FISH EGGS AND LARVAE FROM THE JAVA-SEA (1)

by

DR. H. C. DELSMAN

(Laboratorium voor het Onderzoek der Zee, Batavia).

5. Caranx kurra, macrosoma and crumenophthalmus.

One of the most important fisheries in the Java Sea is that on the l a j a n g or b e n g k o l (*Caranx kurra* C. V., *Decapterus kurra* BLEEKER), one of the smaller species of the numerous Carangids occurring in tropical waters. At definite places and at definite times of the year it is caught in large numbers and often hardly mixed with any other species. This is especially the case in the eastern half of the Java Sea and in the latter half of the year. The l a j a n g, accordingly, has been the subject of more than one publication of our laboratory (2) and the object of experiments with European herring-nets (3) which, however, have as yet not been very successful, the meshes of the ordinary herring-nets being too wide for the relatively small l a j a n g.

L a j a n g-fishery is practised in the Java Sea from the Thousand Islands (northwest of Batavia) to the Kangean Archipelago, south of a line from the northernmost Thousand Islands to the Karimon Djawa Archipelago, from there to a point about 13 sea-miles north of Bawean and eventually to the Polo Archipelago, north of the Kangean-group. The distance of the fishing vessels from the Java coast is from 20 to 40 sea-miles. The importance of the l a j a n g fishery increases from west to east, culminating between Karimon Djawa and Kangean, whereas e.g. in Batavia l a j a n g is brought ashore only from time to time, in the first months of the year. In the eastern half of the Java Sea l a j a n g is caught during several months, from August on to the end of the year. Near Bawean, however, an important fishery on mature l a j a n g, known as „b e n g k o l", during the months April—June has developed in later years.

ROOSENDAAL (1910) makes certain suggestions concerning the spawning

(1) cf. Treubia, Vol. II, p. 97, Vol. III, p. 38, Vol. V, p. 408 and Vol. VI, p. 297.

(2) KONINGSBERGER, J. C., 1908, De lajangvisscherij in het Oosten der Javazee, Jaarboek Dept. v. Landbouw voor 1907.

ROOSENDAAL, A. M. VAN, 1910, De lajangvisscherij in de Javazee en in Straat Madoera.

Mededeelingen van het Visscherijstation, nr. 5.

VINK, W. C. A., 1911, Verdere opmerkingen over de lajang-visscherij, ibid., nr. 6.

(3) VINK, W. C. A., 1911, Resultaten bereikt met haringdrijfnetten, ibid., nr. 6.

„ 1912, Voortgezette proefnemingen met haringnetten, ibid., nr. 9.

period and the migration of the lajang, which, however, remain very hypothetical. Thus he writes: "Possibly towards spawningtime the fishes migrate to stony bottom to fix their eggs". The results of my investigation show that this hypothesis can not be held upright.

The way in which the lajang is caught is quite peculiar. The native fishers make use of the tendency of carangoid fishes to gather round floating timber and sea-weed. They set out so-called rumpons or tendaks consisting of a long rope hanging down from a bambu which floats at the surface of the sea. At the lower end of the rope which reaches to the bottom a stone or primitive anchor is attached and along its whole length a number of palm leaves are twisted in. In the evening already the fishers in their majang-boats sail to the tendaks and pass the night there. Early in the morning they throw out their pajang-net rowing in a wide circle round the tendak. The pajang-net is a floating net which consists of a sac with two large wings. After the ring has been closed the net is hauled in again. The sac, which comes last, contains the catch.

This way of fishing, described more fully by VAN KAMPEN (1), is practised along the whole north coast of Java. The fishes caught by it are: a number of species of *Caranx,* further *Scomber kanagurta* (kembung lelaki, or banjar), *Clupea leiogaster* (lemuru) and a few other species of *Clupea, Stromateus niger* (bawal hitam), and sometimes *Thynnus thunnina* (tongkol).

In the right season and at the right places the lajang dominates so much, that it is caught practically unmixed. A restricted number of a somewhat smaller and more elongate species is, however, nearly always to be found among the lajang. It is the *Caranx macrosoma* BLKR. Often also quantities of *Caranx crumenophthalmus* (sělar běntong) are caught together with the lajang.

As mentioned above, the larger, mature, lajang is known as "bengkol".

In order to make an attempt to find out the eggs of the lajang, I visited in June 1920 and 1922 and again in May 1924 the waters round Bawean where at that time quite a fleet of native majang-vessels had gathered. They landed their catches either in Sangkapura on the south coast, or in Tambak, on the north coast of Bawean, where the lajang is salted. In the evening some dozen or more, at one time even 22, majang-boats could be counted far and near round our investigation-vessel "Brak", waiting near their tendaks. The catches consisted preponderantly of fullgrown and mature lajang.

In looking for the eggs of the lajang the question lay at hand as to what information we have concerning the eggs of the *Caranx trachurus,* the

(1) KAMPEN, P. N. VAN, 1909, De hulpmiddelen der zeevisscherij op Java en Madoera in gebruik.
Mededeelingen Departement van Landbouw, nr. 9.

only European representative of the genus *Caranx* of which so numerous species occur in Indian waters. We owe our knowledge of these eggs chiefly to the investigations of HOLT (1) and of HEINCKE and EHRENBAUM (2).

They are pelagic and of moderate size, with a diameter of 0.84—1.04 mm., and contain one oil-globule. A very characteristic feature is the segmented yolk which seems strongly vacuolated. Besides in the egg of *Caranx*, a segmented yolk is found only in the eggs of clupeids and apodes, for both of which it is very characteristic. In other groups of fishes this segmentation of the yolk is rarely found. This is the case with *Caranx*, whereas in the species of *Solea* the circumferal part of the yolk only shows segmentation.

Now, in the Java Sea we often find pelagic eggs, of various size, resembling those of *Caranx trachurus*. They have a segmented yolk, as is the case in clupeoid eggs. However, they may be distinguished at first sight from the latter. In the first place the vacuoles causing the segmented or foam-like appearance of the yolk are much larger, especially in the centre of the yolk, whereas, approaching the circumference, we find them more or less flattened and less distinct. Thus we see them best at microscopical examination in an optical section of the living egg, focussing the centre of the yolk, whereas in clupeoid eggs the segmentation may be seen best by focussing the surface of the yolk. Further the two groups of eggs may be easily distinguished in somewhat further advanced stages by the fact that in the carangoid eggs black and brown pigment spots are present not only in the embryo but also on the surface of the oil-globule and sometimes of the yolk, whereas with clupeoids we see the pigment spots appear as a rule only after the hatching, and then only small black ones.

More easily still may the larvae hatching from the carangoid eggs be distinguished from clupeoid larvae, the number of myotomes in front of the anus being not more than 11 or 12, whereas in clupeoid larvae it is at least 25 and as a rule more.

As mentioned above, several kinds of these carangoid eggs occur in the surface-catches from the Java Sea, there being larger and smaller varieties.

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(1) HOLT, E. W. L., 1893, On the Eggs and Larval and Post-Larval Stages of Teleosteans.
Scientific Transactions R. Dublin Society (2) V, p. 9.
" , 1894, North Sea Investigations.
Journal Mar. Biol. Association, N.S. III, p. 190.
" , 1897, Notes on the Reproduction of Teleosteans. Fishes in the South-Western District.
ibid., N.S. V, p. 116 and 340.
" , 1899, Sur la reproduction des poissons osseux, surtout dans le Golfe de Marseille.
Annales du Musée d'hist. nat. de Marseille, V. 2, p. 27.

(2) HEINCKE, FR., und EHRENBAUM, 1900, Eier und Larven von Fischen der Deutschen Bucht, II.
Wissensch. Meeresunters., Abt. Helgoland, Bd. III, p. 277.

This is in accordance with the fact that the genus *Caranx* is represented in tropical seas by a considerable number of species, all fairly common, and among which there are smaller ones but also such of considerable size.

It is evident from the foregoing that I had to look near Bawean for eggs of the type just described and probably for such of the smaller variety, the l a j a n g being one of the smaller species of *Caranx*. Truly, the diameter of the eggs of animals is by no means proportionate to the size of the species to which they belong. Nevertheless, in restricted groups a certain parallelism between the two may often be noticed, the diameter of the egg being larger as a rule in the larger, and also in the more specialized, forms. Thus, what might be expected in our case is the occurrence in large numbers of a small carangoid egg in the waters round Bawean.

This, now, is what I found to be the case. In a great number of surface-catches — the conical egg net mentioned on page 98 of nr. 1 of this series being hauled horizontally along the surface while the "Brak" was steaming as slowly as possible — I found fairly regularly and often in considerable quantity the eggs to be described now.

The diameter is on an average 0.7 mm. or slightly more, varying from 0.69 to 0.74 mm. The yolk is segmented, the segments being largest in the centre, and contains an oil-globule of about 0.16 mm. diameter. The oil-globule is situated ventrally and has a slightly yellowish tinge. In a stage in which the rudiment of the embryo is visible the surface of the oil-globule shows black and brown pigment spots, the brown ones being situated on the outer half of the surface, the black ones on the inner half, on the side of the yolk.

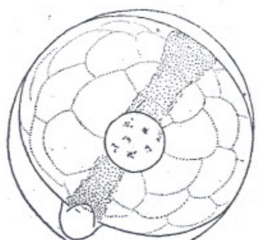

Fig. 1. Egg of *Caranx kurra*, × 50.

The development of these eggs seems to take a very short time. There can be no doubt that, as is the case with most pelagic fish-eggs, the spawning takes place during the night. Early in the morning the rudiment of the embryo is present and develops rapidly during the next hours. The greater part hatches between 11 a.m. and 1 p.m. At the last-named hour all larvae are free. Thus we could fish for these eggs during the morning only, as the tiny larvae are too small to be caught by our net. In the afternoon no eggs were to be found any longer.

To determine at what time exactly during the night spawning takes place, I made, when visiting Bawean in May 1924, two surface hauls, one from 11—12 in the evening of May 17, and one from 2—3 a.m. of May 18. These catches were examined the next morning, the clear daylight being indispensable for picking out the tiny and transparent eggs with the looking glass. The eggs proved to be present in de first catch already, which shows that spawning had taken place before midnight.

In the same way I found the eggs to be present in a vertical haul made on June 4, 1920, north of Bawean (5°39½′ S 112°36½′ E) at 0.15 a.m.

This catch was conserved in formaldehyd-seawater and the eggs proved to show a small germinal disc. Spawning thus evidently finds place in the forenight.

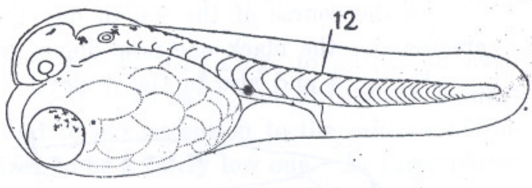

Fig. 2. Newly hatched larva, × 50.

A newly hatched larva is shown in fig. 2. The oil-globule is found now in the anterior part of the yolk, reaching to in front of the head. This is also very typical for the newly hatched larva of the European *Caranx trachurus,* whereas in most other fishes, where an oil-globule is present in the egg, it is found in the posterior part of the yolk in the newly hatched larva, as is, e.g., the case with the mackerel. Three paired groups of brown pigment are present: one pair in front of the eyes, one pair between the eyes and the statocysts, one pair behind the statocysts. More backwards the brown pigment is less regularly distributed over the body. This pigment is quite opaque and looks white when studied under the microscope with light falling from above. Small black pigment spots are found all over the dorsal side in the embryo.

The larva shown in fig. 2 was drawn at 4 p.m. The yolk and the oil-globule now project less in front of the head.

Twelve myotomes are present between the auditory vesicle and the anus, some 16 behind the latter, in the tail. Along their dorsal edge a series of fine black pigment spots is present, as is the case on the inner surface of the oil-globule.

The next morning the yolk had not yet been quite absorbed. The first rudiment of the pectoral fins appeared.

At 9 o'clock in the evening the yolk had been used up, the oil-globule not yet. The eyes were getting pigmented, having a brown colour. The pigment on the body began to spread.

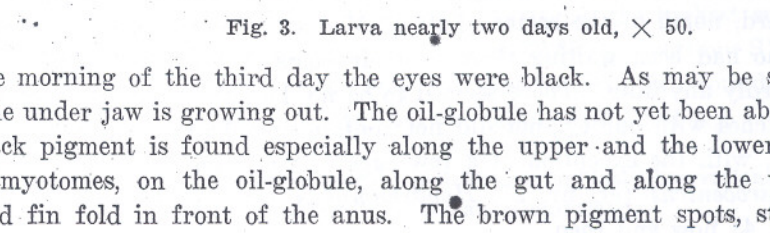

Fig. 3. Larva nearly two days old, × 50.

The morning of the third day the eyes were black. As may be seen in fig. 3 the under jaw is growing out. The oil-globule has not yet been absorbed. The black pigment is found especially along the upper and the lower edges of the myotomes, on the oil-globule, along the gut and along the ventral unpaired fin fold in front of the anus. The brown pigment spots, strongly branched, are found now especially on the dorsal and ventral unpaired skin fold, the caudal part, however, remaining free from them. In the course of the day the oil-globule gets gradually smaller and during the next night it disappears.

In the course of the fourth day the brown pigment on the fin fold decreases and the black one now dominates.

In fig. 4 and also in fig. 3 eleven myotomes may be counted in front of

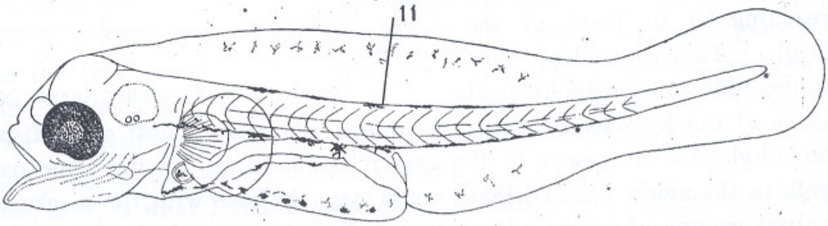

Fig. 4. Larva somewhat more than three days old, × 50.

the anus, and some 14 behind it, the latter number including the terminal unsegmented part of the mesoderm which corresponds to the urostyl. The number of vertebrae of the adult l a j a n g is 10 + 14, the same as that of the European *Caranx trachurus*. I found this number also in other Indian carangids.

