MINISTRY OF FINANCE, EGYPT.

Coastguards and Fisheries Service

FISHERIES RESEARCH DIRECTORATE

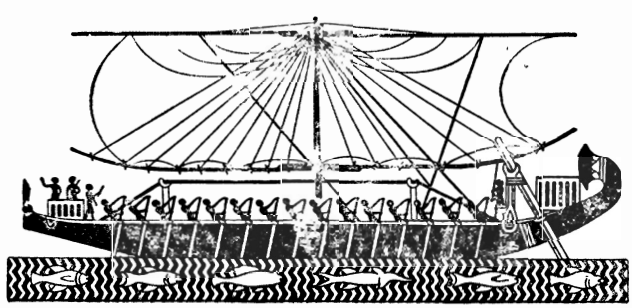
NOTES AND MEMOIRS

No. 4

Report on Fish Eggs and Larvae Taken during 1931

BY

R. H. WHITEHOUSE, D.Sc., F.Z.S.



CAIRO
GOVERNMENT PRESS
1933

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Report on Fish Eggs and Larvae Taken during 1931

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R. H. WHITEHOUSE, D.Sc., F.Z.S.

When appointed on January 27, 1931, to the Fisheries Research Department of the Coastguards and Fisheries Service, I was instructed to continue the work begun by Mr. F. S. Russell during the year 1923 on fish eggs and larvae. At my request, Mr. Russell very kindly sent me his excellent collection of larvae, stained and mounted permanently, which he made while in Alexandria. This collection is comprehensive and contains representatives of most of the common fishes found off the Alexandria coast. Thus the collection forms a good basis for the work.

In his report, Mr. Russell had already identified a number of eggs and larvae, though a considerable number were left in doubt. These and many others needed verification or identification.

There are two principal ways of doing this work : (1) obtaining ripe female and male fishes of the same species and, after stripping them, to attempt artificial fertilization ; and (2) obtaining a complete series of successive stages in the life history of a fish by intensive fishing.

As regards the first method, it is essential that a female fish be caught which has eggs quite ready for deposition, *i.e.* that the eggs by slight pressure exude from the genital aperture in a transparent mass. Opaque eggs are useless, since they are not ready for fertilization ; they are not even of any use for determining the size of the egg, since in the unripe condition eggs of all sizes are extruded and the largest of such eggs do not compare exactly with the naturally deposited egg, fertilized in the open sea. To obtain ripe females is a comparatively rare piece of luck and the chances of getting successful fertilization obviously depend on finding at the same time a thoroughly ripe male. Even provided that such good fortune as the capture of a ripe male and female of the same species at the same time should

occur, as is well known, artificial fertilization is an exceedingly difficult matter, and the instances recorded of effecting satisfactory fertilization with marine fish are very few.

Not all fish will spawn in captivity, but to be successful with those that will do so, facilities like tanks of circulating aerated water are clearly necessary. Such facilities have not been available in the Department ; thus experiments in this direction must wait until facilities are provided.

We are therefore at present left with the second method of work, *viz.* obtaining a series of successive stages in the life histories of the various fishes. Mr. Russell, from January to August 1923, was apparently assisted in his collection work by having the tug " Teir-el-Bahr " placed at his disposal. He established a number of stations and took systematic collections. As a result, he obtained an excellent collection of larvae for study and reference.

In the comparatively short time he had for this work, Mr. Russell was able to attempt identifications in a few instances where the eggs and larvae had previously been studied by biologists. By comparison with described species, he could name some of his collected specimens. But the majority were obviously left in doubt or were only to be labelled temporarily as A, B, C, etc.

To continue the work satisfactorily two essentials are required : (1) the provision of a vessel at the disposal of the Department for regular systematic collection, and (2) time.

As regard facilities which have been available during 1931, the Fisheries Research Department has been entirely dependent on a Coastguards Patrol boat being occasionally available when it could be released from patrol duty. No collection was possible until April 5. The next voyage was not possible till May 6. In June three collections were possible, *viz.* on the 3rd, 21st and 28th, when results were promising. No further collection could be made until August 5 ; the year was therefore rapidly slipping by with little or nothing done. From this date the Director-General of Coastguards and Fisheries kindly responded to my appeal for the use of the vessel once a week. Wednesdays were allotted to me and useful collections were made on August 5, 12 and 26, the weather on the 19th making collection impossible. Owing to a special request following the discovery of the presence of Muraenoid eggs, I was fortunate in obtaining the use of the vessel for three successive days—September 1 to 3—for collection. For various reasons (weather, urgent patrol work or cleaning operations) nothing further was possible until October 21, after a gap of 7 weeks, when a good haul was obtained ; unfortunately, however, the transport arrangements broke down and the catch could not be brought to the laboratory before it had become putrid.

Thus by the end of October only 12 catches were available, several of which, of course, produced little or nothing. A few collections were made after this date, but it was too late to deal with them in the time available, since for reasons of retrenchment, it was decided not to continue the engagement of the European staff beyond the year. With so few collections, little real advance could be made. It must be clear to all that not until the research ship of the Department is engaged in regular systematic collection can results be obtained. As Taning says: " The post-larval stages can only be referred to their proper species with any degree of certainty when a very abundant supply of material is available and even then satisfactory results may not always be attained."

The larvae must be obtained in fair numbers at reasonably regular and frequent intervals in order that successive stages can be followed to a recognition stage. Here the question of time also comes in.

A single year's work, even with every facility available, is too short a time to result in satisfactory work. A recent publication by an American worker on fish eggs and larvae gives, as a result of seven years' intensive study, a description of only 17 species. During the last 50 years, workers have been engaged in this study in the Mediterranean and very few of the species known off these coasts have been dealt with. The vast majority, and especially the food fishes, are quite unknown in their early stages of development. Many years of intensive study are necessary for this extremely important work, which must, sooner or later, be tackled if the fisheries of Egypt are to be scientifically studied with profit to the industry. Needless to say, there is no work of greater importance to fisheries development than a complete knowledge of the biology of fishes, which includes a knowledge of the spawning periods and the nature of the eggs and larvae of each species. The value of such intensive work for Egyptian fisheries cannot be over-estimated. The work *must* be continued, otherwise the work of Mr. Russell and myself which only touches the fringe of the subject will be wasted ; and further, it must be continued in order that the Fisheries Department may be provided with a weapon of inestimable value in fisheries research.

The work on fish eggs and larvae must be studied in association with that of the adult fish fauna. With a complete list of the species of fishes in the vicinity, a biologist has a most valuable and time-saving instrument in his hands. It at once reduces his labours in dealing with extensive references in literature. For the district under investigation, he can at once effect the necessary elimination of species described and reduce reference to manageable dimensions.

Methods of Work

Attempts were frequently made at Alexandria and at Ma'adia to obtain ripe fish in the hope of effecting artificial fertilization, but like previous workers in this direction no success was accomplished. When the tanks in the new laboratory are provided with circulating aerated water, there is hope that some species may be induced to spawn in captivity and provide the necessary material for study. Attempts at this should be possible in the near future, for at the time of writing, the circulation system is being installed.

