FISH EGGS AND LARVAE FROM THE JAVA SEA.

By

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8. Dorosoma chacunda (H. B.).

The s ĕ l a n g e t, *Dorosoma chacunda,* is a small clupeid to be obtained almost daily at the fish-market of Batavia. It occurs quite near the shore, in water only a few fathoms deep. When there is no moon out the Bantam fishermen come to the Bay of Batavia to fish for s ĕ l a n g e t at night with the p u k a t, a kind of seine made of yarn, which is set out and hauled in from a boat near the shore. This p u k a t has a depth of 5 fathoms and is used in water of this depth. The fishes get entangled with their heads in the meshes in the same way as is the case with the European herring seine. Besides s ĕ l a n g e t also k e m b u n g p ĕ r a m p u a n (*Scomber neglectus* Van Kampen) and a few m a t a b ĕ l o *(Clupea kanagurta)* and p ĕ p e r-r e k (*Equula* a.o.) are caught in this way. When the moon begins to wax the Bantam fishermen go home again.

As is the case with several fishes we may sometimes notice a sudden and strong increase of the quantity of s ĕ l a n g e t landed at the Pasar ikan, due to the sudden appearance of shoals of these fishes along the coast. Besides p u k a t s also a few casting nets (j a l a s ĕ l a n g e t) are as a rule in action on such occasions. After a few days or a week these shoals have disappeared again.

Such an opportunity was seized by me to find the eggs of the s ĕ l a n g e t. After having ascertained the night before, where exactly s ĕ l a n g e t had been caught in great quantity, — it was at the Muara Angke between the s e r o's (native fish traps), quite near Batavia — I went there early the next morning (March 11, 1924) with the motorboat and made a few hauls with a small egg-net.

The water had a salinity of 29%. The catches contained a considerable number of a small pelagic egg which, by the segmented yolk, might be recognized at once as belonging to a clupeid. The diameter of the egg membrane varies between 0,77 and 0,82 mm., that of the egg itself between 0,65 and 0,69 mm., the egg membrane being fairly wide. The yolk is coarsely segmented, containing large vacuoles and further a varying number, from 3 to 20, of small colourless oil-globules, distributed over the ventral surface.

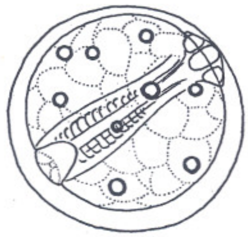

Fig. 1. Pelagic egg at 9.30 a.m., after life, × 39.

I had found this egg before and have found it afterwards on several occasions. A good many of them f.i. had been fished near Labuan in Strait Sunda on September 9th, 1923, and following days, when a stiff breeze was blowing from the Peperbaai (Pepper-bay). The salinity there was 33%.

Early in the morning the egg contains the rudiment of the embryo and the stage of development of the latter makes me suggest that the eggs were discharged in the evening or the first hours of the night, as is the case with the l a j a n g, the k e m b u n g and probably with many other fishes.

In the course of the morning thin black pigment spots appear, scattered over the dorsal side. Between 4 and 5.30 p.m. the larvae hatch. Evidently the incubation period, then, has not lasted longer than 20 hours.

The larva corresponds wholly to the clupeid type, as shown especially by the considerable number of mytomes and the backward situation of the anus (fig. 2). Shortly after hatching the larva undergoes the usual stretching and lengthening and the next morning it presents the aspect shown in fig. 3. The oil-globules are decreasing in size and in the course of the morning they disappear altogether.

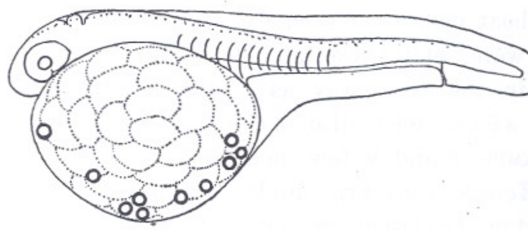

Fig. 2. Newly hatched larva (4 p.m.), × 39.

In front of the anus 33 or 34 myotomes could be counted in this and in slightly older stages, and in the tail some 7 or 8, including the unsegmented terminal part of the mesoderm.

In the adult *Dorosoma chacunda* I found for the number of vertebrae

$$26 + 15 = 41$$
$$25 + 16 = 41$$
$$25 + 16 = 41$$

Now in former articles we have seen that a very characteristic phenomenon during the development of clupeid larvae is the forward movement of the anus, by which the number of trunk myotomes decreases and that of the tail myotomes increases correspondingly. Thus the number of trunk myotomes in the larva is always considerably higher than the number of trunk vertebrae in the adult. This is shown by the following examples in which at the left are given the number of vertebrae in the adult and at the right the number of myotomes in the larva, as a result of investigations which are partly still to be published.

	larva
Elops hawaiensis	
46 + 21	59 + 7—8
Chirocentrus dorab	
44 + 29	54—57 + 17—18
Megalops cyprinoides	
38 + 30	51 + 18
Dussumieria acuta	
40 + 16	50 + 10—11
Clupea spp.	
26—32 + 14—16	37—40 + 4—6 ?
Engraulis mystax	
20 + 25	29—30 + 16
Stolephorus spp.	
19—22 + 19—21	24—28 + ... (1)

Our results regarding *Dorosoma chacunda* fit in very well:

Dorosoma chacunda	
25 + 16	34 + 7—8

Here also a decrease of the number of trunk myotomes and a corresponding increase of the number of tail myotomes may be noticed during development.

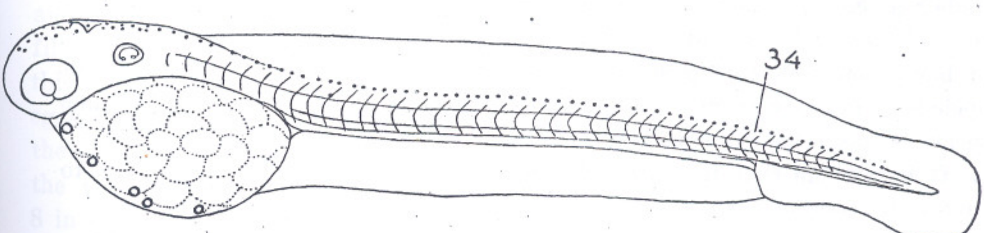

Fig. 3. Larva of the morning of the day after hatching, × 39.

In the stage represented in fig. 3 which is of the morning of the day after hatching we find the black pigment spots all situated dorsally, partly in a continuous row along the dorsal edge of the myotomes.

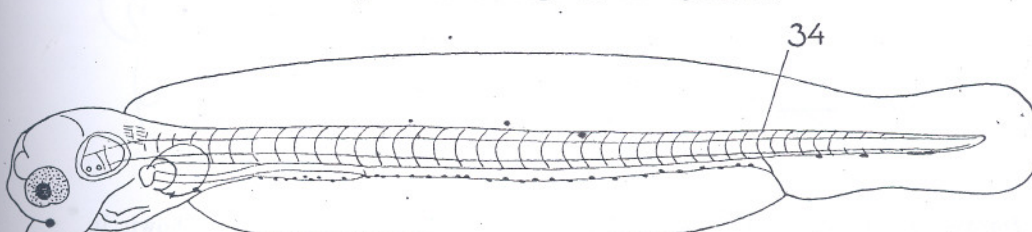

Fig. 4. Larva at noon of the second day after hatching, × 39.

On the third day, however, we find the pigment spots arranged ventrally along the gut and the same remains the case on the fourth and the fifth day. I have not succeeded in rearing up the larvae any further.

(1) The number of tail myotomes is left open, being very variable and indefinite.

In the evening of the day after hatching the eyes begin to get dark and the next morning they have become quite black. The yolk has been resorbed then and the pectoral fins have appeared. Their first rudiment was visible as a small prominence at noon of the day after hatching, at the limit of the second and the third myotome (with *Chirocentrus dorab,* where the number of myotomes is much larger, we have seen it appear between the third and the fourth myotome).

In larvae of the second day after hatching the situation of the lateral line organs, appearing as little knobs, could sometimes be observed very distinctly. As I could state in more fish larvae, they show no strictly metamerical arrangement, their number being much smaller than that of the myotomes. Their situation, however, is always at the limit of two myotomes. Thus in a sĕlangĕt-larva of two days a lateral organ was present at the limit of the 8th and the 9th, of the 9th and the 10th, of the 12th and the 13th, of the 13th and the 14th, of the 18th and the 19th, of the 23rd and the 24th, of the 32nd and the 33rd and, on the tail, of the 39th and 40th myotome, making 7 in all.