I did not succeed in rearing up the larvae to the fourth day nor did I succeed in identifying with certainty pelagic larvae. Thus my report on the development of the l a j a n g must end here.

The great resemblance of the eggs collected near Bawean and of the larvae hatched from them to those of the European horse mackerel together with their abundant occurrence in a region where mature *Caranx kurra* is caught in large numbers and hardly at all mixed with any other species (see, however, below) warrant the conclusion that we have found here the eggs of the l a j a n g. During five successive mornings in June 1922 I made 31 surface hauls with the egg-net and of 25 minutes each, partly on the fishing grounds south and partly on the fishing grounds north of Bawean. In 29 of these 31 catches the eggs described were present and often in very considerable number. In one of these catches, e.g., this number amounted to 3300, mixed only with a few eggs of *Chirocentrus dorab* (cf. nr. 2 of this series) and of an eel. In May 1924 I made same 20 hauls and found the l a j a n g eggs to be absent in one or two only.

In November 1922 I made a cruise through the l a j a n g fishing grounds north of Madura. Coming from the Kangean Archipelago we steamed westward, north of the eastern half of Madura. Many fishermen were met with who had been waiting there in their boats for several days but had caught hardly anything. There seemed to be no l a j a n g, nor any other fish. The catches with our egg-net did not contain any l a j a n g-eggs nor any eggs at all, with the exception of a few eggs of *Fistularia* (cf. nr. 1 of this series), *Chirocentrus* (cf. nr. 2), *Hemirhamphus* (cf. nr. 3) and *Dussumieria* (cf. nr. 4) now and then.

We anchored at 113°3′ E 6°39′ S, north of the western extremity of Madura. The next morning a fisher boat in the neighbourhood had a very good catch of l a j a n g. The catch of our egg net contained a considerable number of l a j a n g eggs!

If we ask now what induces the mature l a j a n g to gather in such considerable quantities round the isle of Bawean each year during the months of May and June, then it lays at hand to pay attention to the salinity of the water in the first place. This appeared to be a fairly low one. At three places south of Bawean where l a j a n g eggs were caught I found during my visit in 1922 salinities of 32.16‰, 31.37‰ and 31.37‰ respectively. Especially in the latter two places (112°40′ E 6°5′ S and 112°39½′ E 5°38½′ S resp.) these eggs abounded. The depth is about 60 meter. VAN WEEL (1) also indicates a salinity of 31—31⁵ ‰ round Bawean in May (cf. his Chart nr. 10).

In 1924 I found at the l a j a n g-grounds near Bawean salinities varying between 30.9 and 31.1‰, at an average 31‰. Finally, in a vertical haul on June 1st, 1920, at station N (West of Bawean, cf. the chart in Treubia, Vol. II, p. 106) a considerable number of l a j a n g- and d ĕ l ĕ s-eggs were present (cf. anon, p. 202—203), the salinity being there 31.46‰. If we compare this salinity with that in the other months of the year, when no l a j a n g is caught near Bawean, then we find that in the l a j a n g-season, at the end of the West monsoon, it evidently reaches its lowest point. During the periodical cruises 1919—1920 I found for the salinity at station N (depth about 68 M.):

		surface	65 M. depth
July	25, 1919	33.24‰	33.80‰
September	26, „	34.34 „	34.33 „
November	24, „	33.84 „	34.36 „
January	23, 1920	32.12 „	32.16 „
March	27, „	32.14 „	33.28 „
June	1, „	**31.46** „	32.43 „
August	11, „	33.82 „	33.98 „
October	25 „	33.56 „	34.— „
December	16, „	32.90 „	32.90 „
March	5, 1921	32.8 „	32.55 „
May	28, „	**32.5** „	33.2 „

On the other hand, these low salinities in the months May and July are by no means restricted to the neighbourhood of Bawean but found all over the Java Sea. During the cruise of May—June 1920 e.g. the highest surface salinity found at any of the stations A—V was 32.65‰ (station S) and during that same cruise I had a short stay north of Bawean and found there a good deal of l a j a n g-eggs in water with a salinity of 32.81‰.

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(1) WEEL, K. M. VAN, 1923, Meteorological and Hydrographical Observations made in the Western Part of the Netherlands East Indian Archipelago. Treubia, Vol. IV.

Unfortunately my observations regarding the spawning of l a j a n g in other places and its relation to the salinity of the water are still quite insufficient. Thus I regret I did not make observations on the salinity during the cruise of November 1922 north of Madura, mentioned above. During a similar cruise in October 1924 hardly any l a j a n g was found to be caught and no l a j a n g eggs were met with. The salinity at that time was a high one, varying between 34.25 and $35^0/_{00}$ as is the rule there at this time of the year (end of the East monsoon).

Although the l a j a n g largely preponderates in the catches near Bawean and Madura, yet two other carangids are caught together with it. One of these is the C a r a n x m a c r o s o m a, first described by BLEEKER in 1851 as *Decapterus macrosoma* (1). It is somewhat smaller and more slender than the l a j a n g. A restricted number of this fish is nearly always found mixed with the l a j a n g-catches. It is known as d ĕ l ĕ s, l u n t j u or b u l u s. The other species, *Caranx crumenophthalmus,* is larger and more robust than the l a j a n g. It is easily recognized by its large eyes. The native name is s ĕ l a r b ĕ n t o n g. Although sometimes l a j a n g and s ĕ l a r b ĕ n t o n g are caught together, yet the shoals of these two species seem not to mix up in the same way as do the l a j a n g and the d ĕ l ĕ s. Thus I saw catches of s ĕ l a r b ĕ n t o n g pure, with hardly any l a j a n g, whereas other catches made quite near consisted of l a j a n g only, mixed with a few d ĕ l ĕ s.

Fig. 5. Egg of *Caranx macrosoma,* × 66.

Now, in the catches with the egg-net, two other kinds of carangid eggs were met with, easily to be recognized as such by the segmentation of the yolk and their general resemblance to the eggs of the l a j a n g.

One of them (fig. 5) is smaller than the egg of *Decapterus kurra.* It has a diameter of 0.6—0.635 mm., the variability of this diameter

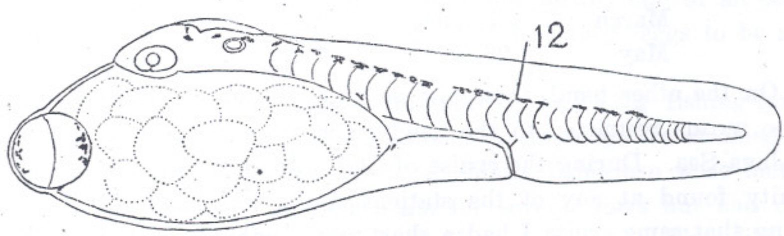

Fig. 6. Newly hatched larva, × 66.

(1) BLEEKER, P., 1851, Over eenige nieuwe geslachten en soorten van makreelachtige visschen van den Indischen Archipel.
Nat. Tijdschr. Ned.-Indië, Vol. I.

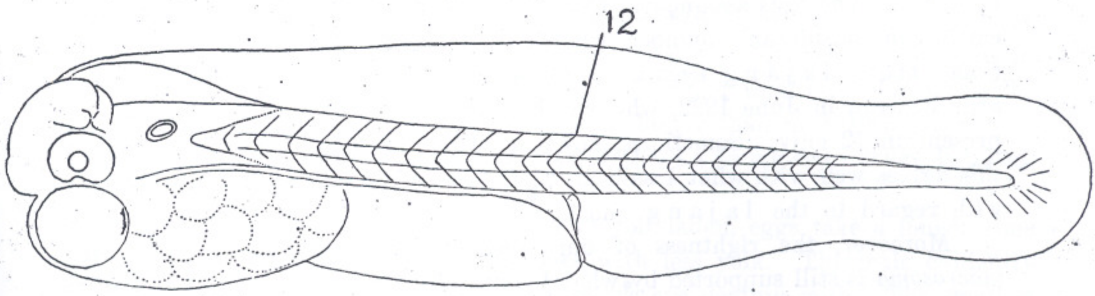

Fig. 7. Larva of the next day, × 66.

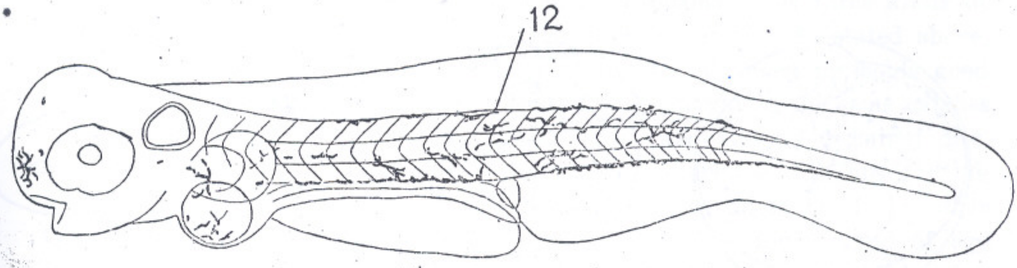

Fig. 8. Still slightly older larva, × 66.

as well as of that of the lajang being so restricted that the two species may always be distinguished from each other at first sight. The oil-globule also is slightly smaller. In advanced stages it bears yellow pigment-spots on the outer, and black ones on the inner side, just as in the lajang-egg. In the one shown in fig. 5 (7 a.m.) the heart begins to beat feebly, at a rate of 120 times per minute.

The other egg (fig. 9) is larger than that of the lajang, having a diameter of 0.775 mm. at an average. Besides by its diameter, it may be easily distinguished from that of the lajang by the relatively larger size and the yellow colour of the oil-globule, which has a diameter of 0.24 mm., and by the fact that, when it is examined during the morning hours, pigment spots are seen to be present not only on the rudiment of the embryo and on the oil-globule — as is the case with the lajang-egg — but also in considerable quantity on the surface of the yolk, especially on the dorsal side.

I suppose the smaller one of these two eggs must be that of the *Caranx macrosoma*, the larger one that of *Caranx crumenophthalmus*. It is impossible to make this out with absolute certaintly, e.g. by taking into consideration the number of myotomes in the larvae hatched from them, as compared with the number of vertebrae of the adult fishes. In all species of *Caranx* the number of vertebrae seems to be the same, viz. 10 + 14. At any rate the three species we are dealing with afford no exception to this rule.

The small eggs, evidently belonging to *Caranx macrosoma*, are found fairly regularly, though in considerably smaller number, between those of the lajang. The eggs assigned to *Caranx crumenophthalmus* are found in some catches in considerable number, whereas in other they are missing. As mentioned above, lajang eggs were present in 29 of the 31 surface hauls made near Bawean in June 1922, whereas those of *Caranx crumenophthalmus* were present in 12 only. Sometimes, however, the latter might predominate. All this agrees well with what I said about the behaviour of the fishes themselves with regard to the lajang shoals.

Moreover, the rightness of our conclusion as far as regards *Caranx macrosoma* is still supported by what I found during the cruise round Madura in October 1924. Hardly any lajang was caught by the fishermen but at several places, as well north as south of Madura, dĕlĕs proved to be plentiful. At these same places we more than once found the small eggs

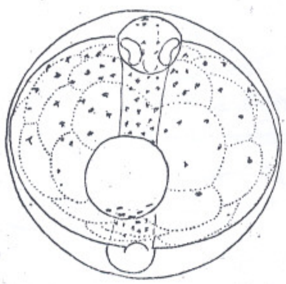

Fig. 9. Egg of *Caranx crumenophthalmus*, × 50.

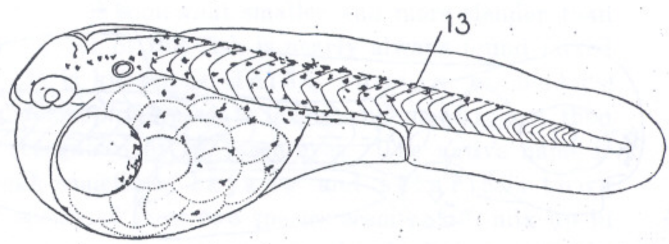

Fig. 10. Newly hatched larva, × 50.

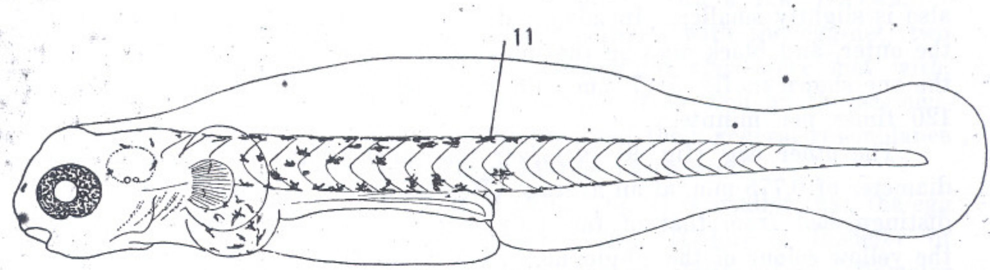

Fig. 11. Larva of 48 hours, × 50.