During the few voyages that were possible in the open sea, both a large stramin young fish net and an ordinary bolting silk net were employed. The catches by the stramin net were unexpectedly small. Eggs were taken successfully but the larvae were always damaged and usually suffered from attacks by crustacea in the net. The rate of the vessel during the hauls was as slow as possible, *viz.* 2 miles per hour, and the duration of the haul was one hour. It might have been better if the hauls had been of shorter duration and more hauls taken, but this was not practicable as the time for which the vessel was available was limited.

The silk net was quite successful in procuring fish eggs, but larvae were rarely caught by it.

Owing to the very limited number of times when the boat was available it was considered wisest to confine attention to one station which was the most promising, *viz.* 3 to 5 miles north of Agami Point.

Not until the end of May was the laboratory ready for occupation. In June, Cannon and Grove's apparatus was set up in an attempt to hatch out larvae. The circulation of aerated water by this means is very slow and the eggs remained settled on the bottom of the shallow vessels in which they were placed. Here they were subject to attacks of protozoa and rarely hatched. Afterwards, agitation of the water in cylinders was tried with complete success in hatching and keeping the larvae alive for varying periods form 3 to 7 days or longer. With circulating aerated water in addition to agitation, the development may be expected to continue much longer. The success appeared to be due to the inability of the protozoa to remain attached to the eggs while continually on the move. It was to be regretted that when reasonably satisfactory methods had been devised, the opportunities for obtaining material were so few.

Eggs were brought to the laboratory and transferred to glass cylinders, containing water brought from the station at which the haul was made. The cylinders were provided with plungers which stirred the water every half minute. In this way most of the eggs taken were hatched out and the larvae lived on the average for 3 or 4 days.

Wherever possible drawings were made from the living material by the aid of a camera lucida either as eggs or as larvae. It was, however, rarely possible to effect a complete drawing of the living larvae in this way on account of its lively movements. Larvae were usually fixed in hot sublimate.

A large part of my work has been the examination of Mr. Russell's collected specimens. Dozens of drawings have been made with a view to comparing them with those accompanying published work. Since, however, in most cases, similarity was not established, it became clear that the larvae in question were those of species not yet described. Very few of the local species of fishes are known in their young condition, hence the necessity for prolonged intensive collection and study in order that complete series might be found up to an identifiable stage. Though but few definite results can be registered from this part of the work, what has been done will prove useful as a point from which to continue the work.

Umbrina cirrhosa, L.

In his identification of the eggs and larvae of *Corvina nigra*, Cuv., Mr. Russell was quite justified, since his specimens agreed most faithfully with the description by Raffaele (Mitth. Zool. Stat. Neapel, Vol. 8, Part I, 1888). Some doubt, however, was entertained regarding this identity because, though *Corvina nigra* is not known locally in Alexandria, these eggs are exceedingly common. Now *Corvina* and *Umbrina* were at one time synonymous, and the genera were later separated on account of the absence, in *Corvina*, of the barbel which is present in *Umbrina*. *Umbrina cirrhosa* is very common off the coast of Alexandria and it is almost certain that the eggs and larvae described as those of *Corvina nigra* are really those of *Umbrina cirrhosa*.

Holt describes the eggs of both *Umbrina cirrhosa* and *Corvina nigra*. As regards *Umbrina cirrhosa* he states: "Les œufs murs, tirés d'une femelle le 9 juin 1926, presentaient les dimensions qui suivent: Diametre de l'œuf ·90 à ·96 millimètres. Diametre de la gouttelette huileuse ·20 millimètres." Now my experience is that eggs taken from a stripped female are not necessarily of the same size as those found in the open sea. The naturally deposited egg is somewhat larger after contact with the water. In fact Holt adds: "Il est probable que les œufs deviennent quelque peu plus gros après la formation de l'espace périvitellin." The eggs found off this cosat measure 1·1 millimetres to 1·3 millimetres and the oil globule ·22 to ·3 millimetres. The difference in the diametre of the egg of ·2 to ·3 millimetres may therefore easily be accounted for.

The newly hatched larva reared by me was rather smaller than that recorded by Mr. Russell. I found that the total length measured 2·6 millimetres and the postanal portion 1·4 millimetre as compared with Mr. Russell's 3 millimetres and 1·7 millimetres respectively. A specimen taken at about a mile between the harbour entrance and Mex at the end of June measured 3·75 millimetres.

There is therefore very little doubt that Mr. Russell's very full description, which needs no amplification, refers to *Umbrina cirrhosa* and not to *Corvina nigra.*

Serranus cabrilla, L.

The specimen in Mr. Russell's collection was correctly labelled and agrees with Fage's description very closely. In his description Fage says: "In the 5 millimetres specimen, height one-fifth total length. Length of head about one quarter the length. Opercular spines few and small. Upper jaw finely denticulate. Anus nearer the caudal extremity than the end of the snout. Embryonic fin still intact and shews no definite differentiation of rays except in the caudal. However I cannot affirm that the first ray of the dorsal was not already individualized. Very fragile, this ray may have accidentally disappeared from the specimen described here. Ventrals very long, one fourth total length. Spine in front of soft rays distinct. Pectorals relatively well developed. In pigmentation, this stage and later are characteristic.

2 large stellate chromatophores already seen in the larvae, one situated in the median ventral line in front of the posterior third of the trunk, and the other scarcely farther forward in the mid-dorsal line.

1 at the level of the insertion of the ventrals.

1 on the "limb" of the caudal.

1 on the extremity of the jaw.

The beginning of the dorsal, the pectorals and the ventrals are all speckled with black."

Mr. Russell's is slightly smaller than the smallest taken by the "Thor," measuring 4·8 millimetres against 5 millimetres. The ventrals (pelvics) are long, the pectorals scarcely developed and represented only by a narrow strip behind the operculum. The caudal has its ventral differentiation begun. The first rays of the dorsal are bent

down over those behind, but careful examination shews that the second or third ray is long. Fage refers to the absence in his specimen of the long rays (*see* above) and in this he was apparently correct as the rays are quite clear in this specimen.

The distribution map given by Fage (Rep. Dan. Ocean. Exped. 1908–1910, No. 4, A3, 1918, p. 29) shews that post-larval stages were taken S.E. of Sicily and at the Dardenelles. These were the nearest stations to Alexandria where this species was obtained, though the collecting stations of the " Thor " included spots off the African coast as near as the 25th degree of East Longitude.

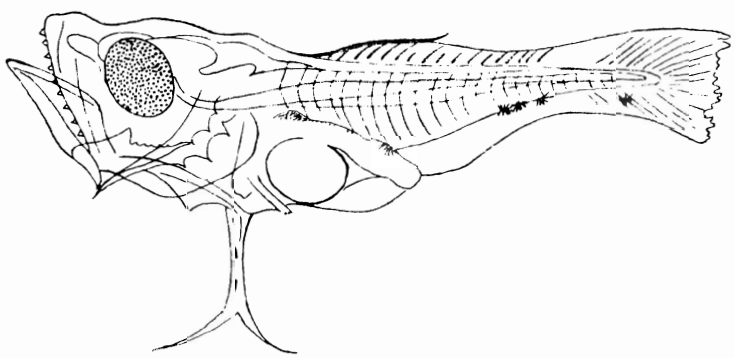

FIG. 1.—Serranus cabrilla 4.8 mm. x 20

Paracentropristis hepatus, Klunz.

