobster hurried forward out of the nest. Sometimes the *Palinurus* was pushed from behind, a method adopted more particularly with large individuals with abdomens bent forwards under them, as with females in berry, although rock-lobsters with extended abdomens were pushed almost as readily. The fish applied its mouth to the abdomen of the crustacean and pushed as hard as it could, making very vigorous swimming movements. As it came up behind the *Palinurus* it would take obvious care to avoid the long backwardly directed antennae, coming into the attack between them; it appeared to the observer that it disliked being tickled by them. As far as could be seen only the lips of the fish made contact with the integument of the rock-lobster. The pushing of a large *Palinurus* off the nest entailed much effort.

Of the many fish attacked by the guarding *Spondyliosoma* only one was ever seen to retaliate. This was a pout (*Gadus luscus*) of approximately equal size and unknown sex. It was the only pout in the tank, where it had lived amicably with all the other fish for many months. This pout persisted in haunting the neighbourhood of the nest though not, apparently, with any intention of eating the eggs which did not seem to interest it. It was repeatedly attacked by the black sea-bream and bore on its body marks of the many bites it suffered. The pout often turned on its assailant; more often it would initiate its own attack and savagely bite the black sea-bream. On several occasions it was seen to rush at the bream while the latter was attacking a plaice or a ray lying on the nest; the bream then broke off its attack and fled before the pout. On one occasion the pout repeatedly prevented the bream from attacking a ray lying on the nest (Pl. I, fig. 2) and it was some minutes before the bream got a chance to bite the ray. On another occasion the two antagonists met unexpectedly face to face; for about a second they looked at one another, almost touching mouth to mouth, then they rushed at each other each trying to bite the other in the side. The fight, which was over in a few seconds, ended with the pout chasing the bream right down the tank.

This curious behaviour of the pout was observed both in 1953 and in 1954; by 1955 it was dead. As soon as nesting was over, and the male *Spondyliosoma* had shoaled up again with the other fish, attacks by both parties ceased and they again lived peaceably with one another. It is not known if the male black sea-bream which figured in this drama in 1953 was the same individual as that which played the part in 1954. In the latter year the nesting male was generally much more darkly pigmented than the male which nested in 1953; the two males therefore may not have been the same fish.

The events described took place during daylight hours and it is not known for certain what happened at night. On two occasions after dark the caretaker, Mr W. H. Gladwell, reported that when he had switched on the lights he saw that the male had reverted to non-breeding pale coloration and was swimming with the shoal up and down the tank. Several plaice were lying

over the eggs unmolested. Just before darkness had fallen the male had been very darkly pigmented and on guard.

In general, the pigmentation of a nesting male is darkest during the first few days. Later there is a lightening, but there are temporary intensifications of the darkly coloured areas during moments of special excitement, as when attacking intruders. When the male has rejoined the shoal, after the eggs have hatched, he can only be distinguished from others of his species by his frayed fins, evidence of the heavy work he has accomplished.

More fully illustrated accounts of these observations were published in *The Illustrated London News* for 28 August 1954, and in *Neptune* for April 1956.

THE SEXUAL DISPLAY OF *LABRUS OSSIFAGUS* L.

The Cuckoo Wrasse (*Labrus ossifagus*) is not uncommon on or near rocky grounds near Plymouth. Usually one or more specimens, male or female, are to be seen in the aquarium, some of them surviving for several years. Until recently breeding had never been observed, although males had fought one another.

In the spring of 1955 two males and three females shared the same tank. As was usual, the males were hostile but had tolerated one another for some time without undue disturbance. Early in May one of the males was found dead and was believed to have been killed by the other, which had become sexually active and was engaged in nest-building. The nest was merely a cleared area, a few inches across, of the slate bottom of the tank. The bottom was strewn with shell gravel and in order to clear his patch the male turned over on his side and flapped vigorously with his tail (Pl. II, fig. 1). This action should be contrasted with that of the male *Spondyliosoma* which remains upright during the same operation. In nature the fish may in this way clear patches of rock, or make saucer-shaped depressions in sand or gravel. In the tank two separate patches of slate were cleared and so the one male had two nests a foot or so apart. Nest-making took place on several evenings over a period of 1 to 2 weeks.