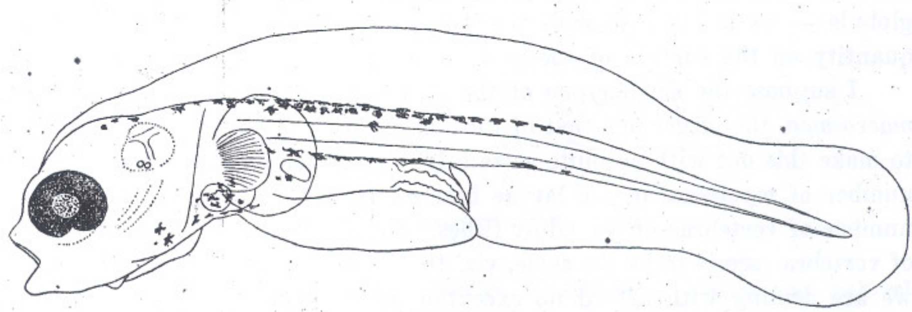

Fig. 12. Larva about 3 days old, × 50.

ascribed to the latter in considerable quantity, whereas no l a j a n g eggs were met with. We found them in considerable quantity e.g. near Panarukan in water with a salinity of $34.4^{0}/_{00}$ which is much higher than near Bawean. The diameter of the eggs proved to be distinctly larger than near Bawean, viz. at an average 0.653, thus approaching that of the l a j a n g-egg. They hatched, however, at the usual hour, viz. 9 a.m.

Is is a general rule that larger, more yolk-laden, eggs take a longer time for their development than smaller ones with less yolk. This rule evidently holds good also for the three *Caranx*-eggs we are dealing with. The smallest ones, those of *Caranx macrosoma*, hatch at 9 o'clock in the morning, those of the l a j a n g, as mentioned above, between 11 a.m. and 1 p.m., and the large ones of *Caranx crumenophthalmus* at 6 p.m. Probably these three kinds of eggs are set free at about the same time during the night. As stated above, those of the l a j a n g are laid against midnight and the same holds good for the *macrosoma*-eggs, as these were found to be present in the same catches from which I drew this evidence and equally showed a small germinal disc. For the *crumenophthalmus*-eggs I could not yet determine this, but I think it probable that they are laid at about the same time as those of the other two species, as proved, moreover, to be the case with a fourth kind of egg occurring regularly together with those of the carangids and probably belonging to *Scomber kanagurta*, the k e m b u n g (cf. a later number of this series).

From the above observations it results that the incubation period of the eggs of *Caranx macrosoma* is less than 12 hours! These eggs, then, are to be found only in the early morning catches. Those of the l a j a n g disappear from the catches about 1 p.m., so that in the afternoon only those of *Caranx crumenophthalmus* remain, which hatch about 6 p.m.

The young larvae of *Caranx macrosoma* and *crumenophthalmus* resemble those of the l a j a n g. There are, of course, differences in size corresponding to those of the eggs themselves. They have, however, the same anterior situation of the oil-globule which especially in newly hatched larvae of the first named species is very evident. The oil-globule here projects far in front of the head, less so in l a j a n g larvae, and still less in those of the s ĕ l a r b ĕ n t o n g. During further development this becomes less pronounced.

For the number of trunk myotomes I found as a rule 12, sometimes 11 or 13, for those of the tail some 14, although in quite young larvae, newly hatched, this number might amount to 16 or 17, besides the unsegmented part of the mesoderm corresponding to the urostyl. From this it is evident that the number of trunk-myotomes as well as that of the tail myotomes decreases slightly during development. As stated above, the number of vertebrae in both species is 10 + 14 (the urostyl included).

As mentioned above, the eggs of the three species of *Caranx* may easily be recognized and distinguished from each other when examined in the living state. The question, however, presents itself, if it will be possible to distinguish these eggs with certainty from others in catches conserved in formaldehyd-seawater, e.g. in the catches made during the periodical cruises mentioned in the first article of this series (Treubia Vol. II). This seems to me very doubtful. The segmentation of the yolk, the main characteristic of these eggs, is no longer recognizable in conserved specimens, so that in this case we can operate only with the diameter of the egg and the presence of the oil-globule. This, however, will not prove sufficient in view of the multitude of small eggs with an oil-globule present in tropical waters.

Moreover, as we have seen, the eggs of the *Caranx macrosoma* can be expected to be found only in the catches made during the night and before 9 a.m., and the eggs of *Caranx kurra* only in those made before noon, the tiny new-born larvae not being caught by the ordinary plankton-gauze.

A case in which the eggs of l a j a n g and d ĕ l ĕ s may be fairly well recognized in conserved catches is afforded by the catch made at station N (West of Bawean, cf. the chart in Treubia II, p. 106), on June 1st 1920. This vertical haul, made in the l a j a n g-season and near the region of the l a j a n g-fishery, had moreover the advantage of being made at 7 a.m. when none of the eggs have hatched as yet. If we leave aside the eggs without an oil-globule we find the following diameter for those with an oil-globule. The diameters are given in lines of my ocular micrometer, each corresponding to 40.8 μ.

diameter:	14	14½	15	15½	16	16½	17	17½	18	19½	20	20½	21	21½	22	22½	24	31½
numbers:	3	20	25	1	3	6	**36**	11	3	1	1	2	**19**	**21**	**38**	4	1	1

It is evident that the bulk of this catch — as far as concerns the eggs with an oil-globule — consists of three kinds of eggs, with a diameter of 14—15, 17 and 21—22 respectively, which corresponds to 0.6, 0.7 and 0.87 mm. respectively. These eggs apparently belong to *Caranx macrosoma, Caranx kurra* and a third species which, however, is not *Caranx crumenophthalmus* whose eggs evidently are not represented in this catch. This third kind of eggs was found also regularly and in considerable number in the surface catches near Bawean, together with those of the *Caranx*-eggs from which, however, they differed in having no segmented yolk. Apparently they belong to the "k e m b u n g" *(Scomber kanagurta)*, a very common and esteemed fish which regularly occurs in fairly considerable number among the l a j a n g-catches. They will be treated of in a following article.

In this case, then, where, moreover, we could a priori more or less expect them, it was possible to state with a fair degree of certainty the presence of l a j a n g-eggs. It will be difficult, however, to do so in a catch made at random somewhere in the Java Sea. Even when examining a living catch, where we can distinguish the segmented structure of the yolk, it seems questionable if it will be possible always to identify the l a j a n g-eggs with certainty, as there may be eggs of other small carangids closely resembling them.

I found such eggs e.g. in surface catches with the egg net made on April 6, 1924, north of the Bay of Bantam. We happened to find here an intensive and successful fishery with the pajang-net on tembang *(Clupea fimbriata),* lemuru *(Clupea leiogaster)* and sĕlar kuning *(Caranx leptolepis),* a fishery which lasted a few days only: then the fish had disappeared again. The eggs of both the *Clupea*-species, which will be treated of in a later article, were found in the surface-catches with the egg-net, those of the first-mentioned species even in enormous quantity. These catches now also contained the small carangid eggs evidently belonging to *Caranx leptolepis* and which showed a great resemblance to those of the lajang. The diameter varied from 0.685 to 0.725 mm. and that of the oil-globule measured 0.18 mm. The pigmentation also showed no marked difference from that of the lajang-embryo, and the eggs hatched at the same time, although slightly later, viz. between 1 and 3 p.m. At first I was inclined to the view that I was dealing here with lajang-eggs, but lajang not being represented at all in the rich catches made by the numerous fishermen and sĕlar kuning being present in fairly considerable number, it seems to me probable that the eggs were those of the latter species. Evidently, then, the differences between the eggs of *Caranx kurra* and of *Caranx leptolepis* are too insignificant as to allow us to distinguish them from each other, even in fresh and living catches with the egg-net.

During a cruise in Sunda-Strait, November 1925, I also found *Caranx*-eggs with the same diameter as those of sĕlar bĕntong but with a colourless and somewhat smaller oil-globule. The pigmentation of the embryo also differed from that of *Caranx crumenophthalmus.* Evidently I had before me the egg of *Caranx affinis,* the sĕlar tjomo or hedjo (the green sĕlar) which was caught there by the majang-fishermen together with *Scomber kanagurta.* The eggs hatched in the course of the afternoon and the eyes were black at the morning of the second day afterwards. In the living condition these eggs were well to be distinguished from those of *Caranx crumenophthalmus* but this would not be possible with eggs conserved in formaldehyd.

We have been dealing until now only with the eggs and new-born larvae of the lajang and other small carangids. As regards the later stages the evidence gathered until now is very scanty. It seems questionable if it will ever be possible to distinguish the larvae of the different species of *Caranx* from each other and even if this might be the case we might ask if it would pay the amount of trouble and time required to do so.

In the surface catches near Bawean larvae were not found, however numerous the eggs were. Evidently they abide in somewhat deeper water layers, as seems to be the case with many fish larvae. In the vertical catches larvae were found among which those of the lajang may have been present. Neither their number nor their characteristics, however, allow us to make reliable conclusions in this respect.

6. On a few other Carangid eggs and larvae.

Many kinds of Carangids occur in the Java-Sea, some of them attaining a fairly considerable size, as is especially the case with those species in which the body has a greater height and which are known by the Malayans as "k w e e" (pron.: kway), in opposition to the smaller and more oblong species which are called "s ĕ l a r". It is no wonder, then, that many kinds of carangid eggs, with the characteristic segmentation of the yolk, may be found in the surface catches of the Java Sea, several of them being larger than those described in nr. 5 of this series. It will take a long time before we shall be able to identify them all, if we shall ever succeed in doing so.

In addition to those described in the foregoing article, however, an egg may be mentioned which is not rarely met with in the catches with the egg-net, e.g. in the Bay of Batavia and in Madura and Sunda Strait, and which, I believe, must also be attributed to a *Caranx*-species. It is a fairly large egg, having a diameter varying from 1.55 mm. to 1.65 mm., thus 1.6 mm. at an average, about the same size as those of *Fistularia* (cf. nr. 1 of this series, in: Treubia Vol. II), *Chirocentrus dorab* (cf. nr. 2 in: Treubia, Vol. III), and *Dussumieria acuta* (cf. nr. 4 in: Treubia Vol. VI), the latter, however, being slightly smaller.

Fig. 1. Egg with embryo, × 26,7 (the egg floats with the oil globule upside).

The yolk shows segmentation which, however, is most evident in the youngest stages of development, e.g. in eggs where the germinal disc has not yet grown round the yolk and where the yolk blastopore has not yet closed. A foamy structure with large vacuoles is quite evident here. This is no longer the case in further advanced eggs where a few large round vacuoles may be discovered in the centre of the yolk only, and in still older eggs even these can no longer be observed. An oil-globule of about 0.25 mm. diameter is found. The hatching takes longer than in any of the smaller Carangid eggs described before. On August 5, 1921, e.g., I fished 35 of these eggs in the Bay of Batavia, south of the island of Edam. It was early in the morning, at 7 a.m.; and the yolk had just or nearly been enveloped by the blastoderm. The next morning the heart was seen beating and only at 9 p.m. of this second day the eggs began to hatch. On another occasion, November 15th, 1925, near Labuan (Sunda Strait) I found the blastopore closing no earlier than at 10.30 a.m. Hatching occurred during the second night. Black branching pigment cells are already present on the embryo and on the surface of the yolk before hatching (fig. 1).

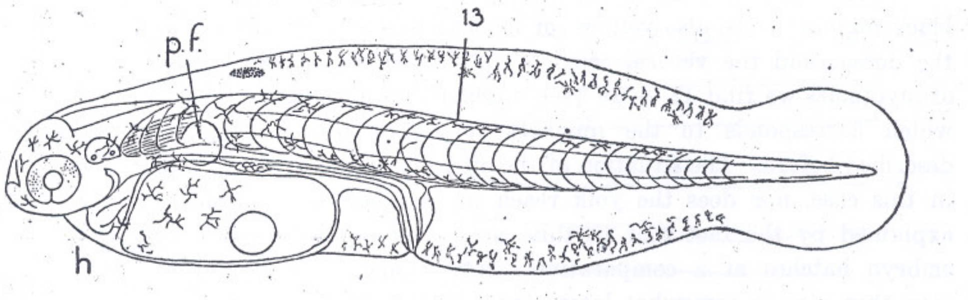

Fig. 2. Newly hatched larva, × 26,7.

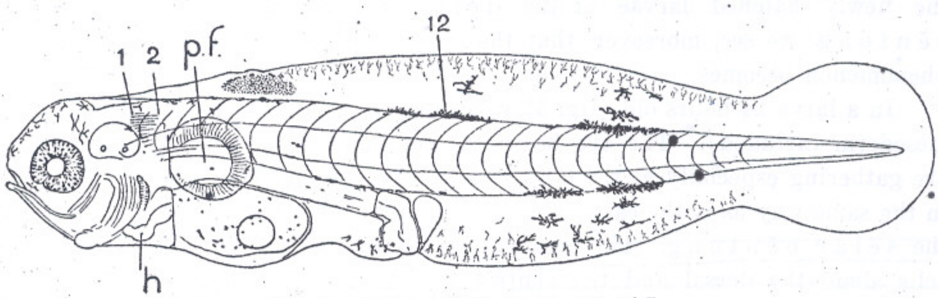

Fig. 3. Larva of 24 hours, × 26,7.

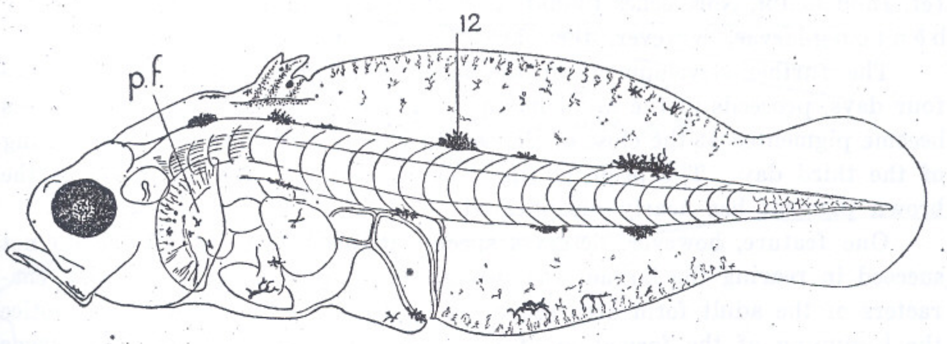

Fig. 4. Larva of 40 hours, × 26,7.