Serranus hepatus, L.

The mounted specimen in Mr. Russell's collection labelled " Type XXI 4/6/'23 " is undoubtedly *Paracentropristis hepatus*. It measures 7·1 millimetres in length from the extremity of the jaws to the extremity of the caudal fin.

According to Fage (Rep. Dan. Ocean, Exped. 1908–1910, No. IV, A3, p. 24) at the 6 millimetres stage the head is one-third the total length. The anus is situated half way along the body and the depth of the body is contained $3\frac{1}{2}$ times in the total length. The operculum has three spines and the lower jaw is denticulate, and the first two or three rays of the dorsal fin are just differentiated in the embryonic fin. No chromatophores are found on the dorsal sides of the body and the pigmentation is confined to a patch at the articulation of the jaws, another in front of the base of the pelvic fins, one at the anterior end of the anal fin, one near the end of this fin, another at the beginning of the caudal, and lastly one at the base of the rays of the caudal

fin. It appears that Lo Bianco mentioned two other pigment spots at the dorsal edge of the embryonic fin in the living larvae, but Fage says they are not found in the preserved specimens.

The specimen under consideration, stained and mounted in Canada balsam agrees very closely with Fage's description and figure. Being 1·1 millimetre longer, development would be expected to be more advanced than the 6 millimetre specimen described by Fage. It shews a distinct advance. The caudal fin is fully formed with a full complement of young hypural bones. Five or six spines are found in the dorsal fin against two or three in the 6 millimetres stage. The pelvic fin is longer and the head is definitely more developed. But the proportion of the head to the total length, the position of the anus and the pigmentation are exactly as in Fage's description, except that a small chromatophore appears in the dorsal fin as described by Lo Bianco. The depth of the body, however, is contained $4\frac{1}{2}$ times in the total length. In this connection, though Fage states that the proportion is $3\frac{1}{2}$ times in the total length, his figure shews 4 to be more accurate. In the 10 millimetres specimen figured by Fage, the proportion of depth to total length is a little over 4 times. Four or five spines have appeared on the operculum in the 7·1 millimetres specimen.

This specimen was taken by Mr. Russell on June 4, 1923, a time which corresponds well with the time Fage's specimens were taken, *viz.* June to September.

The distribution shewn by Fage corresponds almost exactly with that of *Serranus cabrilla*, *viz.* S.E. of Sicily and on the coast of the Balkan Peninsula. (*See* Figure 2.)

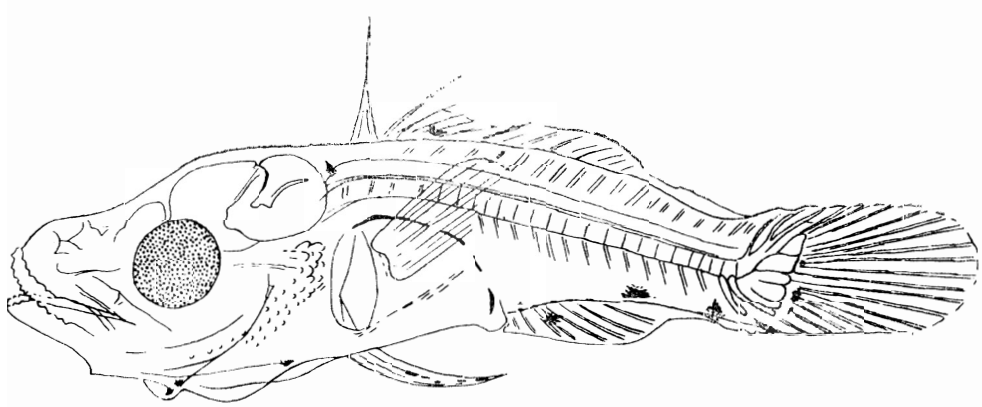

FIG. 2.—Serranus hepatus (Paracentropristis hepatus) 7.1 mm. x 18

Clupeidae

So far as we know, three species of Clupeidae are commonly found in the waters round Alexandria ; these are *Engraulis encrasi cholus* L. *Sardinella aurita*, C. & V. and *Sardinella granigera*, C. & V. Mr. Russell records that he found, in February, eggs which were undoubtedly to be regarded as those of *Clupea pilchardus*. The eggs of this species are so characteristic that he can scarcely have been mistaken : but he left no figure of this egg, and so far as is known locally, the pilchard is not taken near Alexandria. Mr. Russell says that his is the first record of the presence of this egg so near to Alexandria.

The egg and larva of *Engraulis encrasicholus* have been fully described by Raffaele, but as Fage says, the egg and young stages of *Sardinella* are not known with certainty. In Mr. Russell's collection there appear to be two species of larvae referable to the genus *Sardinella*. The specimens are certainly not *Engraulis*, nor are they *Clupea pilchardus*. One agrees very well with Raffaele's description of his " Clupea species B " and it has been generally agreed (Holt and Fage) that this species belongs to *Sardinella aurita*. This view is confirmed by its discovery in the waters off Alexandria where the species is very common.

The other species may be regarded as *Sardinella granigera*, C. & V. which is the commonest littoral species of the Clupeidae off Alexandria. The egg has been described and figured by Mr. Russell and the newly hatched larva has been figured by him under the heading " *Sardinella aurita* ?" I would prefer, however, to regard this species as *Sardinella granigera* for two reasons : the yolk sac in the newly hatched larva is a little different from that figured by Raffaele, having little or no perivitelline space to speak of, and the position of the anus is a little further back than in the related species assigned to *Sardinella aurita*. Mr. Russell, in his figure of the larva, shews a ventrally situated oil globule ; he probably made his figure from the living larva, but the preserved specimen, stained and mounted permanently, does not shew the oil globule ; at least I cannot satisfy myself that an oil globule is present.

Sardinella aurita, C. and V.

The smallest specimen measures 2·3 millimetres and agrees very closely with Raffaele's " Species B." It is clearly a very recently hatched specimen. The yolk sac is large and oval and the yolk is segmented. Ventrally in the yolk sac is a large oil globule with a smaller one near by. In the anterior perivitelline space is a group of globules, a feature not shewn in Raffaele's figure.

Pigmentation resembles that of " Species B " and consists of a series of black chromatophores dorsally almost along the whole length.

The anus is well back along the body and the tail is contained 5 times in the total length.

At 3·2 millimetres length, the pigment has become a little more pronounced and a group of chromatophores has appeared on the ventral side of the tail near its extremity, as well as above the anus. It appears also that the dorsal chromatophores are undergoing a migration to the ventral side, a position they occupy in later stages. The tail is contained $5\frac{1}{2}$ times in the total length, and the yolk sac is much reduced ; the oil globules have disappeared.

The next stage, measuring 4·06 millimetres, still shews the chromatophores to be dorsal, so that the size at which the migration occurs probably varies. It is very similar to the previous stage except that the tail is proportionately slightly longer. The pigmentation is similar. The otocyst is more prominent.