The nest, or nests, having been made, the male turned his attention to the females, darting swiftly at each in turn, sometimes not otherwise molesting them, but often biting and chivying them. His excitement was great and his colours unusually vivid, the white patch (see p. 305) on head and shoulders visible, though not of maximum prominence. The dorsal fin was fully erect during the attack. The colours of the females were also more pronounced than usual* and had been so for some days. Usually they did their best to avoid the attentions of the male and it was obvious that they were not in full breeding condition. Nevertheless, they were approaching it, for on several

* In the aquarium the colours of healthy but not breeding fish of both sexes are much paler than in living freshly caught specimens, or than in those recently dead.

occasions a female eventually followed the male to one of his nests. When this happened he became wildly excited and with all fins fully spread, showing the most vivid blue and orange colourings, he displayed himself to her, open mouthed (Pl. II, fig. 2). His head and shoulders were jerked from side to side, his body sometimes twisted into an S-curve. The most striking feature of the display was the blanching of a large patch of skin on top of the head and over the shoulders, the blanching extending a little up the base of the dorsal fin as far back as the sixth or seventh fin ray. From this large, almost completely white area the pigment appeared to have been drained away to leave only faint tracings of the irregular stripes normally present. It has already been mentioned that the whitish patch appeared, with varying degrees of prominence, during the attack on the females; it was also present, though not fully blanched, during nest-building (Pl. II, fig. 1). It completely transforms the normal appearance of the male and must to a ripe female be a visual excitation stimulating her to shed her eggs. Our females, not being ripe, responded only by staying for a few minutes beside the male on the nest, never more than one at a time, showing no excitement and with their colours only slightly heightened. Neither eggs nor sperm were shed, the females soon tiring and swimming away, promptly to be followed and attacked by the male. Occasionally this renewed attack would induce a female to return to the nest, but only for a few moments. Eventually the largest female had to be removed to another tank to save her from the persistent biting of the male. Two smaller females remained in the tank with him; they too were bitten but were not as severely treated as was the larger female. After nearly 3 weeks the latter was returned to the tank, (on 1 June) but almost at once was viciously attacked by the male and had to be rescued for the second time. This last attack took place in the morning, with no nest and with no appearance of the whitish head and shoulder patch, and therefore may not have been an attempt to mate.

Sexual displays always took place during the evening, after about 6 p.m. They occurred almost every evening during the first week of May, but were observed only every other evening in mid-May. They then became less frequent. The water temperature during May rose slowly from about 11° C at the beginning of the month to about 13° C at the end. The whitish head and shoulder patch was never visible until the evening; it appeared only when the male was sexually excited and then very quickly. During normal daytime activities the area of skin which it occupied could hardly be distinguished from that surrounding it.

On 9 June the male was suddenly attacked by numerous praniza larvae of *Gnathia* (both *G. maxillaris* and *G. oxyuraea* are known to occur in the tanks). The larvae attached themselves to fins and body and even inside the mouth. The fish became poorly and there was no more sexual activity. The praniza larvae also attacked the females, though to a lesser extent. The fish were

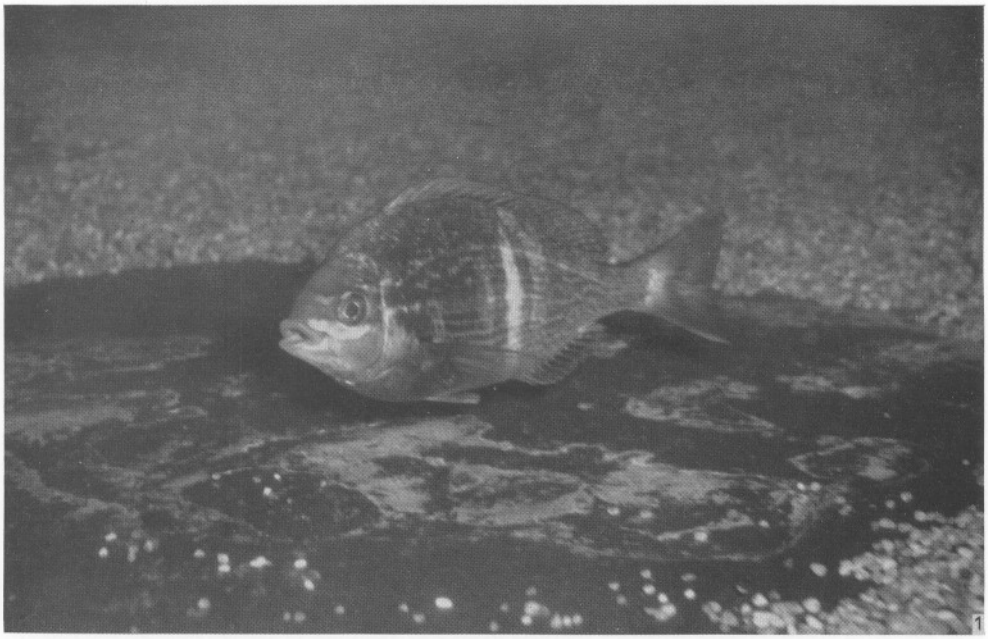
removed, freed from the pests, and their tank emptied and cleaned before they were put back in again. The male survived for about another year and the females for two. The trouble with praniza larvae reoccurred months later and in 1957 may have been largely responsible for the deaths of the females.