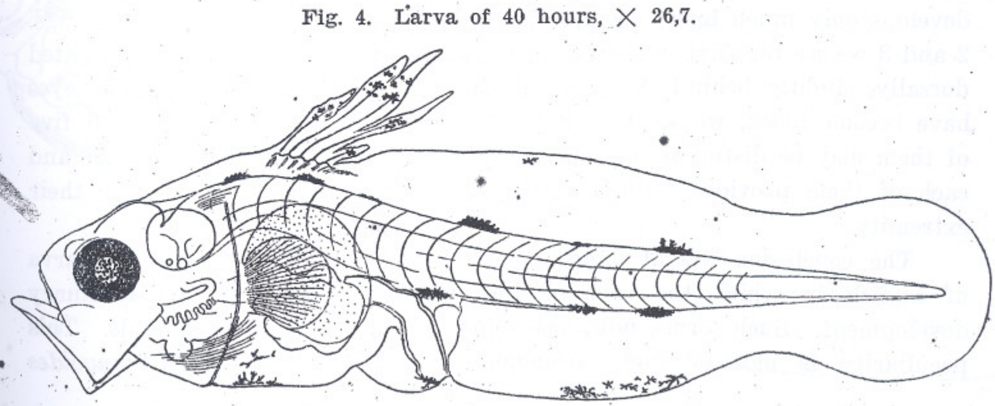

Fig. 5. Larva slightly more than 3 days old, × 26,7.

In a newly hatched larva, as represented in fig. 2, we see, besides these black pigment cells, also yellow (or brown) pigment, arranged especially along the dorsal and the ventral seam of the unpaired fin-fold. For the number of myotomes we find 12 + 16 (the unsegmented terminal mesoderm included), which corresponds to the numbers found in the larvae of the carangids described before. The situation of the oil-globule, however, is further backward in this case, nor does the yolk reach to in front of the head. This can be explained by the fact that in this case, as is the rule with larger eggs, the embryo hatches at a comparatively later stage of development. We have seen that also in somewhat later stages of the lajang- and dělěs-larvae the yolk does not reach any longer to in front of the head. In comparing the newly hatched larvae of the dělěs, the lajang and the sělar běntong we see, moreover, that the larger the egg is the less evident this phenomenon becomes.

In a larva 24 hours old (fig. 3) we count 11 + 16 myotomes (the terminal mesoderm included). The eye begins to get dark. The black pigment cells are gathering especially at the dorsal and the ventral border of the myotomes, in the same way as is the case in the larvae of the dělěs, the lajang and the sělar běntong. The arrangement too of the yellow or brown pigment cells along the dorsal and the ventral border of the unpaired fin-fold corresponds to what we see in the lajang- and also in the horse-mackerel-larvae (cf. EHRENBAUM, Nordisches Plankton, p. 28); in the dělěs- and the sělar běntong-larvae, however, they are absent there.

The further development of the larva which I could keep alive some four days, proceeds in the usual manner. The under jaw grows out, the eyes become pigmented at the close of the second day and are black in the morning of the third day. The pectoral fin grows out, and in the oldest stages the brown pigment has nearly disappeared.

One feature, however, deserves special attention. As a rule we do not succeed in rearing the larvae from pelagic eggs up to a stage in which characters of the adult form are recognizable. In this case, however, we notice the beginning of the formation of an organ which in all other fish larvae develops only much later, viz. the dorsal fin. Already in the stages of figs. 2 and 3 we see the first indication in the shape of a cell-accumulation situated dorsally, slightly behind the pectoral fin. In fig. 4, shortly after the eyes have become black, we see the first fin-rays growing out and in fig. 5 five of them may be distinguished, lengthening in a very conspicuous manner and each of them provided with a gathering of black pigment spots near their extremity.

The conclusion lies at hand, then, that we are dealing with the larva of a fish in which the rays of the dorsal fin show an extraordinary development. Such forms, now, are found indeed among the carangids. This peculiarity is most strongly pronounced in *Caranx gallus* (*Carangoides*

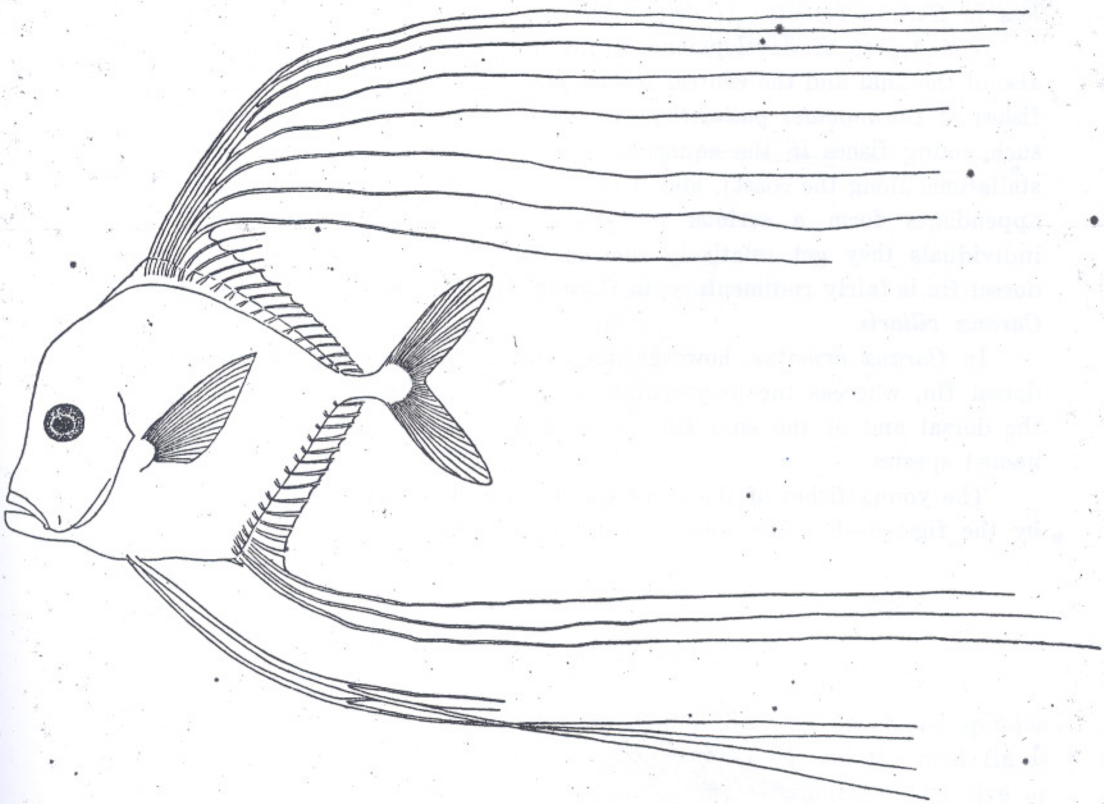

Fig. 6. Young of *Caranx gallus*, × ⅔.

Fig. 7. *Caranx ciliaris*, young, × 1⅓.

gallichthys BLKR.) and *Caranx ciliaris* (*Carangoides blepharis* BLKR.), much less in *Caranx armatus* (*Carangoides citula* BLKR.).

The degree of development of the anterior fin rays of the dorsal and also of the anal and the ventral fins is most extraordinary, especially in young fishes of *Carangoides gallichthys*, as shown by fig. 6. A few times we had such young fishes in the aquarium, caught in the sero's (native fishing installations along the coast), and it cannot be doubted that the long thread-like appendages form a serious impediment for swimming rapidly. In older individuals they get relatively shorter. The anterior, spinous, part of the dorsal fin is fairly rudimentary, in *Caranx gallus* as well as in the less common *Caranx ciliaris*.

In *Caranx armatus*, however, there is a well developed spinous anterior dorsal fin, whereas the lengthening of the anterior rays of the soft part of the dorsal and of the anal fins is much less pronounced than in the above named species.

The young fishes of the three species may be easily recognized, as shown by the figs. 6—9. The concave front of *Caranx gallus* is visible in fig. 6.

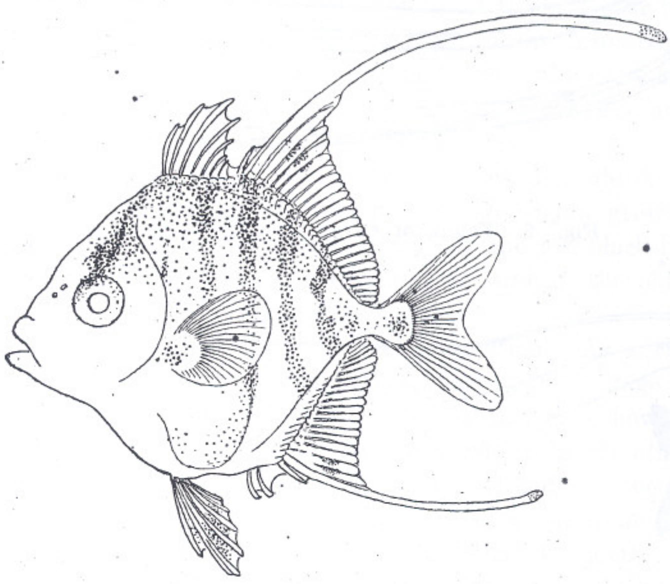

Fig. 8. *Caranx armatus*, young, × 3⅜.

Eight rays of the dorsal — in younger specimens five — and three of the anal fin are extremely lengthened. The ventral fins are also extraordinarily elongated, especially the two outer rays.

The young fish of *Caranx ciliaris* may be at once distinguished by the different shape of the head and by the much less elongated ventral fins. The pectoral fins too are somewhat shorter than in *Caranx gallus*. Of the dorsal fin five soft rays are elongated and of these the anterior one much more so than those following behind. The latter condition, however, is also found in somewhat younger stages of *Caranx gallus.*

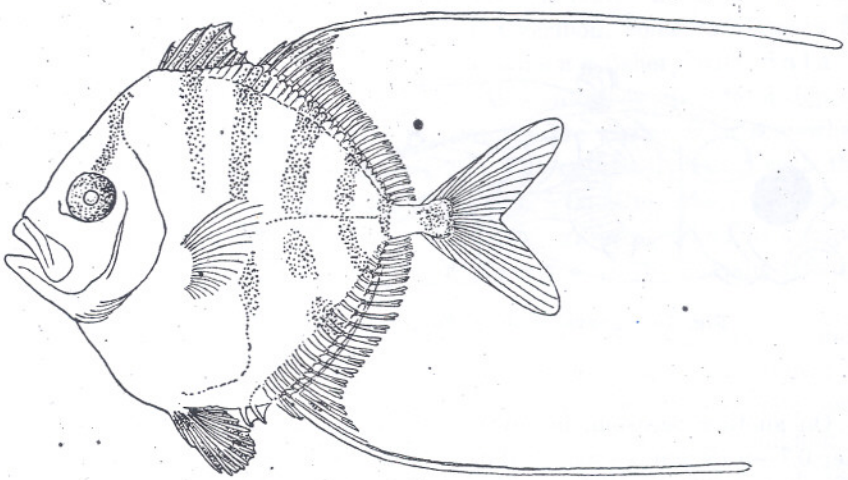

Fig. 9. *Caranx armatus,* young, × 2.

In the young *Caranx armatus,* finally, there is a well developed spinous dorsal fin, and only the first ray of the soft dorsal and the anal fin is elongated. Moreover, the young of this species are characterized by five or six dark transverse bands over the sides of the body, four behind the beginning of the soft part of the dorsal fin and one or two in front of it.

Unfortunately I have not yet succeeded in capturing intermediate stages between the larvae hatched from the eggs described above and the young fishes shown here. But it seems to me fairly evident that we were dealing with the eggs of one of the two first-named species, viz. with those of *Caranx gallus* or of *Caranx ciliaris.*

Besides the eggs described above, I have sometimes found similar eggs of somewhat larger size. The diameter of these eggs was at an average 1.71 mm., varying between 1.67 and 1.75 mm. They had one, sometimes two, pale yellow oil globules, and in the surface of the egg-membrane a fine striping might sometimes be discerned. In the centre of the yolk some 1—6 globular vacuoles could be observed. For the diameter of the yellowish oil-globule I found 0.28 mm. Fourteen of them, caught east of Bawean on May 28, 1921, early in the morning, hatched the next day at 8 p.m. After $1\frac{1}{2} \times 24$ hours the eyes were black, although the yolk had not yet been quite absorbed. The next day, June 1st, the rudiment of the anterior rays of the dorsal fin could be seen. The larva shown in fig. 10 was fixed early in the morning of June 2nd, about $3\frac{1}{2} \times 24$ hours old.

We see at once that it must be closely related to the larva of fig. 4 and 5.

The stage of development of the dorsal fin corresponds to that of the larva of fig. 4, but the lätter is only 40 hours old. In the larva of fig. 5, of which the age corresponds to that of fig. 10, the development of the dorsal fin is much further advanced than in the latter. Development thus seems to proceed slower in the last mentioned egg.

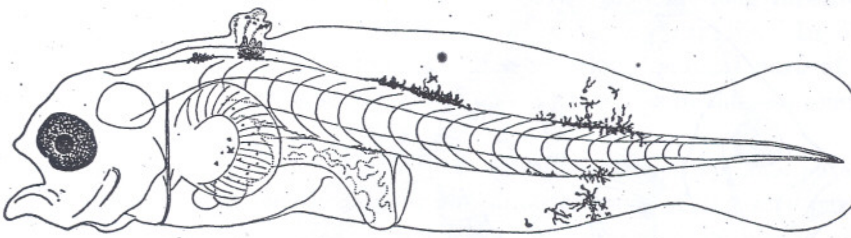

Fig. 10. Larva of June 2nd, 1921, 84 hours old, × 26,7.