Regarding the further development of the sĕlanget-larvae I cannot give reliable data, but propably it would offer nothing particular. A great number of clupeid larvae are to be found in the catches, but the number of species being so large and the number of trunk myotomes, as we have seen, not being constant during successive stages of development, it seems almost hopeless to identify them. They all, however, present more or less the same aspect, as has been described in the foregoing article of this series.

It is possible that the larva shown in fig. 5, length 7,4 mm, belongs to

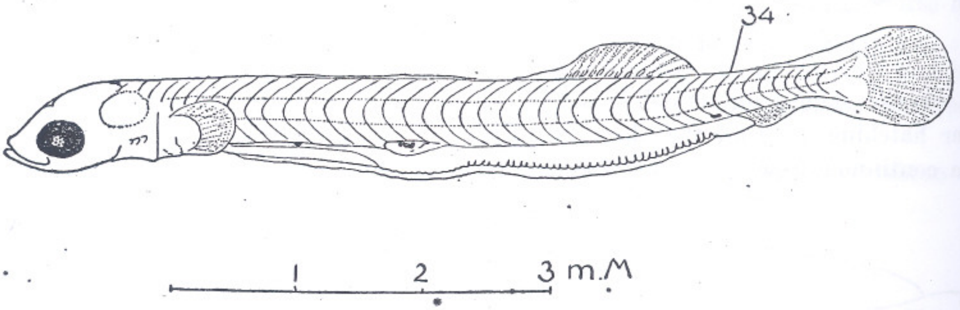

Fig. 5. Planktonic larva, length 7.4 mm.

Dorosoma chacunda. It is slightly smaller than the Clupeid larva shown in fig. 28 of my former article (cf. Treubia p. 235). Nevertheless it is in a more advanced stage of development, as shown by a comparison of the tail and of the gut which shows clearly the beginning of the transverse folding so characteristic of somewhat older clupeid larvae. Evidently, then, it belongs to a smaller species. Only the number of trunk myotomes, 34, is perhaps slightly higher than one might expect in this stage. The larva shown here was caught on March 1, 1922, north of Pasilean, at 5° 57⅔′ S 106° 29½′ E, salinity of the water 32,7%. Similar larvae were found on other occasions, e.g. near Labuan in September 1923.

Besides *Dorosoma chacunda* there is another, larger, species, *Dorosoma nasus*. This species, however, seems to be very rare in the Dutch East Indies. I never saw it at the fish-market of Batavia. The Amsterdam Museum possesses only one small sample from Queensland, the Leiden Museum only 6 specimens, viz. one from New Guinea, one from Bombay, and 4 gathered by BLEEKER from different places in the Archipelago, among which one specimen of 220 mm, a length never reached by *Dorosoma chacunda*.

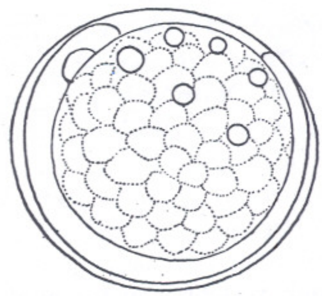

Fig. 6. Pelagic egg of the second species, at 7 a.m. × 39.

Now, together with the sĕlangĕt-eggs, I found near Labuan on September 19, 1923, but a few hours earlier in the morning, viz. between 6 and 6.30 a.m., and also quite near the coast, a number of eggs showing a certain resemblance to the sĕlangĕt-eggs. They had the typical segmented yolk of clupeid eggs and contained some 6—12 small oil-globules. The diameter of the egg-membrane was larger, viz. about 1 mm., and the egg-membrane itself was more completely filled up by the egg. By the latter characteristic this egg deviates from the type of the *Clupea*-eggs, still recognizable, though less distinct, in the sĕlangĕt-egg. The larva hatching from this egg, however, matched the *Clupea*-larvae perfectly, having 37 trunk myotomes, followed by some 8 in the tail.

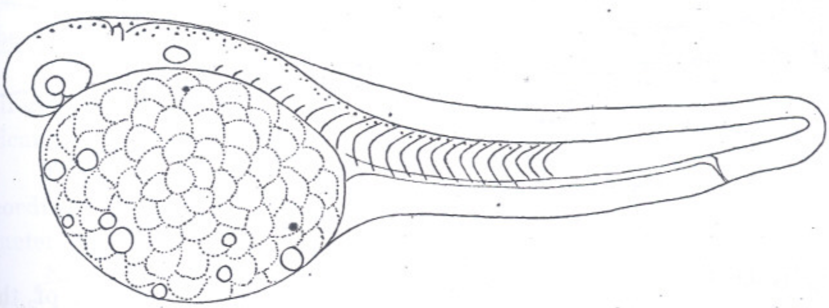

Fig. 7. Newly hatched larva, (1 p.m.), × 39.

The resemblance of the egg to that of the sĕlangĕt suggested to me the possibility that it might belong to *Dorosoma nasus*. Having no opportunity to determine the number of vertebrae in this species, I asked once more for the help of Dr. DE BEAUFORT, of Amsterdam, who again kindly provided me with a Röntgen-foto of the only specimen present in the Amsterdam Zoological Museum. From this foto the number of vertebrae could be determined with fair accuracy. I found 27 + 16 = 43, thus slightly more than in *Dorosoma chacunda*. This result seems not incompatible with the supposition that our egg belongs to *Dorosoma nasus,* although the difference between the numbers of trunk myotomes in the larvae of the two species (34 and 37 resp.) would be slightly greater than that between the numbers of

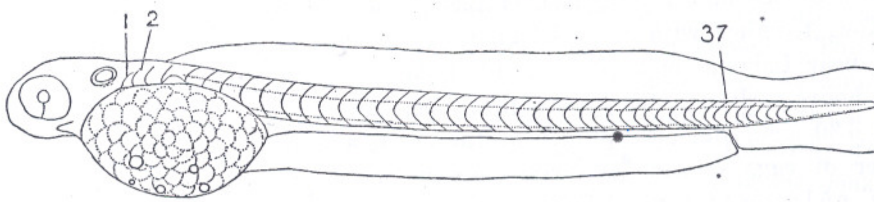

Fig. 8. Larva at 8.30 p.m., × 26.

trunk vertebrae in the adult ones (25—26 and 27 resp.). It is to be hoped that further researches will throw more light on this question.

A short account of my observations on the last mentioned egg follows here. They were fished in great number between 6—6.30 a.m. Fig. 6 represents an egg at 7 a.m., showing a young embryo. They hatched in the

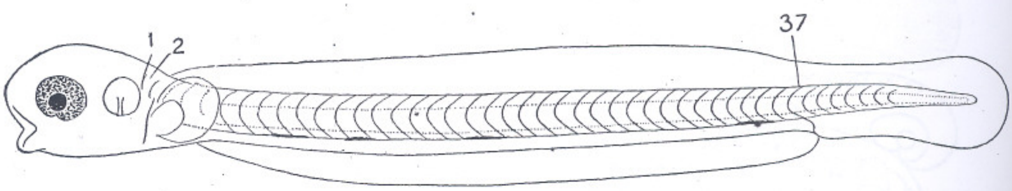

Fig. 9. Larva of the second day after hatching, × 26.

afternoon, from 1 p.m. on. Fig. 8 represents a larva at 8.30 p.m. of the same day. In the evening of the next day the eyes began to get dark and the next morning they were black, in the same way as with the s ĕ l a n g ĕ t. The eggs of the latter, however, hatched later, viz. about 4—5 p.m. of the first day. Thus development seems to proceed somewhat slower in the larger egg, as is generally observed when comparing a larger with a related smaller egg.

9. Scomber kanagurta C. V.

In a former article of this series (1) we have seen that large shoals of lajang (*Caranx kurra*), mixed with dělěs (*Caranx macrosoma*) and sělar běntong (*Caranx crumenophthalmus*), gather round the isle of Bawean in the months of May and June, and that the eggs of these three species are found in considerable quantity among the surface plankton. Together with the three fish species mentioned above a fourth is caught regularly and in considerable numbers. It is the banjar or kěmbung lelaki (*Scomber kanagurta*), a pelagic fish which is very common in the Indian seas and of great importance for the fisheries.

Together with the eggs of the three sělar species a fourth kind of egg was found regularly and abundantly in the surface catches with the egg-net. And as the banjar caught there are all full-grown and ripe specimens and as I have found the same eggs often in other places where hardly anything but banjar was caught by the fishermen — e.g. in the Sunda Strait — the conclusion seems warranted that we are here dealing with the eggs of the kembung lelaki. And this the more so, since the characteristics of the egg tally quite well with those of the egg of its larger Atlantic relative the mackerel, *Scomber scombrus,* and of *Scomberomorus maculatus* (*Cybium maculatum),* the so called Spanish mackerel.