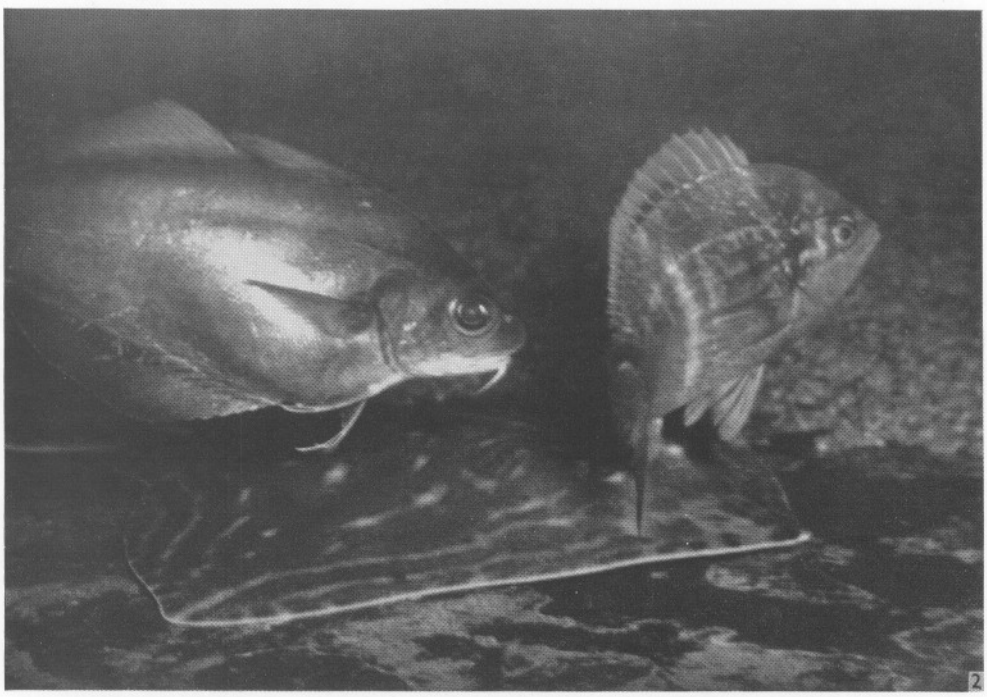
An account of these observations, illustrated by colour photographs, was published in *The Illustrated London News* for 26 May 1956.

LEARNING IN *ZEUS FABER* L.

The John Dory (*Zeus faber*) is predominantly a fish-eater, stalking its prey until sufficiently close to seize it with a sudden protrusion of the long extensile jaws. For very many years living small fishes, especially *Gobius minutus*, and occasionally living shrimps (*Crangon vulgaris*) when fish were scarce, were fed to the John Dories in the aquarium, and it appeared that they would not accept anything else. Dead fish were almost always ignored and, if perchance taken into the mouth, spat out again. Fish were always carefully scrutinized and a goby passively sinking was almost never seized until it made some movement, though some individual John Dories were less particular in this respect than were others. A few years ago one John Dory starved itself to death, for it would so rarely eat anything, though paying great attention to living gobies put into the tank and staring at one for minutes at a time, while its companions were greedily eating others. Pieces of fresh squid (*Loligo forbesi*), the staple food of the inhabitants of the aquarium, were never taken by the John Dories. Pieces of squid are pure white and are unlikely to be mistaken for fish. A dead goby looks unlike a living one, especially when sinking with silvery ventral side uppermost.

For many weeks after their arrival John Dories have always behaved in this way. Of recent years, however, they have been trained to eat squid as well as dead fish. The training takes a long time and says much for the patience of Mr W. H. Gladwell who is responsible for feeding the animals in the aquarium. After some weeks, when the newly arrived John Dories are feeding regularly on living fish, a few whole small squid or pieces of mantle cut into strips roughly fish-shaped, are dropped into the tank. As the strips sink they do so with an irregular motion, imparted by their shape, and to the John Dories may seem alive. They are scrutinized and eventually, sometimes after many such offerings spread over days or weeks, an odd strip or two will be seized. The diet of living fish can then be gradually stopped until finally only squid or dead fish is given. Mr Gladwell maintains that in giving dead fish the heads should first be cut off. At long last the John Dories feed regularly on squid and no longer need to be offered elongate pieces, square or any other shape will be accepted. At the time of writing (October 1957) six medium-sized John Dories, caught during the summer of 1956, are fed two or three times a week on portions of squid, which are taken eagerly.