On another occasion, however, I found a number of similar eggs — diameter 0.7—0.75 mm. — which, though larger, yet corresponded entirely in their development with the egg described first and seemed to me to be identical with the latter, as shown by the structure of the larvae as well as by their rate of development. These eggs were fished on January 16th, 1925, at 1°25′ S 104°42′ E, between Banka Street and Berhala Street, and the larvae were hatched up to the age of nearly five days. During the last two days, however, no considerable changes could be observed anymore. The number of fin rays of the dorsal fin remained five, only the anterior and the posterior one grew slightly longer.

Thus it remains as yet somewhat dubious whether we have been dealing in this article with one or with two kinds of eggs, and also whether these eggs belong to *Caranx gallus* or to *Caranx ciliaris,* or to both. The former species, however, seems to be much more common than the latter, as is also shown by the much more general occurrence of the larvae. The fairly common occurrence of the eggs, then, seems to point in the direction of the former species.

7. The genus Clupea.

Twenty-two species of *Clupea* are enumerated by WEBER and DE BEAUFORT as inhabiting the Dutch East Indies. Three of them belong to the sub-genus *Amblygaster* of BLEEKER, four to the sub-genus *Alosa* of CUVIER, and fifteen (fourteen? (1)) to the sub-genus *Harengula.* In the Java-Sea, however, only a restricted number of them occurs with any regularity.

(1) In "Addenda et Corrigenda" the authors admit the prossibility that MCCULLOCH is right in uniting *Clupea stereolepis* (OGILBY) with *Clupea moluccensis* BLKR.

The most common species no doubt is the tembang or tamban, also djuwi-djuwi, *Clupea (Harengula) fimbriata,* closely resembling the European sprat in appearance. It occurs all along the coasts and is landed daily at the Pasar ikan (fish market) of Batavia. This is especially the case during the West monsoon when a number of fishermen from Pasilean (West of the Bay of Batavia) and also from Cheribon, come to Batavia in their small boats to practise in the Bay the tembang-fishery with jala's (written in Dutch: djala) or casting-nets. As a rule they operate in depths varying between 6 and 8 fathoms and the catches are richer with somewhat disturbed and troubled than with calm water. The nets are treated with the white of eggs to render them less visible to the fish. To allure the fishes small "rumpons" are used, consisting of a bunch of grass attached to a rope. Tembang also occurs rather often in the catches of the majang-fishers, somewhat further from the coast.

Besides the common tembang there is another species very common in the Bay of Batavia, viz. *Clupea (Harengula) brachysoma* BLKR., known as tembang ètok or tembang pĕrampuan (i.e. "the female tembang") in opposition to the tembang lelaki (i.e. "the male tembang") as the common tembang is then denominated. This is due to the fact that the tembang ètok is less slender and its body higher than that of the common tembang. For the same reason the *Scomber kanagurta* and *Sc. neglectus* are distinguished as kembung lelaki and kembung perampuan and *Chanos chanos* and *Elops hawaiensis* as bandeng and bandeng lelaki. As a rule the catches of the jala-fishers mentioned above consist for the greater part of tembang ètok, especially when the East monsoon approaches. According to the fishermen the tembang ètok as a rule is not found in greater depth than some 3 fathoms, whereas the common tembang prefers some 12—13 fathoms.

Another neritic species is the mata belo (i.e. "the foal's eye"), *Clupea (Alosa) kanagurta* BLKR. Just like the tembang ètok, it is higher and less slender than the common tembang, and, according to the fishermen, it likewise prefers depths of 3—4 fathoms. It is larger than the tembang ètok and special jala's with larger meshes are used for its capture. Its shoals, however, which do not mix up with those of the tembang ètok, appear and disappear fairly irregularly. According to the fishermen it is caught most during the East monsoon and along the muddy East-coast of the Bay.

A few more clupeids, though not belonging to the genus *Clupea,* may be mentioned here as occurring still nearer to the coast than the tembang ètok and the mata belo. It is the selanget, *Dorosoma chacunda* (H.B.), and the tembang putih (i.e. "the white tembang"), *Clupeoides lile* (C.V.). The former occurs in water of a few fathoms, the latter even in water of ½—1 fathom only.

Much rarer at Batavia is the tembang montjong (montjong =

muzzle) or tembang mata kutjing ("cats eye"), *Clupea (Harengula) longiceps* (C.V.), a slenderer and evidently a more pelagic species than the common tembang. Sometimes, however, it may be caught at once in considerable quantities and quite near the coast. This was e.g. the case during more than a week in September 1924 when boat-fuls were landed from the sero's (fish-stakes) east of Tandjong Priok. I found the salinity of the sea-water there, quite near the coast, to be 33,1$^0/_{00}$ which is fairly high. The fish caught was all immature. In British India this species, rightly called the Indian Sardine, plays a very important part and has recently been the subject of interesting investigations by HORNELL and NAJUDU (1).

Among the other more pelagic species the lĕmuru or sabólah, *Clupea (Amblygaster) leiogaster* (C.V.), is no doubt the most important. It is caught in large quantities with the pajang-net especially in the Eastern extremity of the Java Sea and often also in the neighbourhood of Sunda Strait, including the Thousand Islands. It is often mixed with smaller quantities of *Clupea (Amblygaster) clupeoides* (BLKR.), *Clupea (Harengula) longiceps* (C.V.), *Clupea (Amblygaster) sirm* Rupp and sometimes also with *Clupea fimbriata.*

The other *Clupea*-species, including the well-known trubuk, *Clupea (Alosa) macrura,* from Sumatra's East coast, are only of little importance in the Java Sea.

Of the three purely marine species of *Clupea* found in the European seas *Clupea harengus* has demersal eggs. Those of *Clupea sprattus* and of *Clupea pilchardus* are pelagic. As is the case with the eggs of Clupeids in general the yolk is segmented. For the literature and general description I can refer to EHRENBAUM's "Eier und Larven von Fischen", in "Nordisches Plankton". The egg of the sardine is characterized by a very wide egg-membrane, with a diameter of 1,5—1,8 mm., whereas the egg itself measures only 0,8—0,95 mm. A small oil-globule is present. The egg of the sprat has no oil-globule and no particularly wide egg-membrane. In the North Sea the diameter varies as a rule between 0,9 and 1,1 mm.

KISHINOUYE (2) describes the egg of the Japanese sardine, *Clupea melanosticta* SCHLEGEL. It closely resembles that of the European sardine, having a wide egg-membrane with a diameter of about 1,5 mm., the egg itself measuring only 1 mm. A small oil-globule is also found here.

My investigations concerning the pelagic fish-eggs in the Java Sea have thus far made me acquainted with six kinds of eggs belonging to species of *Clupea* and they all belong to the type of the sardine-egg, having a wide egg-membrane and, of course, a segmented yolk. In both respects they resemble

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(1) HORNELL, J., and M. RAMASWAMI NAJUDU, 1923, A Contribution to the Life-history of the Indian Sardine. Madras Fisheries Bulletin, Vol. 17.

(2) K. KISHINOUYE, 1907, Notes on the Natural History of the Sardine. Journal of the Imperial Fisheries Bureau, Vol. 14, nr. 3.

the numerous kinds of eel-eggs found in Indian waters. However, the latter are considerably larger.

a. The most common of these six *Clupea*-eggs is the one evidently belonging to *Clupea fimbriata* (figs. 1 and 2). The egg membrane has a diameter of 1,4—1,55 mm., the egg itself of about 0,8 mm. There is a small, more or less yellowish, oil-globule present, with a diameter of about 0,1 mm. (sometimes a second one still smaller).

b and *c.* These two kinds of eggs (figs. 6 and 11) show a great resemblance to each other. The egg-membrane is less spacious than in the foregoing and inside the outer membrane a second one is found. Both eggs contain a similar small oil-globule as is the case with *a.*

In *b* the diameter of the (outer) egg-membrane varies between 1,06 and 1,14 mm., that of the egg itself being about 0,75 mm. The inner egg-membrane is quite thin and closely attached to the outer one, so much so that sometimes it is not easy to distinguish. The diameter of the oil-globule is about 0,1 mm.

In *c* the diameter of the outer egg-membrane is slightly larger than in *b,* amounting to about 1,1—1,2 mm. In this case, however, it is the outer membrane which is very thin and which even easily wrinkles. The inner one is much less spacious and is often not perfectly globular, having a longer diameter of about 0,98 mm. and a shorter one of about 0,94 mm. The inner membrane is thick and in optical section distinctly double-lined. Its contents are slightly less transparent than the surrounding sea-water. The egg itself shows hardly any difference from the one of *b* and we shall see that the same is the case with the larvae hatched from these two kinds of eggs. There is, however, a constant difference in the time of hatching, *c* hatching early in the morning and *b* about noon only.

Both *b* and *c* are often to be found in considerable numbers not far from the coast, e.g. also in the Bay of Batavia.

d. More than once did I find in the Java Sea of fourth kind of *Clupea*-egg (fig. 15), evidently belonging to the l e m u r u, *Clupea leiogaster.* The egg-membrane has a diameter varying from 1,42 to 1,63 mm., the egg itself being about 1 mm. Thus it resembles *a,* but there is no oil-globule.

e. A few times did I find an egg, of which the egg-membrane had a diameter of about 1,75 mm. and which was further characterized by the presence of some 4—6 small oil-globules (fig. 20).

f. Finally an egg (fig. 24) has to be mentioned here which I have thus far caught on one occasion only. Oil-globules were absent here, as in *d.* The diameter of the egg-membrane, however, amounted to fully 2 mm., although that of the egg itself was less than 1 mm.

The larvae hatching from all these eggs have much the same appearance, all having the lengthened clupeid type with the anus situated far backwards, as we have seen with the larvae of *Chirocentrus* and *Dussumieria.* Here also do we meet with the crossed arrangement of the muscle-fibres in the myotomes as described in the article on *Chirocentrus.* The number of myotomes in front of the anus, indeed, is smaller in *Clupea*-species than in *Chirocentrus* and *Dussumieria*, and varies between 37 and 40. The number of myotomes behind the anus is not always easy to determine with certainty as these myotomes become less and less distinct when we approach the end of the tail. In favourable cases some 10 may be counted in young stages, but as a rule their number does not surpass 5 or 6.

I give here the number of vertebrae counted in those species of the genus *Clupea* which I have had an opportunity of examining until now.

Clupea fimbriata	29 + 16 = 45
(tembang,	29 + 16 = 45
tamban,	29 + 16 = 45
djuwi-djuwi)	29 + 16 = 45
	29 + 16 = 45
	29 + 17 = 46
	30 + 16 = 46
	30 + 16 = 46
	30 + 16 = 46
	30 + 15 = 45
	30 + 15 = 45
	30 + 15 = 45
Clupea brachysoma	27 + 15 = 42
(tembang ètok	28 + 15 = 43
or perampuan)	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	28 + 15 = 43
	29 + 15 = 44
	29 + 14 = 43
Clupea kanagurta	25 + 18 = 43
(mata bĕlo)	26 + 16 = 42
	27 + 16 = 43
	26 + 17 = 43
	26 + 17 = 43
	26 + 17 = 43
	26 + 17 = 43
	26 + 17 = 43
	26 + 17 = 43
	26 + 17 = 43

Clupea longiceps	30 + 16 = 46	
(tembang montjong	30 + 17 = 47	
or mata kutjing)	31 + 16 = 47	from
	31 + 16 = 47	Madura Strait
	31 + 16 = 47	
	31 + 16 = 47	
	31 + 15 = 46	
	32 + 15 = 47	
	32 + 15 = 47	from Batavia
	32 + 15 = 47	
	32 + 15 = 47	
Clupea leiogaster	29 + 14 = 43	
(lĕmuru)	29 + 14 = 43	
	29 + 14 = 43	
Clupea clupeoides	29 + 14 = 43	
(gili)	28 + 15 = 43	
	28 + 15 = 43	
Clupea sirm	28 + 14 = 42	
	28 + 14 = 42	
	28 + 14 = 42	
Clupea macrura	26 + 16 = 42	
(trubuk)	26 + 16 = 42	
	27 + 18 = 45	

For the sake of completeness I add:

Dorosoma chacunda	26 + 15 = 41
(sĕlanget)	25 + 16 = 41
	25 + 16 = 41
Clupeoides lile	24 + 16 = 42
(tembang putih)	24 + 16 = 42
	24 + 16 = 42

From this list it may be seen that the numbers in the different species vary only slightly and that it will be difficult, and we may safely say impossible, to identify a larva, and the egg from which it hatches, by the aid of this character only.

From a comparison of the number of trunk vertebrae in the adults with the number of trunk myotomes in the larvae it at once becomes evident that during their development the anus moves forward over a distance of about 10 myotomes. This phenomenon, stated already in the articles on *Chirocentrus* and *Dussumieria,* will be met with regularly in further articles on the development of clupeoid fishes.

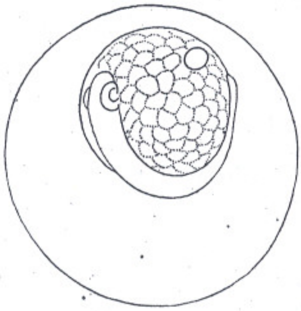


Fig. 1. Egg of the t e m b a n g *(Clupea fimbriata)* at 10.30 a.m., × 26.