The eggs and larvae of the former species have been studied and figured by several investigators for which I refer to EHRENBAUM's Eier und Larven von Fischen, in "Nordisches Plankton", and especially to his recent publication "Über die Makrele" (Wissenschaftliche Meeresuntersuchungen N.F. Bd. 15, 1923). The diameter of the egg varies in the southern part of the North Sea from 1,0 to 1,38 mm., the average decreasing gradually from 1,276 in the end of May to 1,1 in the middle of July. In the Mediterranean the diameter seems to be less, according to HOLT 0,86—1,04 mm. Along the American coast the eggs seem to have the same diameter as in European waters.

The egg is furthermore characterized by the presence of a relatively large oil-globule, with a diameter of 0,25—0,35 mm. in the North Sea and in American waters, and of 0,20—0,22 mm. in the Mediterranean.

The egg of the Spanish mackerel (*Scomberomorus maculatus*) has, according to RYDER (2), a diameter varying from 1,02 to 1,27 mm. The diameter of the oil-globule is about 0,25 mm., judging from RYDER's figures.

Now the diameter of the egg of the kembung lelaki, varies from 0.85 to 0,95 mm. The oil-globule, which is nearly colourless, has a diameter

(1) cf. page 199.

(2) J. A. RYDER, 1882, Development of the Spanish Mackerel *(Cybium maculatum),* in Bulletin U. S. Fish Commission, Vol I.

of about 0,21—0,24 mm. The yolk is not segmented, unlike to what we find with *Caranx*-eggs. All this corresponds very well with what we know about the eggs of other Scombridae.

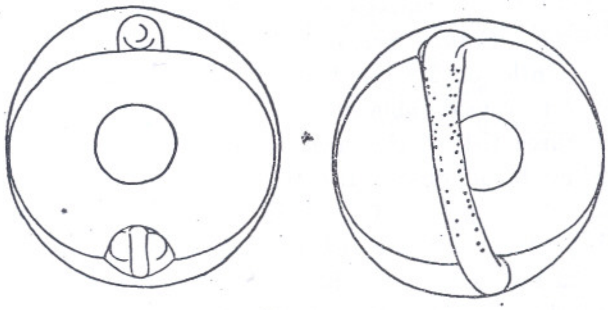

Fig. 1 and 2. Egg at 1 p.m., × 40.

It is interesting to quote here the following statement made by HEINCKE and EHRENBAUM (1), viz. that "wiederholt die *Caranx*-Eier gleichzeitig mit denen von *Mullus* und von *Scomber* gefangen werden". In the same way we find the *Caranx* and *Scomber* eggs often mixed together in Indian waters.

We have seen that the eggs of the lajang are discharged in the forenight, before midnight. The same is the case with the kembung. The eggs fished early in the morning contain the rudiment of the embryo. In a catch made at midnight (north of Bawean, June 3rd—4th, 1920) the eggs all showed a germinal disc, just like the lajang-eggs (cf. nr. 5 of this series).

Near Bawean as well as in Sunda Strait I found the eggs in water with a salinity varying from 31% to 32%. Regarding the European mackerel EHRENBAUM (1923, p. 6) says:

„Von vielen Autoren ist der Versuch gemacht worden, die Abhängigkeit „des Laichens von bestimmten Bedingungen der Temperatur und des Salz- „gehalts nachzuweisen; indessen kann dieser Nachweis doch nicht als gelungen „betrachtet werden .... Doch kann man wohl ganz allgemein behaupten, „dass die Makrelen — auf der europäischen wie auf der amerikanischen „Seite — zum Laichen vielfach kühleres und schwächer salziges Wasser auf- „suchen, als sie bis zum Eintritt der Laichzeit bewohnten".

As stated in my lajang-article the salinity near Bawean indeed reaches a minimum in the months when the lajang and the kembung gather there for spawning. On the other hand I found the *Scomber*-eggs in October 1924 in Strait Madura in water with a salinity of 34,25% ! In the middle of the Strait the water indeed had a still higher salinity, viz. 34,56% and it was only when approaching Surabaya, where the salinity decreases consi-

(1) FR. HEINCKE and E. EHRENBAUM, 1900, Eier und Larven von Fischen der Deutschen Bucht, in: Wissenschaftliche Meeresuntersuchungen, Abt. Helgoland, III, p. 278.

derably, that I suddenly found the eggs, and in abundance, together with a considerable quantity of other eggs, viz. those of *Dussumieria* (cf. nr. 4 of this series), *Stolephorus indicus* and several species of *Caranx.*

My impression, therefore, is that the favourite spawning-places of these pelagic fishes are those where the ocean water with its high salinity and the coast water with its low salinity meet and where, therefore, the salinity begins to decrease but the pollution and troubledness of the coast water does not yet hinder the fishes. It is possible that also the depth of the water is of importance, too shallow places being avoided. EHRENBAUM (l.c. p. 6) quotes European and American authors who contend that the mackerel at the time of spawning goes into deeper water-layers where the eggs are evidently discharged.

A characteristic feature of the kembung eggs is that they are fairly difficult to hatch. When isolated in a glass with clear sea water a good many of them die in the course of the day and sink to the bottom, becoming opaque. As a rule only a few hatch. This occurs in the course of the evening, between 4 and 6 p.m.

So the hatching of the eggs takes less than 24 hours. For the sake of comparison it may be mentioned here that CUNNINGHAM (Journal Marine Biological Association I, p. 31) found that the eggs of the mackerel hatched after 6 days only. MOORE found for the American mackerel 5 days, at an average temperature of 13° C. (U.S. Fish Commission Report, pt. 24, 1899).

Pigment has already appeared within the egg. There are two kinds, black and yellow. Small black pigment spots are found at an early stage scattered all over the body of the embryo and a few are found on the surface of the yolk. The yellow pigment which appears slightly later consists of groups of small granules. It is absolutely opaque, and, when the light falls upon it, very bright. At 1.30 p.m. I found a pair of yellow pigment spots close behind the eyes, another pair a slight distance behind the otocysts, about the anterior myotomes, a third pair near the anus and one more about the middle of the tail. An unpaired spot is found on the nose and one more on the oil-globule. The same arrangement of the yellow pigment is observed in newly hatched larvae.

In specimens conserved in formaldehyd-seawater, like the one represented in fig. 3, this yellow pigment has faded and only the black pigment is

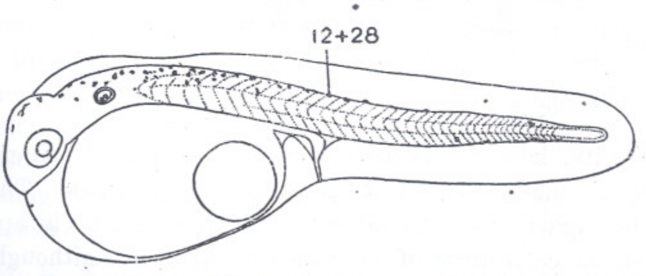

Fig. 3. Newly hatched larva, × 40.

obvious. The oil-globule is situated in the posterior part of the yolk. At the usual distance behind the auditory vesicle the series of myotomes begins. The number of myotomes in front of the anus varied from 10 to 12, as a rule 10, whereas behind the anus some 30 could be counted. In somewhat older larvae, like those represented in figs. 4—6, I never found more than 10 trunk myotomes, whereas the number of tail myotomes varied from 30 to 32 (incl. the terminal unsegmented part of the mesoderm).

For the number of vertebrae of *Scomber kanagurta,* as wel as for *Scomber neglectus,* I found 13 + 18 = 31

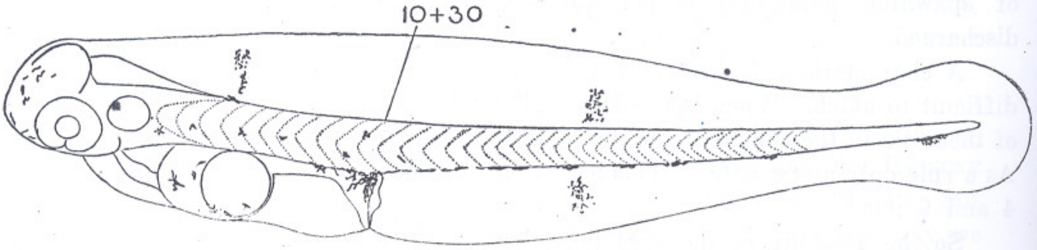

Fig. 4. Larva of the next morning, × 40.