Considerable advance is shewn at 5·9 millimetres when development has progressed at least as far as in *Clupea pilchardus* at 11 millimetres. Though there is still no indication of the anal fin, the basal elements of the dorsal and caudal fins are laid down. The pectoral fin is a thoroughly functional organ. The gut is fully differentiated : the anterior part is shorter than the posterior and measures about one-third of the total length of the body behind the head. At this stage, the larva agrees in all details with the 6·5 millimetres stage described by Fage.

The various stages complete the series previous to those described by Fage. (*See* Figures 3, 4 and 5.)

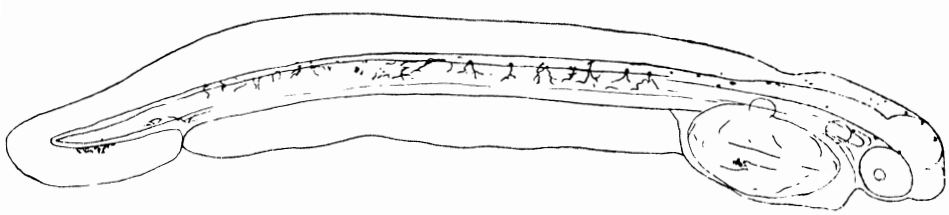

FIG. 3.—Sardinella aurita 3.2 mm. x 39
(Russell's Collection) station 46 (2) 21/8/23.

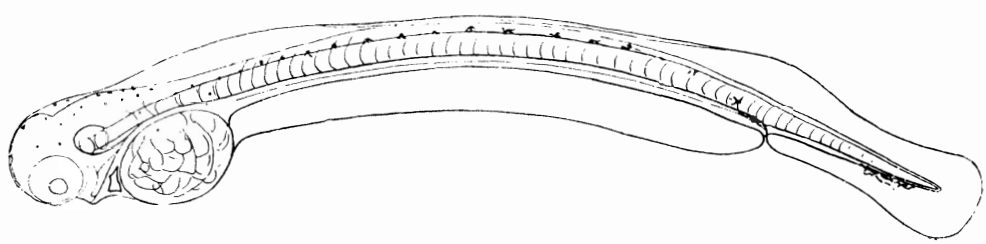

FIG. 4.—Sardinella aurita 4.06 mm. x 33
Russell's collection St. 45-26/6/23 Killed 6 p.m. 27/6/23.

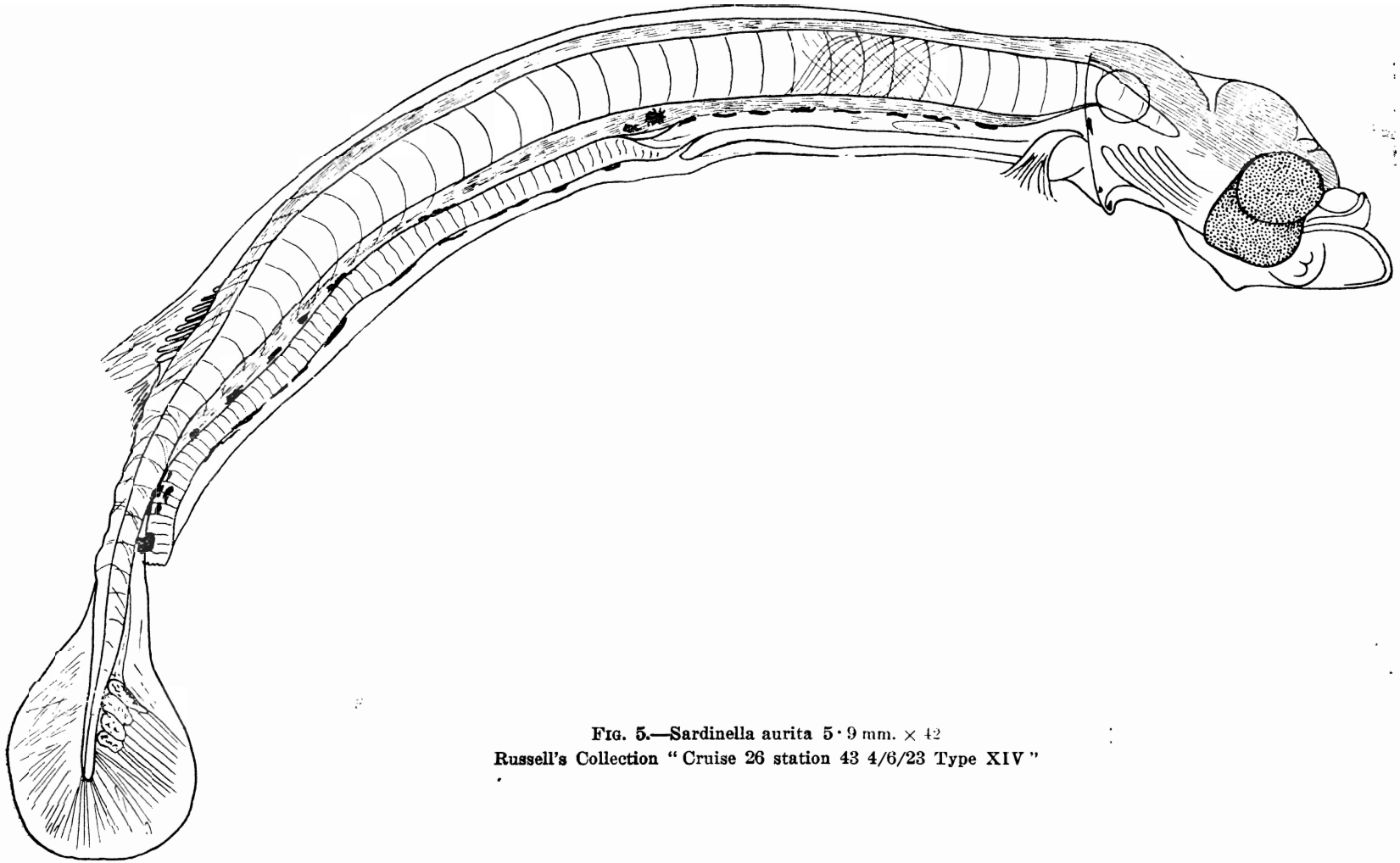

FIG. 5.—Sardinella aurita 5·9 mm. × 42
Russell's Collection "Cruise 26 station 43 4/6/23 Type XIV"

Sardinella granigera, C. and V.

In this species, the adult characters are : the height, length of head and length of tail without the caudal fin all about the same ; a sharply triangular snout ; the pelvic fins inserted at the middle of the body (exclusive of the caudal fin), a character which, however, is also found in *Sardinella aurita*, and at the level of the first third of the base of the dorsal fin ; a black spot at the front edge of the dorsal fin ; no patch on the operculum ; scales perforated at their free edge. Specimens of *S. aurita* measured in the laboratory also had the pelvic fins inserted exactly in the middle of the length of the body, but the insertion was definitely vertically below half way along the base of the dorsal fin.