We will now proceed to a more detailed description of the eggs mentioned above. As has already been stated the egg mentioned sub *a* (fig. 1 and 2) is by far the most common one and is sometimes found in very large quantities. This was found to be the case more than once in places where at the same time t e m b a n g *(Clupea fimbriata)* was caught plentifully. By the presence of the small oil-globule this egg to be sure, of all those described above, resembles most of all the eggs of the European and of the Japanese sardine, and we might be inclined, therefore, to attribute it to the nearest Indian relative of these two, being the l ĕ m u r u *Clupea (Amblygaster) leiogaster.* Continued observations, however, have convinced me that this supposition cannot be right. The l ĕ m u r u is a more pelagic species than the t e m b a n g and hardly ever enters e.g. the Bay of Batavia, where t e m b a n g is regularly caught in considerable numbers, as mentioned in the beginning of this article. Yet the egg *a* was often found in the surface catches there in considerable quantity, and more than once in places where at the same time the ripe t e m b a n g itself was caught by the fishermen.

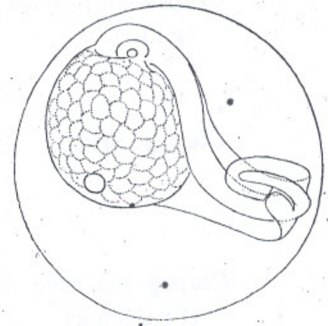


Fig. 2. The same ready to hatch, at 5 p.m., × 26.

This was also the case on April 5th and 6th, 1924, north of the Bay of Bantam, where we found a number of native fishing-boats from Bantam, so called majang-prahus, engaged in a very profitable fishery of t e m b a n g which, however, was mixed in this case with l ĕ m u r u. The latter, as stated above, is generally met with in the eastern part of the Java-Sea and in and near Sunda Strait, in general there, where the water is more oceanic. Just like the t e m b a n g, the l ĕ m u r u swims in large shoals, but the shoals of these two species seem to mix up only to a limited extent. Some of the fishing-prahus, at least, caught almost exclusively t e m b a n g, others, quite near, only l ĕ m u r u. The t e m b a n g prevailed on the whole.

The surface catches with the egg-net contained an enormous number of eggs *a* and hardly any *d.* Of the latter I did not succeed in finding more than 3 specimens. To get an idea of the number of the egg *a* I made, at 7 a.m. on April 6th, a vertical haul with the egg-net, at 5°52′ S 106°12′ E. The depth being 11½ fathoms there, I hauled from 18 M. to the surface. There proved to be present 4500 eggs under 1 M², i.e. 45 eggs under 1 d.M². The salinity of the water was $31{,}5^0/_{00}$.

Evidently spawning had taken place not very long before, as all the eggs showed a small germinal disc. They floated below the surface of the water with the germinal disc turned down and the small oil-globule at the upper side. In accordance with the rapid rate of growth we may safely conclude that spawning had taken place not more than a few hours before, towards the morning.

At 8.45 a.m. the germinal disc had grown round half the circumference of the egg, and the first indication of the embryo appeared. At 10.45 a.m. the blastopore closed and the rudiment of the embryo had grown more distinct, as shown by fig. 1. The oil-globule now lay near the caudal end. During the afternoon the tail grew out, the embryo began to sprawl within the spacious egg membrane and at 6 p.m. the eggs hatched. On another occasion the development proceeded in quite the same way but hatching occurred slightly later, viz. between 7 and 8 p.m.

The new-born larva is shown in fig. 3. Just like the egg it floats right below the water-surface, head up and tail down, or upside down with the tail directed obliquely downwards. The anus lies under the 40th myotome, behind it some 11 or 12 more could be counted. Pigment is absent.

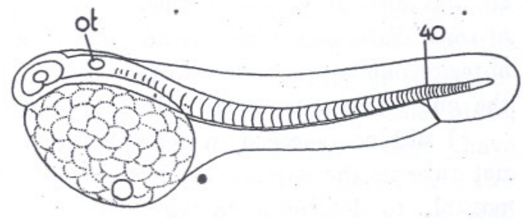


Fig. 3. Newly hatched larva of the tembang, × 26. *ot* ear vesicle.

During the night stretching occurs, as shown by fig. 4 representing an embryo of the next morning. The length has increased, the yolk has decreased. The head develops and the rudiments of the gill-slits are visible. Under the

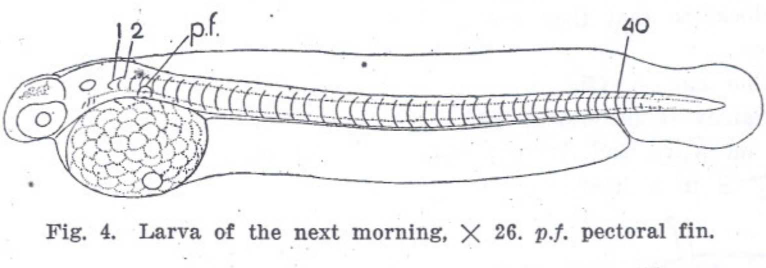


Fig. 4. Larva of the next morning, × 26. *p.f.* pectoral fin.

fourth myotome the rudiment of the pectoral fin appears. The anus still lies under the 40th myotome but behind it no more than some five others can be counted. The muscle-fibres in the myotomes show that crossed arrangement, formerly described in *Chirocentrus*-larvae. A few faint pigment-spots may be observed dorsally behind the auditory vesicles and on the brain.

In the evening of the second day the eyes begin to get slightly pigmented and the under-jaw grows out. The next morning the eyes are black and the yolk has disappeared. The larvae are swimming about in a snake-like manner, now as a rule near the bottom of the glass, with their heads downwards, as if they were trying to get into deeper water-layers. This may be observed with many fish-larvae reared from eggs and perhaps it accounts for the relatively small number of very young larvae found in the horizontal surface catches with the egg-net.

A larva still one day older, so of about 2½ days, is represented in fig. 5.

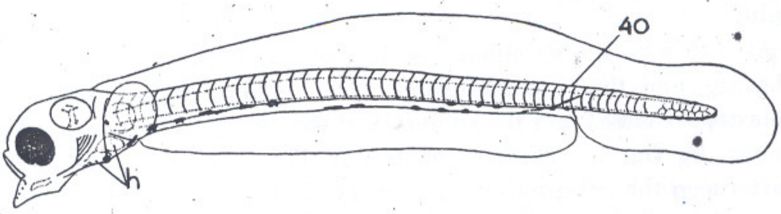


Fig. 5. Larva of 2½ days, × 26. *h*. heart.

The gill-slits have developed and the gill-cover is growing out. The pectoral fin has also developed further. The anterior myotomes, originally situated at some distance behind the auditory vesicle, have moved forwards so that the anterior one now lies close to the vesicle. Black pigment spots are found along the gut. The anus is still situated under the 40th myotome.

I did not succeed in rearing the larvae any further. Older larvae are not rare in the surface catches with the egg-net, but as it has not yet been possible to determine to which of the eggs dealt with in this article they belong, we will describe and show a few of them at the end only.

Besides the t e m b a n g egg, two other kinds of *Clupea* eggs may not rarely be met with in the surface catches in the Bay of Batavia, viz. the eggs *b* and *c*. Of these *b* was most frequently met with, but this is evidently due to the fact that the eggs *c* always hatch very early in the morning, as a rule already before 8 o'clock, so that they are no longer found in later catches.

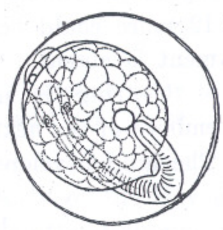


Fig. 6. The egg *b* (probably m a t a b ĕ l o, *Clupea kanagurta)*, at 10 a.m., × 26.

The egg *b* (fig. 6) was a few times met with abundantly right north of the harbour of Priok. Thus on April 2nd, 1925, I found them at 106°53′ E 6°4½′ S in a hawl from 9—9.30 a.m. In the next hawl, 9.45—10.15 a.m., slightly more to the north, viz. 106°52′ E 6°1½′ S. I found them in large numbers. In the next hawl, 11—11.15 a.m. and 106°52½′ E 5°59′ S, they were still present though less numerous. The salinity of the water in these three places was

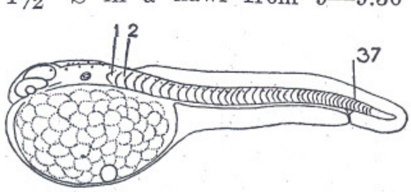


Fig. 7. Newly hatched larva from the egg b, × 26.

$30{,}1\,^0/_{00}$, $28{,}9\,^0/_{00}$ and $27{,}2\,^0/_{00}$ resp. On January 10th, 1923, steaming in the same way north of Priok-harbour and making horizontal surface hawls, I found one *b* at 9.30 a.m. and 106°53′ E 6°4′ S, a number of them at 10 a.m. and 106°53′ E 6°2′ S, not a single one at 10.30 a.m. and 106°53′ E 6°0′ S, and a great quantity at 11 a.m. and 106°53′ E 5°58′ S. The salinities were then $33{,}2\,^0/_{00}$, $33{,}4\,^0/_{00}$, $33{,}85\,^0/_{00}$ and $33{,}2\,^0/_{00}$ resp. Further northward the salinity sank below $33\,^0/_{00}$, being on an average $32{,}8\,^0/_{00}$.

On January 13th, 1923, I steamed eastward across the Bay from 106°44′ E 5°58′ S to 106°58′ E to 5°58′ S, making 8 surface hawls of 6 minutes each, with equal intervals of 2′ each. I found *b* in the last two catches only, 106°56′ E and 106°58′ E resp. In these places the salinity was $33{,}1\,^0/_{00}$, whereas at the other six stations the salinity rose gradually from $32{,}7\,^0/_{00}$ to $32{,}95\,^0/_{00}$.

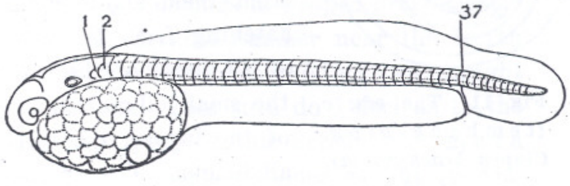


Fig. 8. Larva at 5.30 p.m., × 26.

From all this it seems fairly evident that the spawning places are not determined by the salinity of the water in the first place, as the eggs have been found in water of $27{,}2\,^0/_{00}$ as well as in water of $33{,}4\,^0/_{00}$.

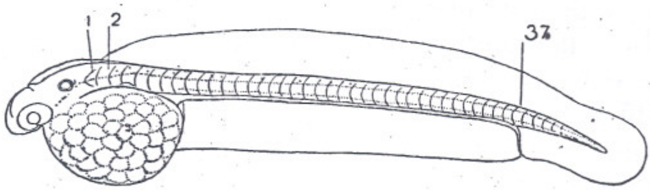


Fig. 9. Larva of the next morning, × 26.

Regarding the egg *c* my observations are less numerous. It has been found in water with a salinity of $31{,}4\,^0/_{00}$, $31{,}9\,^0/_{00}$, $32{,}7\,^0/_{00}$ and $32{,}85\,^0/_{00}$. I have found it in large numbers especially on April 3rd and 4th, 1925, along the north coast of Krawang, near the native village of Tjimara. Some of them began to hatch as early as 6.30 a.m. and at 8 a.m. most of them had come out. A number of them caught on July 27th, 1922, between the Bay of Bantam and Pulu Babi (106°17½′ E 5°52¼′ S) hatched between 8 and 9 in the morning. Never did I find the eggs in later catches.

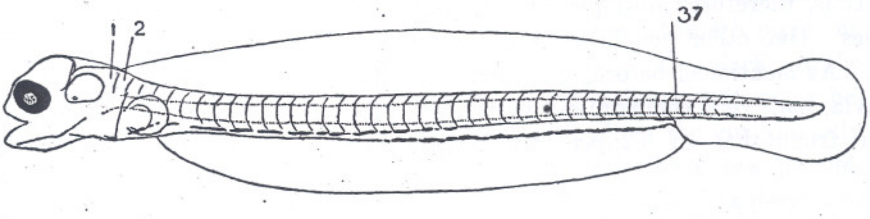


Fig. 10. Larva of the second morning, × 26.

The egg *b* hatches somewhat later, a few beginning as early as 10 a.m., the majority coming out before noon.

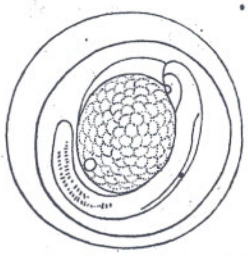


Fig. 11. The egg *c* (t e m b a n g è t o k, *Clupea brachysoma*), × 26.

Although the eggs *b* and *c* themselves differ from the other four kinds described in this article by the double egg-membrane and by the absolutely and relatively smaller diameter of the outer membrane (not so much of the egg itself), yet the larvae hatching from them show hardly any difference from those hatching from the other eggs. They resemble most of all those of the t e m b a n g, by the presence of the small oil-globule in the yolk-sack and by the size of the larvae, those from the eggs *d*, *e* and *f* being all longer. The number of myotomes in front of the anus is 37 in both (in the t e m b a n g-larva 40).

Now the only *Clupea*-species which, besides the t e m b a n g, occur regularly in the Bay of Batavia are *Clupea brachysoma*, the t e m b a n g è t o k or t. p e r a m p u a n, and *Clupea kanagurta*, the m a t a b ĕ l o, both with a slightly smaller number of vertebrae, this number being on an average 30 + 15 = 45 for the t e m b a n g, 28 + 15 = 43 for the t e m b a n g è t o k, and 26 + 17 = 43 for the m a t a b ĕ l o.

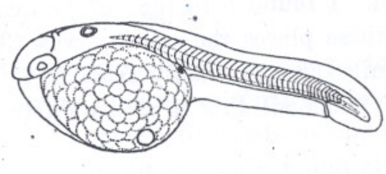


Fig. 12. Newly hatched larva, at 8 a.m., × 26.

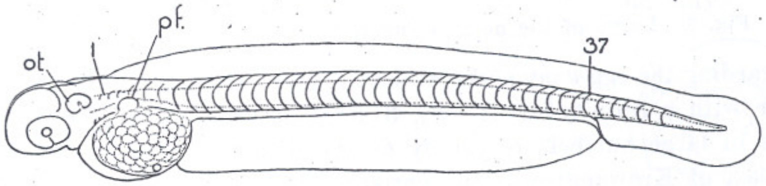


Fig. 13. Larva of the next day, × 26.