Thus we see that the number of myotomes of the larva tallies fairly well with that of the trunk vertebrae of the adult fish, although the latter is slightly higher. This may be accounted for by assuming that during further development the anus moves slightly backward (or the myotomes forward). In a subsequent article we will state the same phenomenon, but still more strongly pronounced, in the development of several species of *Trichiurus.* It is the reverse of what we find very generally among the larvae of clupeids (cf. nrs. 2, 4, 7 and 8 of this series, and also further articles still to be published), viz. that the anus moves forward (or the myotomes backward) during development.

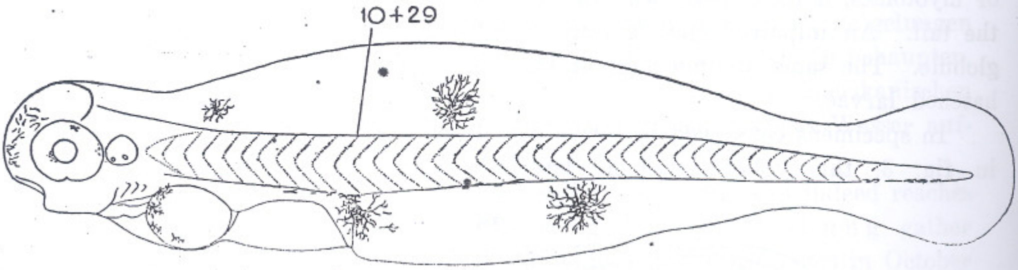

Fig. 5. Larva of the second night, × 40.

More difficulty, however, is caused by the number of tail myotomes as compared with the number of tail vertebrae of the adult fish. The former is no less than 10 higher than the latter! This incongruity is apt to throw serious doubt on the correctness of our identification. For although it is quite possible that a number of myotomes present at such early stages of development as those represented in our figures may disintegrate afterwards, yet it is a matter of fact that in the newly hatched larvae of fishes which I could study thus far, — in Clupeids e.g. — I did not find as a rule such considerable differences between the number of tail myotomes in the larva and that of the tail vertebrae in the adult. Truly, here too the former was sometimes higher than the latter.

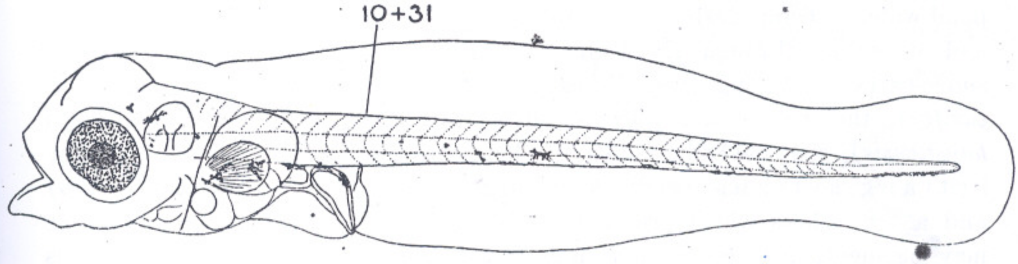

Fig. 6. Larva of the second morning, with yolk completely absorbed and eyes black, × 40.

I was, therefore, very anxious to know, how the larvae of the Atlantic mackerel behave in this respect. The number of vertebrae of *Scomber scombrus* appears to be the same as in *Scomber kanagurta* and *neglectus*, viz. $13 + 18 = 31$.

Unfortunately the investigators who have occupied themselves with the study of the eggs and larvae appear not to have paid as much attention to the exact number of myotomes in the earliest stages as would be required in view of the question that occupies us now. Numbers are not mentioned in their publications. If, however, we study their figures, we find as a rule a high number of tail myotomes. Unfortunately the figures shown by CUNNINGHAM could not be consulted by me. In HOLT's figures I find 23 (1893, fig. 3 (1)), 34 (ibid fig. 5), 27 (fig. 6) and 30 (fig. 7) myotomes in the tail. The great variation of these numbers shows that they cannot be relied upon, however carefully the figures have evidently been made. Nevertheless it is worth noticing that they are all considerably higher than the number of vertebrae in the adult fish.

I hope further investigations, in Europe also, will throw more light on this question. It is greatly to be desired that future investigators should pay more attention to the numbers of myotomes in newly hatched fish larvae.

Characteristic of the stage of fig. 5 are the four spider-like black pigment-cells on the upaired larval fin fold, two dorsal and two ventral. In the stage of fig. 4 they are developing, in that of fig. 6 they have disappeared again.

Older stages of development have not yet been studied by me so that my account must finish here.

Concerning the eggs and larvae of the so-called k e m b u n g p e r a m p u a n *(Scomber neglectus)* I have not got any data at my disposal yet.

(1) HOLT, E. W. L., 1893, On the Eggs and larval and post larval Stages of Teleosteans, in: Scientific Transact. Roy. Dublin Soc., Vol. V, 2. S.

10. On a few larvae of empang fishes.

In the year 1922 Dr. SUNIER published an interesting "Contribution to the knowledge of the natural history of the marine fish-ponds of Batavia (1). Besides the b a n d e n g *(Chanos chanos)*, which is reared in these ponds, a number of other fishes is found there more or less regularly, "the young brood penetrating from the coastal sea into the empang zone, especially when pond-water is being drained off into the sea, by swimming against the current and wriggling through the trellis work partition (k e r e h) of the little sluice-gates". Among these fishes are mentioned the k a k a p *(Lates calcarifer)*, the b e l a n a k (*Mugil* spp.), the b a n d e n g l e l a k i *(Elops hawaiensis)*, the b u l a n b u l a n *(Megalops cyprinoides)*, the k i p e r or k e t t a n g k e t t a n g *(Scatophagus argus)*, the l u n d u *(Macrones gulio)* and a few others which are found there less regularly. Among the latter may be mentioned the b a n d e n g t j u r u r u t *(Albula vulpes)* which is only rarely met with at the Pasar ikan of Batavia.

We know very little of the propagation of all these fishes. And this gap in our knowledge will be filled up only very imperfectly by the present article, the results of my observations being still quite fragmentary. However, I won't delay the publication any longer as this delay might be of long duration if we wanted to wait for more complete results.

It is a well-known fact that the b a n d e n g does not spawn in the e m p a n g s or marine fish ponds and that the latter, therefore, have to be populated every year anew with fry gathered for this purpose along the coast. Along the north coast of Krawang, e.g., we find a few small and poor villages with little or hardly any fishery, but where the gathering of b a n d e n g fry is no insignificant source of revenue. This is the case in the kampongs of Sedari, Tjimara and Soengei Boentoe. The b a n d e n g fry appears periodically, viz. first in the months of April and May and again in the months of September, October, November, the catch during the latter period being of the greatest importance.

The way in which the b a n d e n g fry is gathered has been described in detail by P. N. VAN KAMPEN (2) and, recently, by REYNTJES (3). In the shallow water quite near the coast a number of installations are made consisting of a horizontal rope floating on the surface at right angles with the shore. Into this rope trusses of rushes or alang-alang have been twined. The b a n d e n g fry gathers round these r u m p o n s (allurements) and is scooped up with a small landing net by the fishermen who wades through the water from the shore to the end of the rope and back again. Men, women and children are engaged in this business during the right season.

(1) Treubia II p. 159.

(2) De hulpmiddelen der zeevisscherij op Java en Madoera in gebruik, Batavia, 1909, p. 73, 74.

(3) REYNTJES, E. J., 1926, De vischteelt in zoutwatervijvers, in: Mededeelingen Afd. Landbouw, nr. 10.

In the village the fry is collected by Chinese traders in large pots of earthenware in which the larvae may live for a long time. Every day the water is renewed and the larvae are fed with the yellow of a cooked egg which they eat eagerly. When a sufficient quantity has been gathered, the pots with fry are loaded in a small native sailing boat and transported to Batavia or other places where empangs are found (Bantam, e.g.). The price paid for this "bibit bandeng" at Batavia fluctuates round *f* 1.— per 100.