Three or four newly hatched specimens all of the same length, *viz.* 2·9 millimetres, which can be referred to *Sardinella granigera*, are found in Mr. Russell's collection. The distinction from *S. aurita* is based on the relative length of the tail and the difference in the form of yolk sac, which has no perivitelline space as in *S. aurita*, the yolk completely filling the sac. The length of the tail is contained at least 6 times in the total length. No oil globule is seen in the preserved specimens, though Mr. Russell's figure of the living larva shews one mid-ventrally. Pigmentation is confined to a longitudinal series of black chromatophores dorsally, but not extending to the head.

No other stages have been taken younger than a specimen measuring 13·5 millimetres contained in Mr. Russell's collection and labelled "*Clupea pilchardus* ?" Though it is strikingly similar to the larva of C. *pilchardus*, as described by Fage, there are two features which make it most probable that it is *S. granigera*, apart from the fact that *C. pilchardus* is not known near Alexandria. Its height is contained 12-times in the total length, whereas in *C. pilchardus* it would be about 16 times at this stage. In *S. aurita* of this size, the height is contained about 13 times in the total length. Unlike *S. aurita*, the head is equal in length to the tail exclusive of the caudal fin, and in this respect it resembles *C. pilchardus*, being contained $7\frac{1}{2}$ times in the total length. But the length of the snout is distinctly shorter than in *C. pilchardus*, the preorbital space being equal to the diameter of the eye. The length of the posterior part of the gut is $1\frac{1}{4}$ times that of the anterior part measured from behind the head. There is no indication of the pelvic fins. The dorsal fin is well developed and shews 14 radials ; the anal fin also contains the elements of radials. The skeleton of the caudal fin is well developed, all the hypurals being present.

Pigmentation consists of a double row of chromatophores ventrally, one above and one below the gut. Several pigment spots are on the ventral side of the tail and one or two in a central position on the hypurals. Two or three spots are found on the operculum and head.

The next stage taken was 20 millimetres long. Here the lower jaw projects prominently. The length of the head is about the same as that of the tail, and when there is a difference in these two lengths, the tail is slightly the shorter. The height of the body is contained 8 or more times in the total length. The diameter of the eye is about the same as the distance from the eye to the end of the snout.

It is in the position of the insertion of the pelvic fins that a noticeable difference from the adult is seen. The pelvic fins, with six rays developed, are inserted a little in front of the anterior edge of the dorsal fin. This holds good for all the definitely larval stages up to 32 millimetres length. At 34 millimetres however, the relative positions are as in the adult, *viz.* the pelvic fins are inserted a little posterior to the anterior edge of the dorsal fin. The adult form is, then, gradually assumed from the 32 millimetres stage.

The pigmentation of the larva is scanty and is almost entirely confined to the ventral side. A single line of chromatophores is found in the mid-ventral line of the head. From the head a double ventral series extends as far as the pelvic fins ; and again a single line is continued from the pelvic fins to the anus. From the anus to the base of the caudal fin, the same line is continued, but with large chromatophores. Thus in side view there appear three large patches of pigment along the base of the anal fin, while in ventral view prolongations of these pigment spots produce a continuous thin line. The hindmost of these patches is sometimes broken up into two or three smaller patches. Just below the middle of the base of the caudal fin is another black patch. In the caudal fin, pigment is found at its base dorsally, and an oblique line is formed to the ventral lobe similar to that in *Engraulis*.

On the assumption of adult characters and colouration a reduction in length is noticeable, for specimens with all such characters measuring only 28 millimetres have been taken. (*See* Figures 6, 7, 8 and 9.)

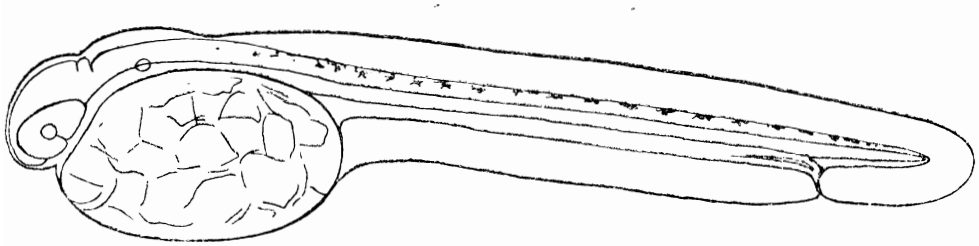

FIG. 6.—Sardinella granigera C & V 2.9 mm. x 44

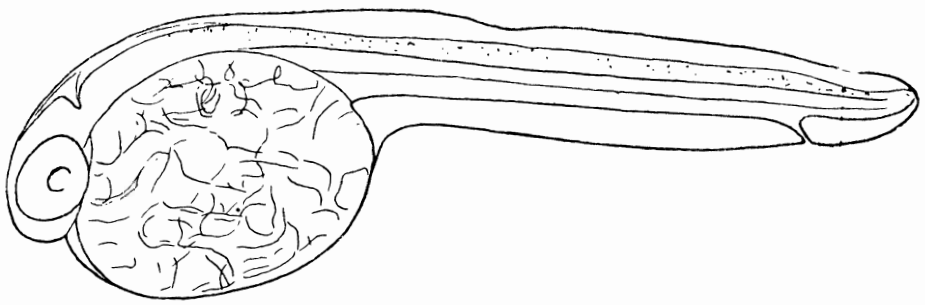

FIG. 7.—Sardinella granigera 2.9 mm. x 48
Same as Raffaele's "Species B."
(Russell's Collection) station 45 26/6/23

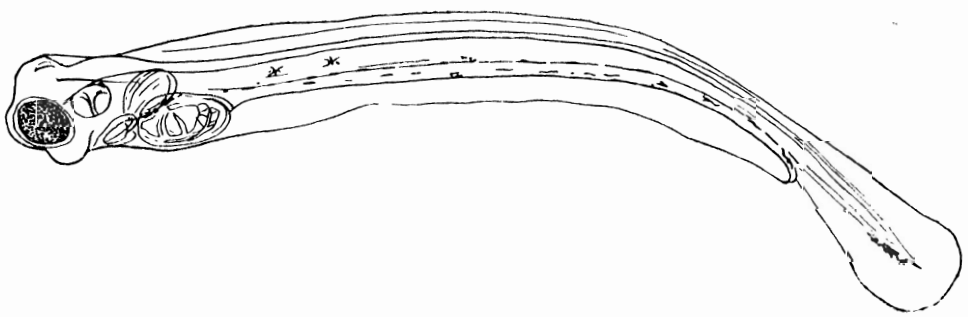

FIG. 8.—Sardinella granigera 3.75 mm. x 34
Russell's Collection St. 46 21/8/23 12 a.m. 22/8/23

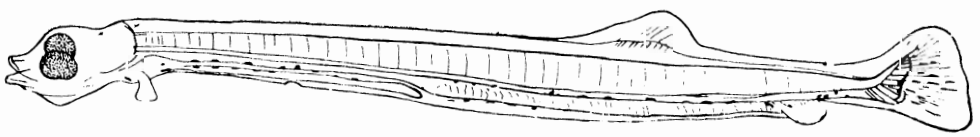

FIG. 9.—Sardinella granigera 13.25 mm. x 10
Russell's Collection 10/4/23

Engraulis encrasicholus, L.