It is, therefore, most probable that the eggs *b* and *c* belong to these two species. One other possibility, however, may not be left out of consideration here. As mentioned before, there are two other clupeoid fishes in the Bay of Batavia, both very common and with a number of vertebrae not differing very much from that of *Clupea brachysoma* and *kanagurta*. These are the

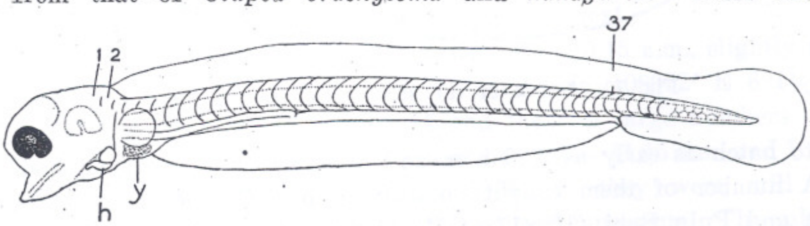


Fig. 14. Larva of the second morning, × 26. *y* rest of the yolk.

s ĕ l a n g e t, *Dorosoma chacunda,* with $25 + 16 = 41$ vertebrae, and the t e m b a n g p u t i h, *Clupeoides lile,* with $24 + 16 = 40$ vertebrae.

The egg of the former species has been identified by me and will be described in a following article. Incidentally it may be mentioned here that the newly hatched larva has 33 pre-anal myotomes. I have not yet found, however, the eggs of the t e m b a n g p u t i h, nor, indeed, did I ever see ripe specimens of this fairly common little fish.

Now it seems probable to me that the egg *c* belongs to *Clupea brachysoma:* the eggs were caught in April 1925 in considerable number near the North coast of Krawang and in this same region the t e m b a n g è t o k was caught near the coast and landed in great quantities. Less sure do I feel as to the origin of the egg *b*. As stated in the beginning of this article, the m a t a b e l o is fairly irregular in its occurrence, being sometimes caught in considerable quantity in the sero's quite near the shore, then again disappearing after a few days. If, on such an occasion, I were able to make surface catches with the egg-net in the neighbourhood of these sero's and could state the presence of the eggs *e* there, it would be possible to prove the correctness of our supposition that we are dealing with the egg of the m a t a b e l o. I have made a few attempts in this direction which, however, have not yet yielded convincing evidence. No doubt, however, the opportunity will come some day, sooner or later.

The other possibility, viz. that the egg *e* belongs to the t e m b a n g p u t i h, seems less probable in view of the fact that the number of trunk vertebrae here is still lower than in the m a t a b e l o, so that also a lower number of trunk myotomes in the larva might be expected. Yet it seems strange that the eggs of this common fish have never been found by me. Do they perhaps hatch still earlier than the eggs *b*, possibly even before sunrise? In this case we cannot expect to find them in the surface catches, which can be examined only by daylight.

As may be seen by comparing the figures, the larvae hatching from the eggs *b* and *c* are practically identical. Even in the number of pre-anal myotomes there is no difference. Just as with the t e m b a n g we see the rudiment of the pectoral fins appearing between the 3rd and the 4th myotome on the morning of the second day, and the eyes have become black on the morning of the third day. In this stage there is one striking difference between the larvae *b* and *c*: in *b* black pigment is present along the gut, dorsally in the anterior part, ventrally in the posterior part, and also a few patches at the end of the tail. This pigment seems to be even more strongly developed than in the corresponding t e m b a n g-larva. In *c*, on the contrary, no pigment can be discovered, althought, just as with *a* and *b*, scattered small black dots are already present in the egg.

After having dealt with the three kinds of *Clupea*-eggs occurring in the Bay of Batavia, we now proceed to the three eggs which have thus far been found outside the Bay only and evidently belong to less neritic species of *Clupea*.

The egg *d* (fig. 15) is less frequently met with than the egg *a*, from which it is distinguished mainly by the absence of the oil-globule, the diameter differing only slightly. My opinion that it must be ascribed to the l ĕ m u r u rests on the following evidence. We caught a good many of these eggs on July 31st and August 1st and 2nd, 1921, between Pulu Kotot and Pulu Karang (Thousand Islands), where at the same time a number of fishing-prahus were operating which were making good catches of l ĕ m u r u. As mentioned above, I also found these eggs, though in very limited quantity, in April 1924 north of the Bay of Bantam where t e m b a n g was caught mixed with l ĕ m u r u. These eggs were met with also on a few other occasions.

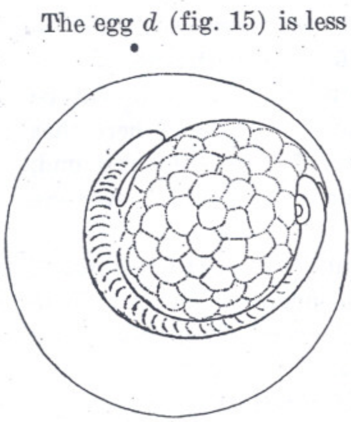


Fig. 15. Egg of the l e m u r u *(Clupea leiogaster)*, × 26.

In general I found these eggs to be somewhat further advanced in development early in the morning than those of the t e m b a n g. This was very evident in the case of April 1924 when both kinds were caught together. Whereas the eggs of the t e m b a n g showed a germinal disc, those of the l ĕ m u r u already contained an embryo with the tail growing out. They hatched at 3.30 p.m. (those of the t e m b a n g at 6 p.m.). It seemed evident that the l ĕ m u r u had spawned earlier during the night than the t e m b a n g.

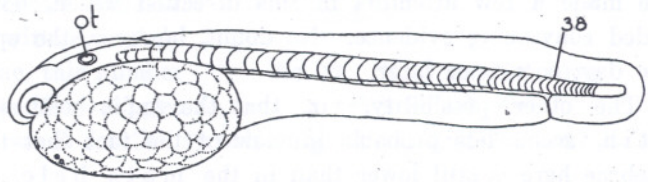


Fig. 16. Newly hatched larva, × 26.

On other occasions, indeed, I found that the eggs hatched somewhat later, e.g. on August 7, 1920, near Karimon Djawa, at 3.45 p.m., on July 31, 1921, at 5.15 p.m., and on August 1st, 1921, even somewhat later still.

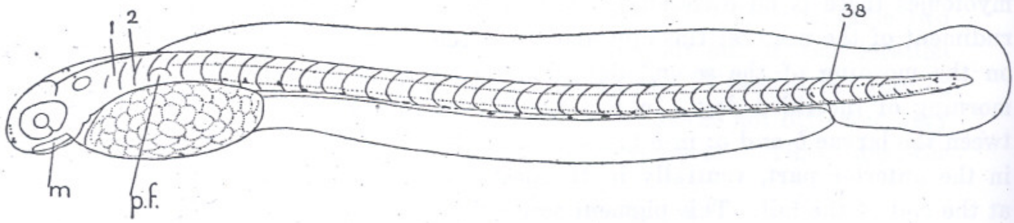


Fig. 17. Larva of the next morning, × 26.

On the other hand, I have also made a few observations of tembang eggs hatching earlier. Thus on April 5th, 1924, a few hatched already at 5 p.m., and in the catch of Juli 18th, 1919, at station J (cf. Treubia II, p. 106) a number of tembang eggs occurred which were on the point of

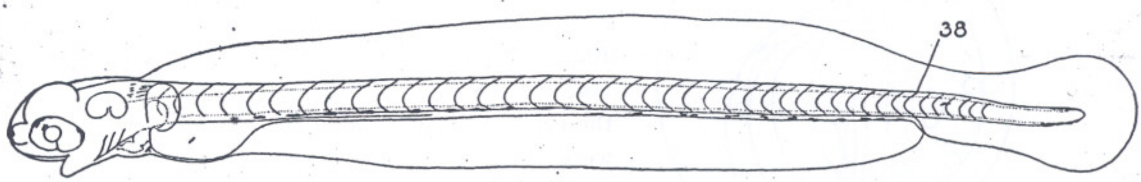


Fig. 18. Larva of 24 hours, × 26.

hatching (one larva was already free at 2.30 p.m.).

As the surface temperature in the Java Sea does not vary more than 1 or 2 degrees as a rule, these differences can hardly be attributed to the influence of the temperature on the rate of development, but are mainly a consequence of the different times at which spawning had occurred. It is evident that both tembang and lemuru spawn during the night, but this may take place somewhat earlier or later.

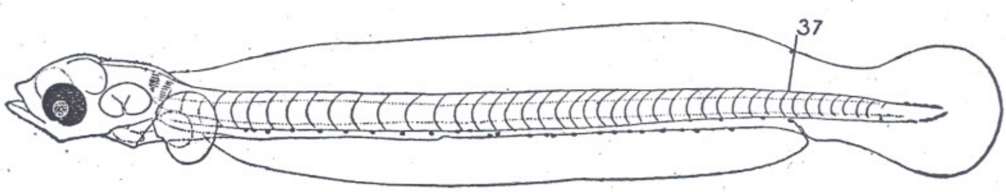


Fig. 19. Larva of 3 days, × 26.

If we now compare the lemuru larvae with those of the other three kinds, described above, there appears to be hardly any difference again. It is evident from a comparison of the figures, however, that the lemuru larvae are larger and longer. The number of myotomes in front of the anus, (37—)38, is slightly less than in the tembang larvae (40) and corresponds more with that in the tembang ètok and the mata bĕlo (37). In the adult fishes, indeed, the number of trunk vertebrae is hardly less than in the tembang; the total number appears to be somewhat higher for the tembang than for the lĕmuru, being 45—46 and 43 resp.

The rate of development seems to be almost the same as in the three foregoing species. Here also the eyes showed a first trace of darkening in the evening of the second day, and were black on the morning of the third day. Pigment spots along the gut were present already the morning after hatching and so seem to appear somewhat earlier than in the tembang larva.

The development of the eggs *e* and *f* proceeds much along the same lines. The egg *e* (fig. 20) has been met with three times until now. Eighteen of them were caught, together with l ĕ m u·r u eggs, on August 9th, 1920, near Karimon Djawa, one was caught on October 23rd, 1924, near Sapeken (Kangean Archipelago, salinity $34{,}8^0/_{00}$), and one on January 16th, 1925, slightly South of Berhala Strait (salinity $28{,}7^0/_{00}$!). On all three occasions the eggs hatched as early as 1 p.m. The eyes were found to be black after 1½ days, viz. at 1 a.m. of the third day. The number of myotomes in front of the anus was 38. Pigment spots along the gut were present on the morning of the second day. The larva is considerably longer than that of

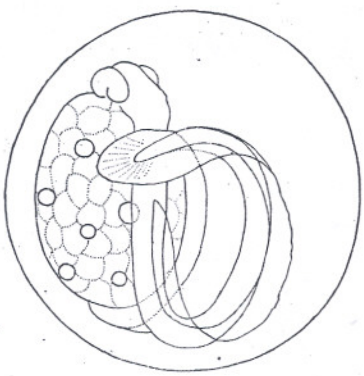


Fig. 20. The egg *e* ready to hatch, × 26.

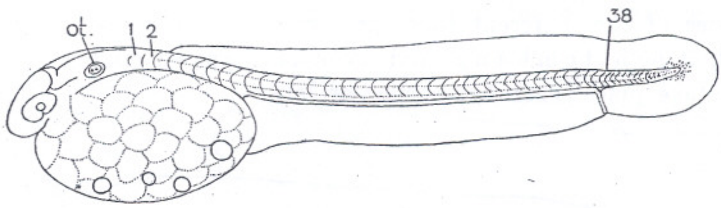


Fig. 21. Newly hatched larva, × 26.

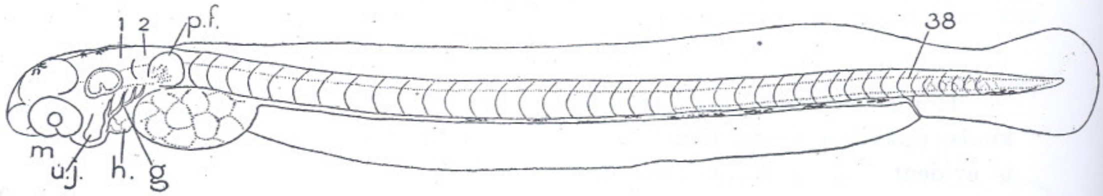


Fig. 22. Larva of 28 hours. *u. j.* under jaw. *g* gills.

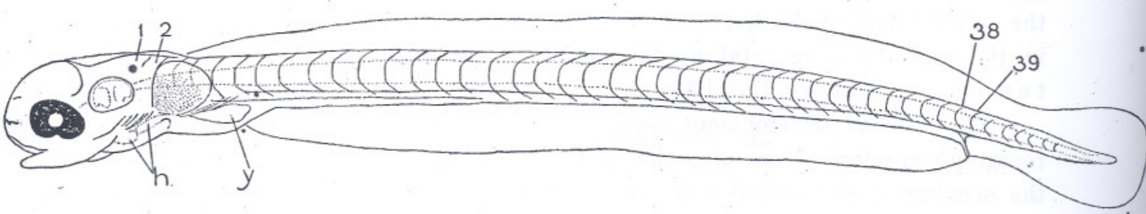


Fig. 23. Larva of 1½ days, × 26.

a, *b* and *c*, and in this respect corresponds with that of the l ĕ m u r u.