From such a collection of bandeng fry brought to Batavia on October 4th, 1924, the larva shown in fig. 1 was taken. It has the usual appearance

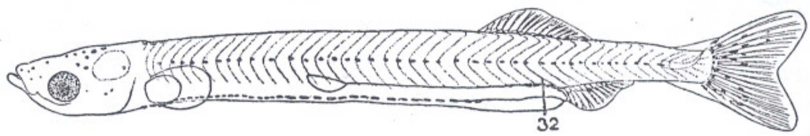

Fig. 1. Larva of *Chanos chanos* from the Pasar ikan. Length fully 13 mm.

of clupeid larvae but a point of difference is that the muscle fibres in the myotomes do not show that crossed arrangement so typical of the latter, as I have described in the article on *Chirocentrus* (1). The muscle fibres are all parallel, as is the case e.g. in eel-larvae. In front of the anus 32 myotomes can be counted, behind it some 11 or 12. In the adult bandeng the number of vertebrae is 30 + 13 (2). Series of black pigment spots are found along the lateral line and along the ventral side of the gut. The length of the larva shown is slightly more than 13 mm. and the other larvae all had about the same length.

I succeeded in rearing up a number of these larvae by feeding them with the yolk of eggs to a length of 19½ mm., which they had reached on September 11th, when they died. In a stage of 14 mm. the first rudiments of the ventral fins made their appearance, under the 20th myotome. In a stage of 16—17

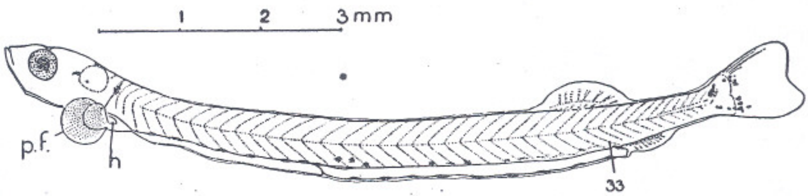

Fig. 2. Larva of 10 mm., fished January 13th, 1923, at 106° 44′ E 5° 58′ S, in a surface catch near the isle of Amsterdam (near the Bay of Batavia; salinity 32,7 ‰, depth 13—14 fathoms).

mm. these fins had developed further and the fin rays had appeared. In this stage I counted 30 myotomes in front of the anus. Evidently, then, the anus shows the same forward shifting as can be traced so regularly during the development of clupeid fishes.

(1) Treubia III, p. 40.

(2) Jordan (Fishes, I, p. 205) gives 72 vertebrae for the bandeng. This statement must evidently rest on a mistake.

The height of the larva increased gradually and as a consequence the shape of the young fish approached that of the adult form. At the same time a fine black dotting spread all over the surface of the body and the fins, being densest dorsally.

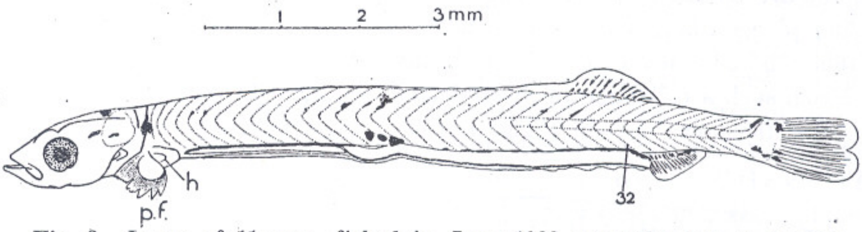

Fig. 3. Larva of 11 mm., fished in June 1922, near the isle of Bawean (north of Surabaja).

In the horizontal surface catches with the egg-net I have sometimes found younger bandeng larvae also. Figs. 4, 3 and 2 show one of nearly 12, one of 11 and one of 10 mm. resp., the first one having been caught near the isle of Sapeken, October 23, 1924 (salinity of the water 34,8°/₀₀), the second one near the isle of Bawean in June 1922 (salinity of the water 32°/₀₀), the last one near the isle of Amsterdam, 106° 44′ E 5° 58′ S, January 13th, 1923, (salinity of the water 32,7°/₀₀, depth 13—14 fathoms). These three larvae, though caught in widely separated places, form a nice series.

They are all of the clupeid type but may be distinguished at once from the larvae of *Clupea, Engraulis, Stolephorus* etc. by the parallel, not crossed, arrangement of the muscle fibres in the myotomes. In this respect they agree with the band-shaped larvae of eels and of *Albula, Elops* and *Megalops* which will be considered below (cf. p. 406). It is, however, evident that such as band-shaped stage is not passed through by the b a n d e n g.

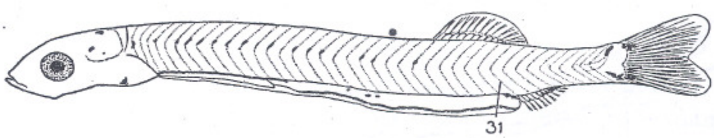

Fig. 4. Larva of nearly 12 mm., fished in October 1924, near the isle of Sapeken (east of Madura).

The number of myotomes in front of the anus is 33 in the youngest larva, 32 in the one of 11 mm. and 31 in the oldest larva. In the dorsal fin 8 fin rays can be counted in fig. 2, 11 in fig. 3, about the same number in fig. 4, and some 13 in fig. 1.

The pigmentation is subject to considerable variation. In fig. 2 we see a number of lengthened pigment spots along the upper side of the anterior part of the gut and along the ventral side of the posterior part. In fig. 3

these spots have united to a black line which we find again in fig. 4. In fig. 1, however, it seems to have broken up again into short strokes lining the ventral side of the gut not only in its posterior but also in its anterior part.

The development of the series of pigment spots present along the lateral line in the stage of fig. 1 may be traced also by comparing the figs. 2, 3 and 4. In somewhat older stages than that of fig. 1 this lateral series becomes less evident again.

I have not yet succeeded in finding younger larvae than the one represented in fig. 2.

Now what about the eggs of the b a n d e n g ? Large "b a n d e n g l a u t" (= sea bandeng) are caught now and then in the s e r o's along the coast. They may attain a length of more than 1 Meter. One of 1.12 M. and weighing 11.9 K.G. is mentioned in Dr. SUNIER's article (p. 226). The roe of this animal weighed 1304 grammes. The number of eggs making up a weight of 1 gramme was counted by me and proved to be 4370. The whole roe therefore contained about 5.700.000 eggs. This is among the highest numbers found in fishes and we may safely draw the conclusion from it that the b a n d e n g is a fish with pelagic eggs, as in fishes with demersal eggs or with some form of parental care not nearly such numbers are found.

Knowing that the b a n d e n g fry appears on the Krawang coast in the latter half of April I tried to find the eggs by making a number of short trips to this coast with the investigation-steamer "Dog" in the course of March and April. Numerous hauls with the egg-net were made, quite near the coast as well as at a more or less considerable distance from it, but all my attempts were in vain. No b a n d e n g eggs were found. It is perhaps a mere chance finding a place where a couple of b a n d e n g s have happened to spawn, much more so than to find a spawning place of fishes occurring in vast shoals.

On another occasion, however, during my numerous cruises on the Java Sea, I have once, and once only, found an egg which I believe must belong to the b a n d e n g. It was north of Surabaya, at 6° 47′ S 112° 50′ E, on September 24th, 1921. In a horizontal surface haul with the egg-net at 7 a.m. I found a.o. one single egg, with a diameter of 1,2 mm. and with a finely segmented, slightly yellowish, yolk. No oil-globules were present.

This egg hatched only the next morning at 6 a.m. The larva was of the clupeid type but somewhat stronger pigmented than is usually the case in the latter. The dorsal and the ventral fin-fold were regularly dotted with fine black dots which were absent only round the end of the tail. The next morning these black dots had changed into little stars.

The second morning at 7 a.m. the larva, old 2 × 24 hours, was fixed, in formaldehyd-seawater. It is shown in fig. 5.

The pigment spots are arranged now along the upper and the lower edge of the myotomes and a number of them is found on the dorsal unpaired fin-fold and on the ventral one behind the anus.

In front of the anus 35 myotomes may be counted which tallies exceedingly well with what we see in the older larvae described above and with what we

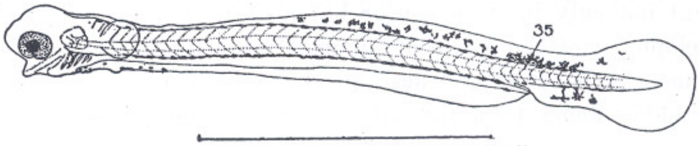

Fig. 5. Larva of 4¾ mm., 48 hours after hatching.

know about the gradual forward shifting of the anus in clupeid fishes. Behind the anus some 10 more can be counted.

A further peculiarity is that the muscle fibres in the myotomes do not show the crossed arrangement so typical of other clupeid larvae. Truly, they are not parallel either, as we have seen in the older larvae. Those of the dorsal half and those of the ventral half of the myotomes diverge more or less in caudal direction.