Engraulis encrasicholus is distinguishable, in the larva in which the fins are differentiated, by the relative positions of the dorsal and anal fins. In this species the posterior end of the dorsal fin is slightly posterior to the anterior end of the anal fin. The two parts of the gut, the smooth and the folded, are of about equal length. The length of the tail is greater than in other Alexandria species of Clupeids ; it is about $\frac{1}{4}$ the total length. The tail, exclusive of the caudal fin is contained $3\frac{1}{2}$ times in the total length.

Pigmentation is not very reliable except that the oblique mark on the central lobe of the caudal fin is very characteristic.

The 3 millimetres specimen figured here was reared from the egg by Mr. Russell. It will be noted that the very small yolk sac remnant is somewhat elongated. The tail, including the embryonic fin fold, is contained very little more than 3 times in the total length. The otocysts are prominent. There is as yet no differentiation of the gut. Pigmentation is confined to a ventral series of pigment spots along the gut, one half way along the tail and near the notochordal extremity.

At 4·2 millimetres the yolk has been completely absorbed. The gut is differentiated into anterior and posterior portions, distinguishable by the foldings on the latter. It will be noticed that these two divisions are of about equal length. This differentiation is effected earlier in *Engraulis* than in *Sardinella*. The dorsal, anal and caudal fins begin to be differentiated and the characteristic oblique line of chromatophores on the ventral lobe of the caudal fin is already indicated. Pectoral fins are present, but there is, of course, no indication of the pelvic fins. The tail is still about $\frac{1}{4}$ the total length.

The 5 millimetres stage shews little change. The tail is contained $3\frac{1}{2}$ times in the total length. The fins are more strongly developed.

From this stage to the 25 millimetres stage, *see* Fage in the Report of the Danish Oceanographical Expeditions, 1908–1910, No. 6, Vol. II, A9, 1920.

It is important to consider the degree of development of the various organs at different sizes, since this often forms a useful basis for the differentiation of species.

Differentiation of the Gut.

Mr. Russell's youngest specimen, which is well preserved, stained and mounted permanently, measures 3 millimetres and it would appear from its contour that little or no shrinkage occurred by fixation. This specimen is labelled " Anchovy " and was killed two days after capture. It must have been captured as an egg, and since the egg of the anchovy is very characteristic, no mistake is likely to have been

made in its identification; further the larva has the characteristics of the larva of *Engraulis encrasicholus* by having a comparatively long tail and the remains of the yolk sac elongated. In this specimen there is no differentiation of the gut, which is a uniformly straight tube.

But the youngest does not appear to be the smallest. The smallest of the collection is 2·1 millimetres long exclusive of the caudal fin. This is, however, a specimen which has suffered crushing badly and which also shews signs of shrinkage, a point which is confirmed by the fact that the limit if the head is well defined, a feature absent in the well preserved 3 millimetres specimen. It is therefore just possible that it was, when alive, at least 5 millimetres long over all. The interesting thing about the specimen is that it has no trace of yolk and that the gut is certainly differentiated into anterior smooth and posterior folded portions. Thus one would be safe in stating that in *Engraulis encrasicholus* the 3 millimetres stage shews the last trace of yolk and that on absorption of the yolk, differentiation of the gut tract occurs. It is interesting to note that Raffaele figures the anchovy on the absorption of the yolk and indicates the differentiation of the gut.

Well preserved specimens of 3·7 millimetres length shew the gut to be very clearly differentiated with a trace of digestive gland immediately anterior to the pylorus. At 4·2 millimetres differentiation of the gut and the presence of the digestive gland are thoroughly established.

Fins.

Even the youngest specimen of *Engraulis encrasicholus* shews the pectoral fin. It is not until the creature has attained 4·2 millimetres in length that the median fins are indicated. At 4·2 millimetres a thickening in the fin fold is shewn in all the median fin positions, the dorsal, anal and caudal, but as yet no radial elements can be made out. One specimen measuring 4·4 millimetres actually shews less development of these fin supports than the 4·2 millimetres one and only the smallest trace is shewn. This slight difference may be individual or the two specimens in question may have shrunk to a different degree; indeed the 4·2 millimetres one has curved somewhat during fixation, whereas the 4·4 millimetres specimen has remained quite straight.

At 5 millimetres exclusive of the caudal fin, a distinct advance is to be noted. The radial elements have appeared both in the dorsal and anal fins, though as yet not in the caudal. In the dorsal fin 7 elements can be counted and in the anal 6. A specimen measuring 6 millimetres exclusive of the caudal fin, shews 10 radials in the dorsal

fin and 8 in the anal ; the hypural elements are also laid down. Fage's figure of a 6 millimetres specimen shews little detail of this kind, but nevertheless the dorsal fin is, at any rate, shewn as a differentiation in the fin fold. At 7·8 millimetres the dorsal fin still has 10 radials but the anal has up to 12. (*See* Figures 10 to 15.)

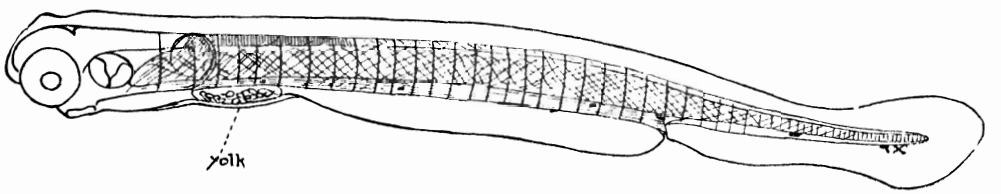

FIG. 10.—Engraulis encrasicholus 3 mm. x 45
Russell's Collection Anchovy St. 45 26/6/23 Killed 9 a.m. 28/6/23