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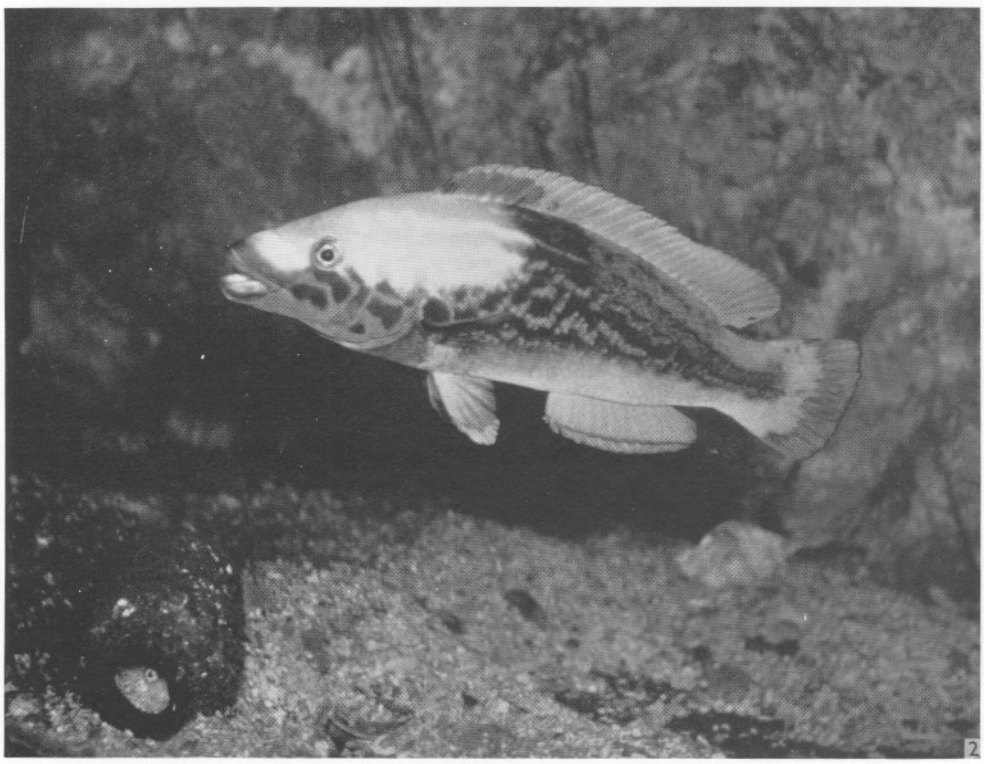
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EXPLANATION OF PLATES

PLATE I

Fig. 1. A male *Spondyliosoma cantharus* on guard over his nest (in May 1954) shows breeding coloration developed to about half full intensity. The nest is a cleared area of slate 3 or 4 ft. across; only a portion is shown in the photograph. Unfortunately, the slate bears the marks of old concrete (where rocks were formerly cemented to the tank floor) and the eggs, which when this picture was taken were hatching and losing their whiteness, are not readily distinguishable from this concrete.

Fig. 2. The male *Spondyliosoma* which was about to attack a *Raia microcellata* lying over the eggs, is being headed off by the *Gadus luscus* and it was sometime before the former shook off his pursuer and returned to his task of removing the ray.

PLATE II

Fig. 1. Male *Labrus ossifagus* making a nest by lying over on his left side and vigorously flapping his tail to wash away shell gravel, disturbed particles of which are seen behind him. The white area on the top of his head and shoulders is present but not fully blanched.

Fig. 2. Male *Labrus ossifagus* in full sexual display before a female; she is too far to one side to be included in the picture. All his fins are erect, his mouth is open, and the white area on top of his head and shoulders is fully developed. Near the lower right-hand corner about half of the nest is visible. The object in the left-hand corner is an old bottle of dark-coloured glass, with a *Blennius ocellaris* inside. This photograph, reproduced in colour from the original kodachrome, appears in *Marine Life of Coastal Waters* (*Western Europe*) by E. le Danois, translated and adapted by N. A. Holme (London: Harrap), p. 155.