From all this, I believe, we may conclude that it is very probable that we are dealing with a b a n d e n g egg here. It is greatly to be regretted that I have never found more of them than this single egg of which I cannot even show a figure.

Together with the "a n a k b a n d e n g" a number of other fish larvae are caught. Among these the ribbon shaped larva described in 1908 (1) by VAN KAMPEN as being the larva of *Megalops cyprinoides* is very common. I gathered a good many of them in the hope that I might find older and younger stages among them, but they showed very little variation in size, which ranged between 25½ and 30 mm., and still less in development.

Among a number of these larvae, however, I found a few of somewhat larger size, viz. 35—37 mm., but a closer microscopical examination showed that they belonged to another species, viz. to *Elops hawaiensis,* a form which is also common in the fish-ponds.

Best known and at the same time most typical is the leptocephaloid metamorphosis of *Albula vulpes,* a form which seems to be rare in India but which abounds in the Gulf of California, where "these band-shaped young are often thrown on the beach by the waves in great masses" (cf. JORDAN and EVERMAN, Fishes of North America, p. 411). Dr. GILBERT who has discovered and identified the *Albula*-larvae in 1889 has never himself published an article on it. A series of figures in JORDAN's "Fishes" Vol. I, p. 147, which show very well the considerable decrease in size during the metamorphosis, was prepared from Dr. GILBERT's material.

A description of this larva is to be found in "Fishes of Panama" by MEEK and HILDEBRAND, published by the Field Museum of Natural History, Chicago, 1923. They write (p. 179):

"The larval form was taken on both coasts. Specimens at hand range

(1) Bulletin du Département de l'Agriculture aux Indes neerlandaises, nr. XX.

in length from 40 to 60 mm., the smallest ones being most nearly like the adult form, but they are posteriorly, at least, still much compressed. The head has assumed many of the adult characters, the snout projects notably beyond the mouth, the mouth is larger than in the adult, the maxillary reaching a little beyond anterior margin of eye. All the fins have become differentiated in the specimens at hand, but a prominent dermal fold remains in front of anal and behind pectorals. The caudal fin is well developed and broadly forked. The body at this stage is still void of pigment. The larvae of this species may be distinguished from those of *Elops* by the larger and deeper head, projecting snout, and smaller mouth''.

In the same book we find a description of the larva of *Elops affinis* of which JORDAN and EVERMAN (cf. above) stated shortly that they ''are ribbon-shaped and elongate, passing through a series of changes like those seen in *Albula*''. No reference, however, is made to any material substantiating their statement nor do they show a figure.

MEEK and HILDEBRAND (p. 176—177) write:

''There are at hand 6 specimens of the larval form of this species, all of about uniform size, being 33 mm. long. The larvae at this stage are still ribbon-shaped, but the head is much depressed and very small, the mouth is terminal or nearly so, and large, the gape reaching under middle of eye. There are sharply pointed teeth on the jaws. The caudal fin is well developed and broadly forked, the pectorals and ventrals are entirely wanting, and the dorsal and anal are just becoming differentiated, but still appear partly as mere skin-folds. The body is transparent, the only pigment spots present appearing on the caudal fin''.

Resuming, we have at our disposal the descriptions of ribbon-shaped larvae of three primitive genera of Malacopterygii, viz. *Albula, Elops* and *Megalops,* and of figures of the larvae of *Albula* (GILBERT) and *Megalops* (VAN KAMPEN). It seemed to me of interest to give once more a figure of each of the three kinds of larvae, paying special attention to the numbers of myotomes and the situation of the anus and of the dorsal and ventral fins with regard to the myotomes. For this purpose I asked the help of the Commissioner of Fisheries of the U. S. A., Mr. H. O. WALLEY, who kindly lent me a number of *Albula vulpes*-larvae, for which I am indebted also to Professor J. O. SNYDER, of Stanford University (Cal), who provided them.

I give here the figures of the three larvae which, as may be observed at once, indeed show a striking resemblance mutually as well as to the *Leptocephalus*-larvae of eels. From the latter, however, they may be distinguished at once by the development of the tail and other fins, whereas the larval dentition is less developed here.

The stage of development of the three does not differ much and may be best judged of by looking at the ventral fins. These are absent still in the larva of *Elops,* just appearing in that of *Megalops* and slightly further developed in that of *Albula.*

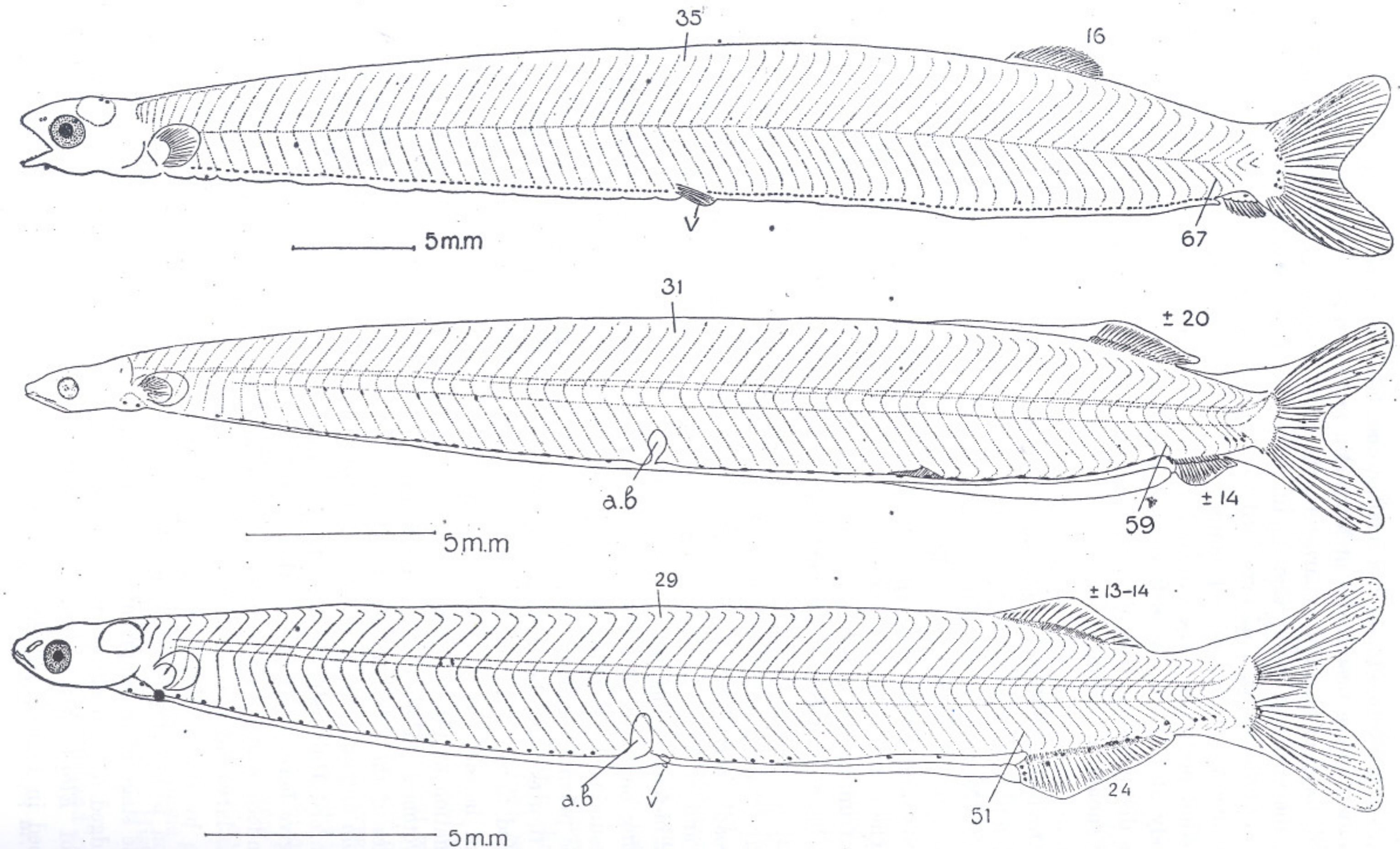

Fig. 6—8. Larva of

a. *Albula vulpes*, fished by the steamer Albatross in Conception Bay (Lower California). Length 58 mm.
b. *Elops hawaiensis*, from Krawang coast. Length 37 mm. *a. b.* air bladder.
c. *Megalops cyprinoides*, from Krawang coast. Length 29 mm.