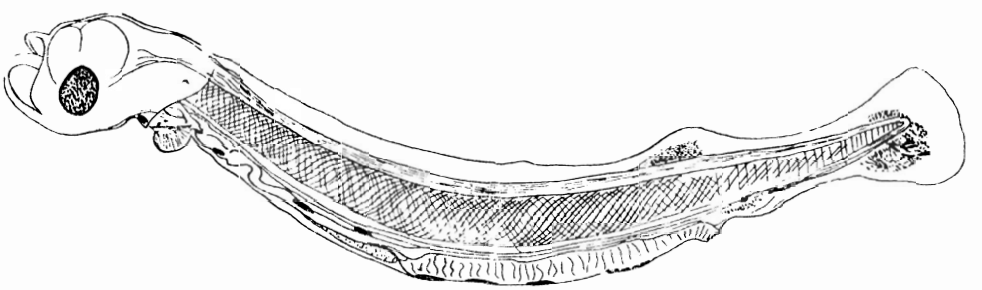

FIG. 11.—Engraulis encrasicholus 4·2 mm. x 29

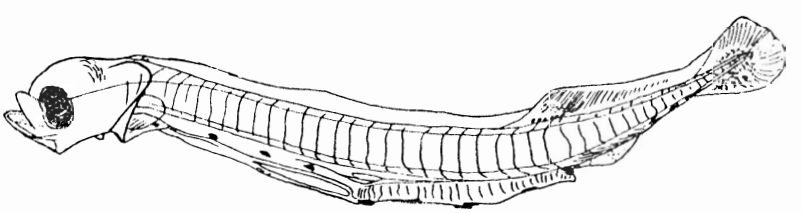

FIG. 12.—Engraulis encrasicholus 5 mm. x 21

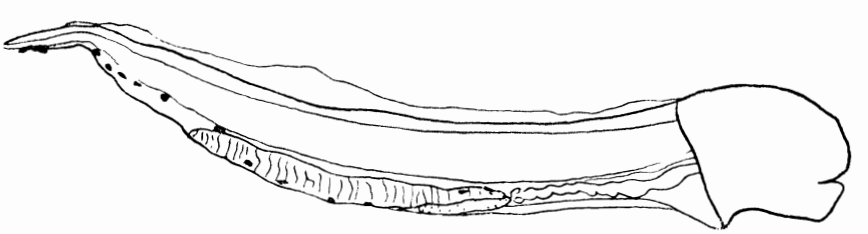

FIG. 13.—Engraulis encrasicholus (Badly crushed) 2·17 mm. 53

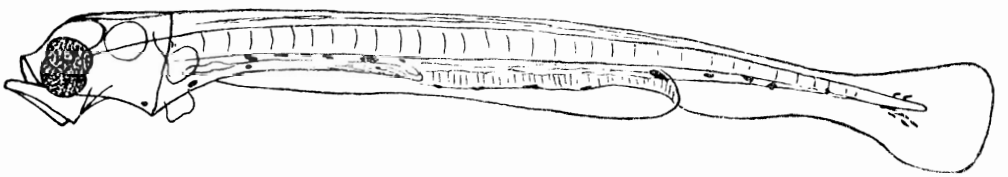

FIG. 14.—Engraulis encrasicholus 3·7 mm. x 35

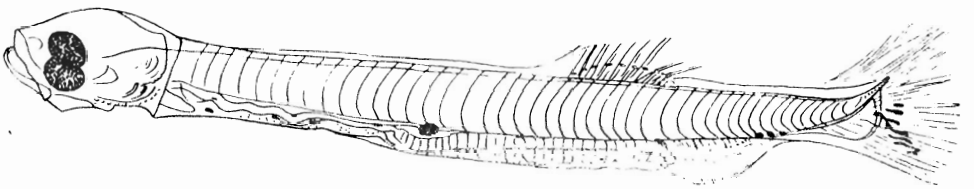

FIG. 15.—Engraulis encrasicholus 7·8 mm. x 16

Pleuronectids

On October 28, the collection from 3 miles North of Agami Point contained one Pleuronectid egg which hatched out in the laboratory.

The egg measured 1·38 millimetres in diameter and contained a fairly well developed embryo. The perivitelline space was comparatively small, the yolk nearly filling the egg. Stellate black chromatophores were distributed throughout the yolk and numerous oil globules were present distributed evenly over the yolk except at one place where there was some approach to bunching. The embryo was rather thinly pigmented with small black pigment spots, more numerous on the head, fin fold and caudal region.

The larva hatched on October 31 and measured 3·3 millimetres in length. It had a large spherical yolk sac having the oil globules gathered together at the antero-dorsal side. The fin-fold was wide; the pectoral fin was prominent and shewed a network of blood vessels plainly; and the rectal end of the gut was a little removed from the yolk sac. The whole of the body and fins were heavily pigmented in black and yellow, the latter being predominant by far and appearing white by reflected light. The pigment was evenly distributed except at the caudal extremity which was almost free from pigment.

On November 2, the place previously occupied by the yolk sac now shewed the gut with a single loop and with constrictions. The oil globules were reduced to 4 or 5 bright yellow globules adhering together just anterior to the gut and posterior to the heart. The

pigmentation remained pretty well as in the 3·3 millimetres stage though there was a tendency to concentration of the pigment in the median fin-fold away from the body, and a slightly heavier pigmentation dorsally and ventrally on the body. The larva now measured 3·8 millimetres in length.

At 4 millimetres on November 4, little further change had occurred. The pectorals were quite large ; the gut more expanded and divisible into stomach, small intestine and rectum, the rectum being considerably wider than the small intestine and marked off from it by a definite constriction. The limits of the head were marked by the appearance of the operculum (which was actually present on the previous day), which shewed a sharp angle just behind the heart. The remains of the oil globules still persisted.

The larva lived on until November 5 when it appeared to shew signs of lessened vitality, and was fixed in sublimate. Later, in an attempt to examine it under slight pressure (since the pectorals were projecting at right angles and made drawing in side view possible) the larva was unfortunately lost.

There is little doubt that this specimen corresponds to Raffaele's " Species 1 (? *Solea*) " which it resembled in all details. The egg was slightly smaller than Raffaele's specimen which was 1·4 millimetres. However, since the species of Pleuronectids have not, as yet, been worked out for the Alexandria district, nothing more definite can be asserted than that this egg and larva belonged to a species of *Solea*.

The specimen differs from one specimen recorded by Mr. Russell and regarded by him as *Solea vulgaris*, though Mr. Russell's specimen " shewed marked differences from the usual type of egg of *Solea*." It was also smaller ; it was also smaller than the species under consideration and measured 0·9 millimetre to 1·04 millimetre in diameter ; pigmentation was different and the oil globules shewed no signs of concentration.

It was also different from another species recorded by Mr. Russell, the egg and larva of which he regarded as possibly belonging to *Solea lascaris*. The egg in this case was 1·04 millimetre in diameter ; the larva was differently pigmented and had a hooded projection in the fin fold above the head.

A third species of Pleuronectid larva figured by Mr. Russell shewed still another type with totally different pigmentation.

We have therefore at least four different kinds of Pleuronectid larvae recorded from this district, and since the type of fish is comparatively easy to rear from the egg, when facilities for rearing are available, the group should be cleared up without much difficulty. (*See* Figures 16–19.)

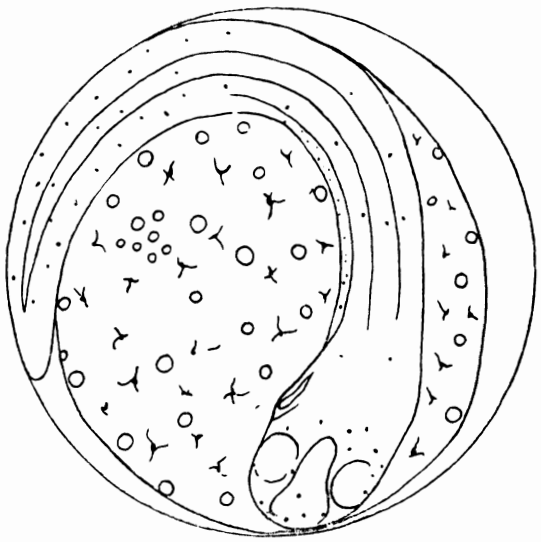

FIG. 16.—Pleuronectid x 53 voyage XV 28/10/31.