According to the size we may arrange the three larvae in the following series: *Albula, Elops, Megalops.* The larva of *Albula* attains a length of more than 60 mm. The largest (and evidently the youngest) one I could examine had a length of 64 mm. During the metamorphosis it decreases considerably and a young fish I examined was just half as long, viz. 32 mm.

The two larvae of *Elops hawaiensis* I could examine have a length of 35 and 37 mm. resp., and the 6 larvae of MEEK and HILDEBRAND are all about 33 mm.

The length of the numerous larvae of *Megalops* I possess varies from 25½—30 mm.

Although only a restricted number of developmental stages is known — in the latter two cases indeed only one — it seems yet fairly evident that the ribbon-shaped larva is best developed, and most like that of the eels, in *Albula*. In *Elops* and *Megalops* it seems to be less pronounced, and in *Chanos* and *Dussumieria* it has disappeared altogether, although in *Chanos*, as we have seen above, the parallel arrangement of the myotome muscles is still a point of agreement which in *Dussumieria* and in other clupeids is replaced by the crossed arrangement described in former articles. Truly, the wide mouth with the pointed larval teeth of *Dussumieria* reminds one more of the head of an eel larva than that of either *Albula, Elops, Megalops* or *Chanos.*

In yet another respect the larvae of *Albula, Elops* and *Megalops* form a series, viz. by the situation of the anus. In *Albula* it is situated nearly terminal, so much so, that in the youngest larva I could examine (that of 64 mm., mentioned above) the rudiment of the anal fin has been quite pushed up against the underside of the tail, as may still be seen, though less pronounced, in the larva represented in fig. 7. During further development the anus moves forward and the anal fin gets more room. Thus, in the larva of 64 mm. the anus was situated below myotome nr. 69, in the one represented in fig. 8 we find it beneath myotome nr. 67, in one of 50 mm. beneath myotome nr. 65 and in one of 46 mm. beneath myotome nr. 62. In the young fish after the metamorphosis, finally, I could count 57 myotomes in front of the anus. At the same rate the number of post-anal myotomes increases and the anal fin gets more room for its development and gradually moves away from the tail.

In the same way the dorsal fin moves forward during development. In the larvae of 64 mm. it begins above myotome nr. 55, in fig. 8 above myotome nr. 54, in the larva of 50 mm. above myotome nr. 51, in the one of 46 mm. above nr. 46 and in the young fish after metamorphosis above nr. 23, far in front of the ventrals. The latter are very constant in their situation. In the larvae I always found them beneath myotome nr. 35 and in the young fish after metamorphosis beneath nr. 34 or 35 which could not be made out with sufficient accuracy.

In the larva of *Elops* the anus is situated beneath myotome nr. 60 and in that of *Megalops* beneath myotome nr. 51. In the adult forms we find for the number of prae-anal vertebrae resp. 46 and 38 (1), so that a forward shifting of the anus over a distance of resp. 14 and 13 myotomes must find place. In *Albula* the number of prae-anal vertebrae is 47, so that here the anus shifts forward over a distance of more than 20 myotomes.

The rudiment of the ventral fins is found in the *Megalops*-larva beneath myotome nr. 29. In the *Elops*-larva it has not yet appeared but may be expected about myotome nr. 31, judging grom the situation of the air bladder.

Together with the *Chanos*-, *Megalops*- and *Elops*-larvae a few more kinds of larvae were caught near the kampong of Tjimara. I show here in the first place a larva which at first I was inclined to attribute to the well-known cock-up *(Lates calcarifer)*, the food-fish par excellence of the European and Chinese tables.

The cock-up lives near the shore and often ascends the rivers. The eggs are not yet known but, in the same way as with the bandeng, it may be considered probable that they are pelagic judging from their number. I examined a specimen of a length of 1,05 meter containing two not excessively developed ovaria of 200 grammes each. By counting the developing eggs in a part of one of these, I found for the total number in one ovary 3.750.000, which makes no less than 7.500.000 for the two. These were, however, the developing eggs only. They were embedded in a mass of small, undeveloped eggs of which the number was certainly ten times as large as that of the developing eggs. It is evident from this that the cock-up is an extremely prolific fish. As similar numbers of eggs are never found in fishes with parental care or demersal eggs, it is evident that the eggs of the cock-up must be pelagic.

It won't be easy, however, to find out the eggs with certainty, for the mere reason that there are such a lot of species of Percidae, whose eggs will all probably resemble each other and whose larvae have all about the same number of vertebrae and myotomes.

Only further advanced larvae, like the one of fig. 9, could probably be determined with any success by considering the number of fin rays.

In the larva of fig. 9 there could be counted 11 myotomes in front of the anus, and, in a specimen made transparent by putting it into glycerine, 13

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(1) I found for the number of vertebrae in:

Megalops cyprinoides	38 + 30 = 68.
Albula vulpes	47 + 27 = 74.
Elops hawaiensis	46 + 21 = 67.

TATE REGAN (Annals and Magazine of Natural History, III, 1909, p. 37) finds fairly considerable differences in comparing the species of the genus *Elops*,

thus for *Elops saurus* and *affinis*	78—79.
„ *lacerta*	74.
„ *hawaiensis, australis, senegalensis*	68—69.
„ *machnata*	63—64.

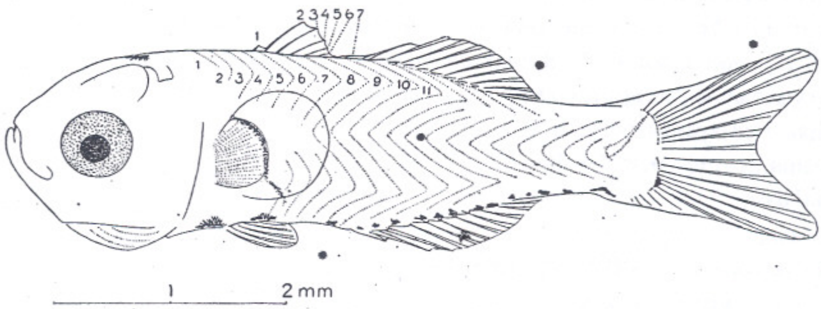

Fig. 9. Larva probably of *Ambassis*, from Tjimara, Nov. 1924.

vertebrae behind it (incl. the urostyle). For the number of vertebrae of the following empang- and shore-fishes I found:

Lates calcarifer	10 + 13
Scatophagus argus	10 + 13
Therapon jarbua	10 + 15
Gobius spec.	11 + 16
Mugil tade	11 + 13

The differences are not great and cannot be too much relied upon. However, *Gobius* may be excluded at once: in the larvae already the two ventral fins have coalesced, as will be shown below. In *Mugil*, on the other hand, the two parts of the dorsal fin are more distinctly separated from each other and the number of fin rays is nearly invariably D^1 IV D^2 I 8—9 which does not tally with what we find in the larva discussed here.

Thus there remain the two Percidae and *Scatophagus*. The latter, together with *Therapon*, however, must be excluded at once on account of the large number of bony rays in the anterior part of the dorsal fin, being 10 and 10—12 resp. In our larva we find for this number 7 which tallies quite well with what is found in *Lates calcarifer*. There is, however, one point of difference with the latter, viz. that in our larva the second fin ray is of equal length as the third one, whereas in the cock-up the third ray is the largest and the strongest, much larger than the two in front of it.

Now there is another group of shore-fishes which in the number of vertebrae and fin rays show a great similarity to the cock-up, viz. the Apogonina, including the genera *Ambassis* and *Apogon*, all small Percidae living in shoals near the shore and the river-mouths. The similarity is evident at once from the following data:

Lates calcarifer	D^1 VII—VIII	D^2 I 10—12	A III 8—9	Vertebrae 10—11 + 13
Ambassis	D^1 VII	D^2 I 9—11	A III 9—10	,, 10 + 14

The differences between these numbers are so slight that they do not allow of a reliable decision to which of the two genera our larva belongs. There are, however, a few characteristics which plead in favour of the genus *Ambassis*. These are 1o only the first spine of the dorsal fin is short, the second is of equal length as the next following (in the cock-up much shorter), 2o the tail is distinctly bi-lobed, as is the case with *Ambassis* and not with the cock-up. The genus *Apogon* must be excluded on account of the fact that the anal fin of our larva has three spines anteriorly, as is the case in *Ambassis,* whereas *Apogon* has two spines only.

It seems to me most probable, therefore, that our larva belongs to the genus *Ambassis*.