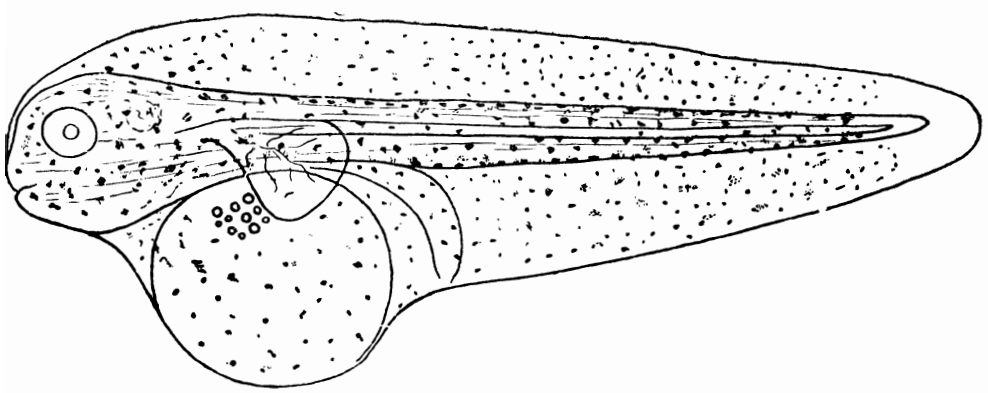

FIG 17.—Pleuronectid 3·3 mm.
Voyage XV Egg. 28/10/31 Hatched 31/10/31.

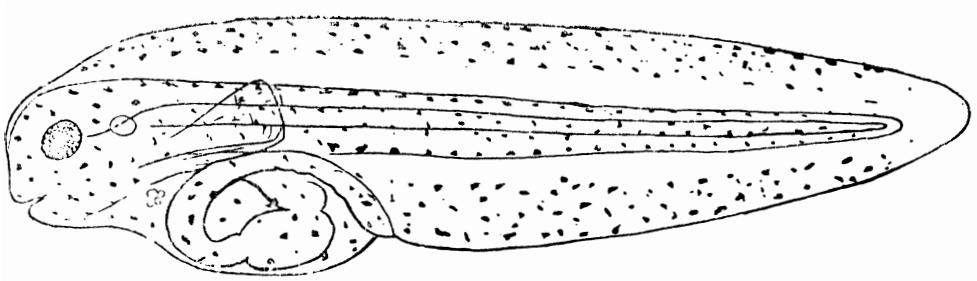

FIG. 18.—3·8 mm. Voyage XV 28/10/31.

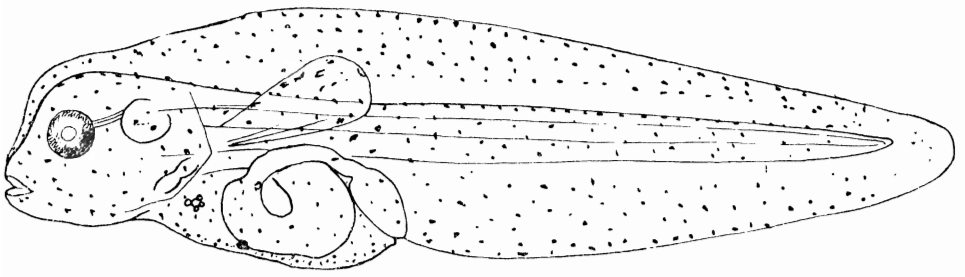

FIG. 19.—Solea (?) 4 mm.
(Voyage XV 28/10/31) Drawn 4/11/31.

Brama raji, Bl.

As regards the records of this species in the Mediterranean, Schmidt remarks (Rep. Dan. Ocean. Exped. 1908–1910, Vol. II, No. 4, A6, 1918) that it is of fairly common occurrence. Except for Lo Bianco's statement (Mitth. Zool. Stat. Neapel, Band 19, 1908–9) that specimens 15 millimetres to 30 millimetres occur occasionally in the Bay of Naples, Schmidt says he is not aware of the discovery of young pelagic stages. In 1928, Sanzo published, in the R. Comitato Talassografico Italiano, Memoria CXLVII, a fairly complete account of the development of this species from the egg to the post-larval stage.

Schmidt concluded that " the occurrence of such tiny stages right out in the central parts of the Mediterranean places it beyond doubt that they must have commenced life there and that *Brama raji* which is so widely distributed in the temperate and tropical parts of the Atlantic also spawns in the arm of that ocean which forms the Mediterranean Sea." He concludes that the species breeds in summer, which agrees with Lo Bianco's statement that young stages were found from October to December in the Bay of Naples.

Sanzo puts the time of sexual maturity as July to August. The egg was, however, discovered here, off Alexandria on December 3. Only a single specimen was taken, but it was unmistakably that of *Brama raji*. My own figure was drawn from the living egg and for several days it remained unidentified. Reference, however, to Sanzo's work disclosed the identity, for the resemblance between my own and Sanzo's figures is identical.

The egg was 1·5 millimetres in diameter with an oil globule of 0·38 millimetre diameter. The embryo was already well developed and coiled a little more than once round the egg. The most striking feature about the egg is the large stellate black chromatophores about the head, the pectoral fins, the yolk and the oil globule. Yellow chromatophores accompany the black and also appear in three

prominent patches on the trunk, that towards the end of the tail being broken up into several component parts. The pectoral fins moved vigorously while the embryo was still in the egg, and the jaws opened and shut periodically.

Two days later, December 5, the egg shewed a great increase in the black pigment in the head region, so much so that all detail was masked. At the sides of the black mass the pectoral fins were to be seen vibrating vigorously.

Before being able to make a second figure of the egg, an interruption necessitated placing the egg in the cylinder of water temporarily. On returning to the work an hour later, no trace of the egg was to be found; it seemed to have disappeared mysteriously and the only explanation that can be offered is that the egg became caught in the crevices of the cork in the centre of the plunger and thus perished. Thus, unfortunately, no further record was possible. (*See* Figure 20.)

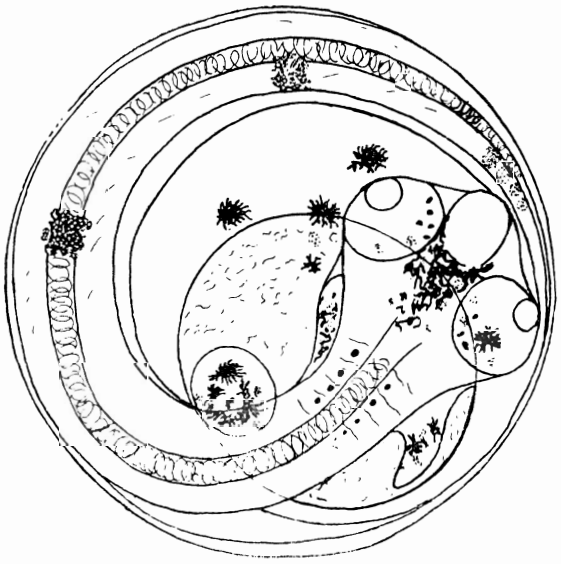

FIG. 20.—Brama raji 1·50 mm. x 52 diameters
No. 1. XVIII 3/12/31.

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