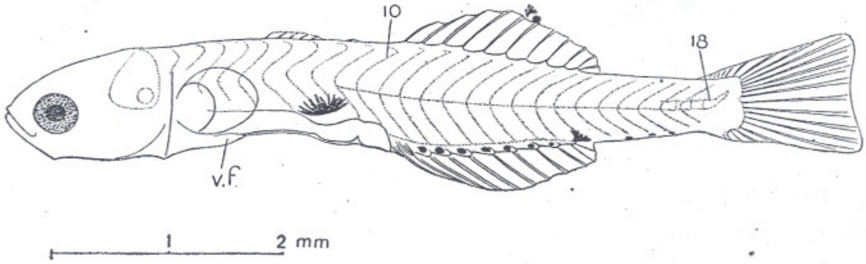

Fig. 10. Larva of *Gobius* spec., from Tjimara, November 1924. Length fully 7 mm. *v. f.* ventral fin.

Finally I show a few larvae here caught together with those described above and belonging to the genus *Gobius*. This can be deduced at once from the fact that the two ventral fins have coalesced. The shape of these larvae is much more slender than with that of fig. 9. The anterior and the posterior part of the dorsal fin are farther removed from each other . Ten myotomes can be counted in front of the anus, and some 18 vertebrae (the urostyle included) behind it. Evidently the two larvae shown here belong to two

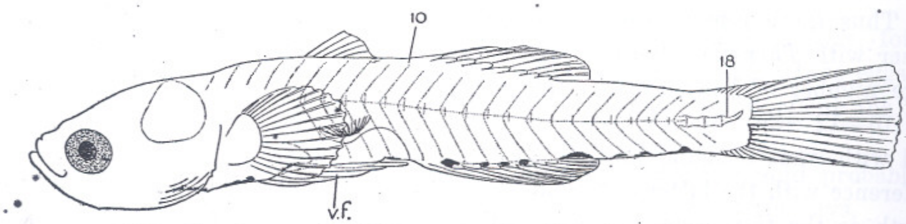

Fig. 11. Larva of *Gobius* spec., length not quite 7½ mm.

different species: they have about the same size but the fins show differences in the stage of development as well as in the numbers of fin rays. In the pigmentation there is a fair correspondence.

A large number of species of *Gobius* live along the tropical shores and in the backwaters. Along the south-coast of Java the fry is caught periodically in great quantities in the river-mouths. It forms an important part of the so-called "i m p u n" which is of no inconsiderable importance for the primitive native fishery there. Several kinds of "i m p u n" are distinguished by the fishermen but the greater part of the samples I received from the Wijnkoopsbaai and from Pagandaran (Dirk de Vries-Baai) consisted almost exclusively of *Gobius*-larvae. Each sample consisted of fishes of equal size, but in the different samples this size ranged from about 1½ c.M. up to fully 3 c.M. The latter remind one of the "teri nassi" which consists of clupeid (especially *Stolephorus-*) larvae of about the same size.

Incidentally it may be mentioned here that through the courtesy of Mr. BOOM, of Pelabuan Ratu, I also received a sample of "impun" consisting of glass-eels of *Anguilla,* which have been identified by J. SCHMIDT, of Copenhagen, as *Anguilla mauritiana.*

Judging from what we know about the eggs of European, American and Japanese gobies it seemed probable that also the Indian species would have demersal eggs of an elongated shape. On opening a few ripe specimens of *Gobius* spec. from the Batavia empangs I indeed found the eggs to be very elongated, almost tube-shaped, as is known from the above-named foreign species of this genus. These eggs are probably fastened in the same way to shells and stones.

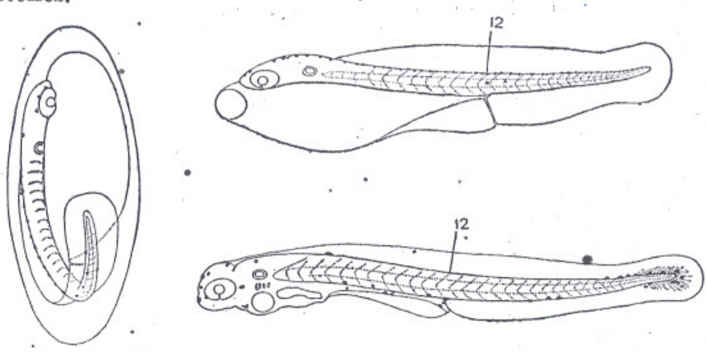

Fig. 12. Egg fished near Karimon Djawa, August 7, 1920, × 30.
Fig. 13. Newly hatched larva, × 30.
Fig. 14. Larva of 24 hours, × 30.

It seems to me the right place, however, to mention here a few kinds of pelagic eggs which I have found on several occasions in the surface catches in the Java Sea and which may also belong to gobioid fishes, although their exact origin is still obscure.

Several kinds of elongate eggs occur in the plankton of the Java Sea, nearly all belonging to species of *Stolephorus* and, perhaps, *Engraulis.* I hope to deal with these eggs in a subsequent article. They are all characterized by the segmented yolk so typical of the eggs of eel- and herring-like fishes.

The eggs to be dealt with here, however, are in the same way distinguished by their elongated shape, but the yolk is not segmented and the larvae hatching from them are different from those of herring-like fishes. This appears at once, e.g., from the more forward situation of the anus and from the different arrangement of the muscle fibres in the myotomes.

The shape of the two kinds of eggs is evident at once from the figures 12 and 15. Especially the egg represented in fig. 12 shows a close resemblance to *Stolephorus*-eggs. It was fished near Karimon Djawa, August 7, 1920 and in great numbers in the Strait between Meeuwen-island (Sunda Strait) and Java, July 24th, 1924 (salinity of the water 31,7$^0/_{00}$). The yolk in both kinds of eggs is quite transparent and colourless. In the egg of fig. 15 it always contained an oil-globule, in the one of fig. 12 the oil-globule would sometimes be absent.

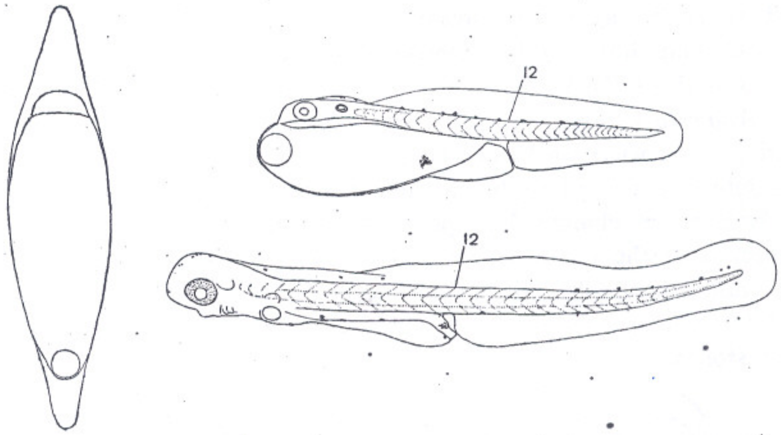

Fig. 15. Egg fished south of the Agenieten Islands, July 27th, 1921.
Fig. 16. Newly hatched larva, × 30.
Fig. 17. Larva about 48 hours old, × 30.

In the course of the morning the eggs showed a germinal disc, probably therefore spawning takes place early in the morning. The eggs hatch the next day only, early in the morning. Within the egg already black pigment dots have developed which in the newly hatched larva are arranged along the dorsal edge of the myotomes. In the larva from the egg fig. 12 they are more numerous than in the other one. In somewhat older stages the distribution of these pigment spots becomes less regular.

In every other respect the two kinds of larvae closely agree. In both we see the oil-globule situated quite anteriorly and reaching to in front of the head. Also in the number of the myotomes there is perfect agreement. There are 12 prae-anal myotomes and behind the anus 15 or 16 myotomes may be counted, besides the unsegmented terminal part of the mesoderm.

The development proceeds fairly slowly; not until three days after hatching had the eyes become black, which in *Stolephorus*-larvae does not take more than 1½ day.

The number of myotomes, 12 + 17, agrees fairly well with what we found for the vertebrae in *Gobius*, 11 + 16 (cf. above) and it seems, therefore, not impossible that we are dealing with pelagic eggs of some gobioid fish, resembling e.g. the oblong eggs described by KUNTZ for *Gobiosoma bosci* (1) which appear to be pelagic also, although this is not quite evident from KUNTZ's description.

The evidence, however, on which our assumption rests is still very imperfect and I only seize the opportunity to mention these characteristic eggs here because it may take a long time before we get more convincing evidence regarding their origin.

(1) Bulletin of the Bureau of Fisheries, Vol. XXXIV, 1916, p. 423.