As uncertain as that of the former is the origin of the egg *f* (fig. 25). It has thus far been caught only once in the surface hauls, viz. 8 specimens on August 7th, 1920, near Karimon Djawa, together with the eggs *d* and *e*, and

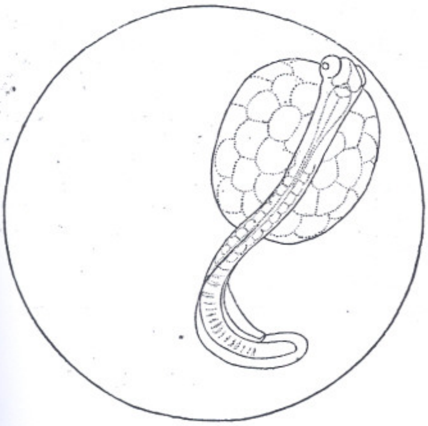


Fig. 24. The egg *f*, × 26.

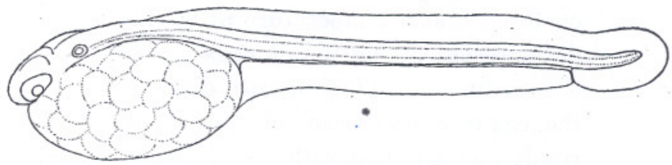


Fig. 25. Newly hatched larva, × 26.

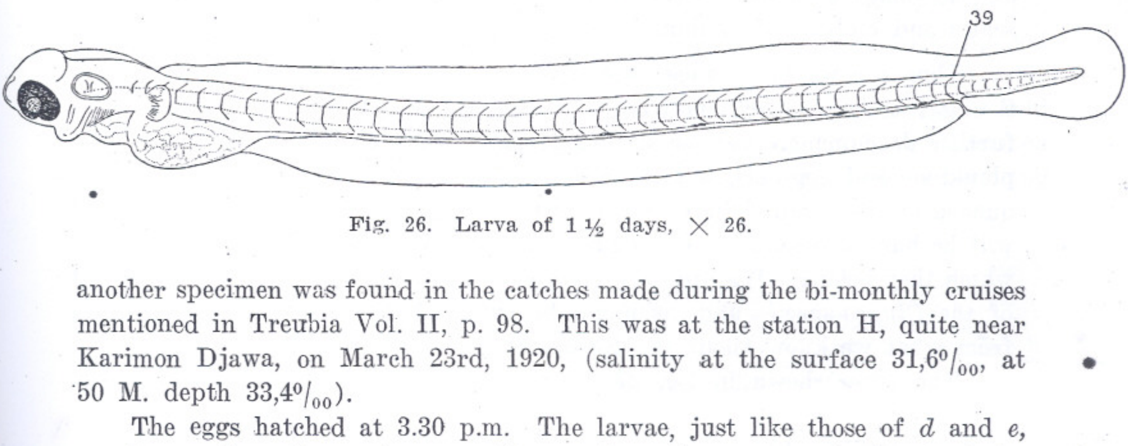


Fig. 26. Larva of 1 ½ days, × 26.

another specimen was found in the catches made during the bi-monthly cruises mentioned in Treubia Vol. II, p. 98. This was at the station H, quite near Karimon Djawa, on March 23rd, 1920, (salinity at the surface $31{,}6^0/_{00}$, at 50 M. depth $33{,}4^0/_{00}$).

The eggs hatched at 3.30 p.m. The larvae, just like those of *d* and *e*, are longer than those of *a*—*c*. The number of myotomes in front of the anus is 40.

Probably the eggs *c* and *f* belong to the *Clupea*-species occurring together with the l ĕ m u r u and which are themselves sometimes designated by the same name. These are *Clupea clupeoides, Clupea sirm* and *Clupea longiceps*, perhaps still others. Further investigations, however, will have to decide the exact origin. International cooperation would be of great use in this respect. Thus *Clupea longiceps* seems to be a very common form in certain parts of British India. What would be more obvious than for the investigators there to try and discover its eggs? Species less common in one country may be common in another. If their life history be studied in the latter, this may also help to eliminate in other countries uncertainties like those exposed above.

If, finally, we compare the rate of development of the Indian *Clupea*-eggs with that of the eggs of the sardine, then we see at once that in Indian waters the development proceeds much faster than in Europe. In India the eggs hatch within less than 24 hours, in some species (cf. the egg *c*) perhaps in hardly more than 12 hours. Concerning the egg of the sardine I read in EHRENBAUM's compendium („Nordisches Plankton"): "Nach etwa 3 Tagen entschlüpft dem Ei eine Larve von etwa 3,8 mm Länge". This evidently refers to an observation of CUNNINGHAM near Plymouth. Unfortunately I have no opportunity here to consult CUNNINGHAM's article and to see, if temperature observations have been made. RAFFAELE (1) gives an incubation period of 4—5 days, at a temperature of 9—12° C. It is evident, at any rate, that the development of the Indian eggs proceeds at least three times as fast as that of the sardine egg, which hardly differs in size from the former (the diameter of the egg-membrane can, of course, be left out of consideration). A similar result was obtained with several other fish eggs. "Nach etwa 5 Tagen ist der Dotter resorbiert", says EHRENBAUM further. In Indian *Clupea*-larvae this takes 1½—2 days. Here again development proceeds 3 times as fast. The probability is great, that this rule applies to the growth process of European and Indian sea-fishes in general which, unfortunately, we have not yet been able to compare, as a consequence of the absence of reliable year rings on the scales and otoliths of Indian fishes.

Thus far we have traced the development of the larvae hatching from the eggs as far as they could be reared in a glass with clean sea-water. The further development may be studied from the larvae in the catches with the plankton- and egg-nets, but it need hardly be emphasized that, as a consequence of the small differences offered by the respective kinds of larvae, it will be hardly possible to distinguish in the older stages the exact species to which they belong. We can only get a general idea of the larval development of the *Clupea*-species and, as might be expected, this does not differ much from what we know about the European species.

The larva shown in fig. 27, length 5,5 mm., was caught on May 5th,

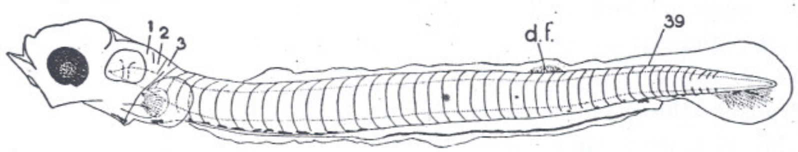


Fig. 27. Larva of the tembang fished May 5th, 1922
Length 5,5 mm. *d.f.* dorsal fin.

1922, at 6°40′ S 110°5′ E (depth 22 fathoms, salinity 32,3°/$_{00}$). From the number of prae-anal myotomes, viz. 39, it seems most probable that we are dealing here with the larva of a tembang. In the same catch eggs

(1) Raffaele, F., 1888, Le uova galleggianti e le larve dei Teleostei nel golfo di Napoli. Mitth. Zool. Station Neapel, Bd VIII.

of tembang were, moreover, met with. Although a good deal larger than the larva of fig. 5 it is not so very much further advanced in development. The myotomes have grown considerably higher and the pigmentation somewhat more distinct. A series of black pigment spots is found along the gut, in the anterior part above and in the posterior part along the underside of the latter. The larval unpaired fin fold is decreasing and the first indications of the dorsal and of the caudal fin are visible.

Fig. 28 represents a larva of 7,7 mm. from the surface of the Bay of Batavia

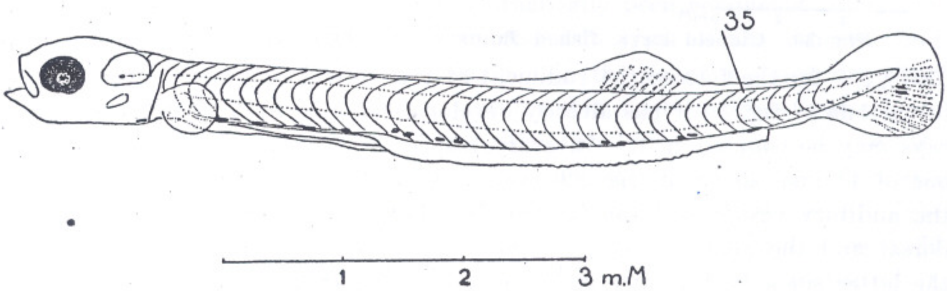


Fig. 28. Clupeid larva, fished January 13th, 1923. Length 7.7 mm.

(January 13th, 1923, depth 14 fathoms, salinity $32,7^0/_{00}$) in which the beginning of the dorsal and the caudal fin is slightly further advanced. In front of the anus we count 35 myotomes. From the anus there emerged an empty copepod skin which gives us an indication regarding the food of these young larvae.

Fig. 29 shows a larva of 11 mm. in which the larval unpaired skin fold has practically disappeared. The dorsal and the caudal fin have developed further; in the former some 15 fin rays may be counted now, new ones being added at the anterior end of the fin.

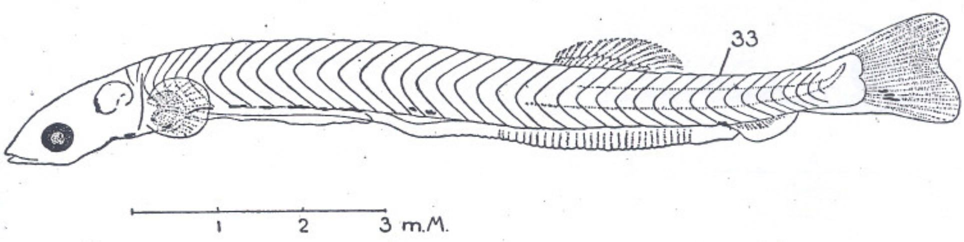


Fig. 29. Clupeid larva, fished January 11th, 1923. Length 11 mm.

In the caudal fin there are 19 fin rays. The anal fin is also developing, some 14 fin rays could be counted in it. No indication can be discovered as yet of the ventral fins. The gut begins to show these peculiar transverse folds of its inner wall which are so characteristic of somewhat older clupeid larvae. A first trace of them may already be discovered in the larva of fig. 28.

In front of the anus there are now 33 myotomes, whereas in a larva of 9,25 mm. 34 were present. This illustrates very well the gradual forward movement of the anus during the development. This larva also was caught on the surface of the Bay of Batavia, on January 11th, 1923, the salinity being $32{,}85^0/_{00}$ and the depth 14 fathoms.

A larva of 13,5 and one of 14,25 mm., the latter shown in fig. 30, were caught east of Pulu Pandang (Thousand Islands) in January 1925 (salinity

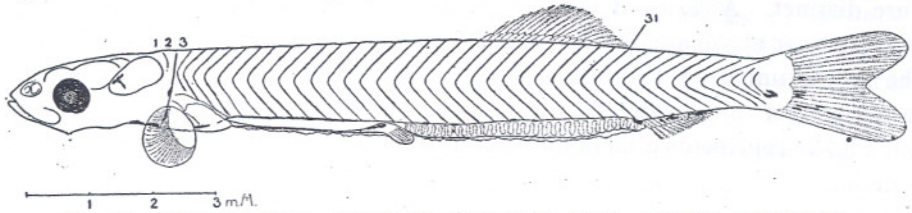


Fig. 30. Clupeid larva, fished January 14th, 1925. Length 14.25 mm.

$31{,}5^0/_{00}$). In the former the rudiment of the ventral fins had just appeared, in the one of fig. 30 it has already developed slightly further and some 6 fin rays may be counted in it. In every respect this larva closely resembles the one of 11 mm. shown in fig. 29, even in such details as the pigment spot on the auditory vesicle and the further distribution of the pigment spots. The dorsal and the anal fin have developed further, in the former some 17, in the latter some 16 fin rays can be counted. In front of the anus there are now only 31 myotomes, two less again than in fig. 29. The transverse folding of the inner wall of the gut has become more pronounced.

In all these larvae the situation of the dorsal fin is still very different from what we find in the adult fish where it is placed in all *Clupea*-species right above the ventral fins and a good distance in front of the anus.

A few older stages, to be described now, were gathered from the so-called t r i n a s s i. T ĕ r i is the general Malay name for *Stolephorus*-species. At the Pasar ikan there sometimes arrive quantities of very young, scale-less fishes,

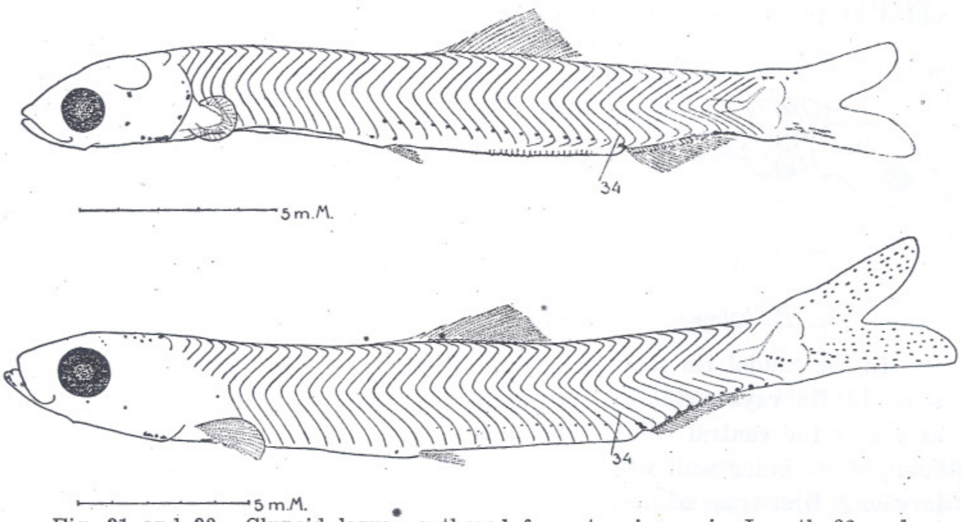


Fig. 31 and 32. Clupeid larvae gathered from t e r i n a s i. Length 22 and 27.5 mm. resp. (the fin rays of the tail have not been drawn, only the black pigment spots).

called tri nassi and consisting mainly of older larvae of *Stolephorus, Dussumieria* and *Clupea*. The larvae shown in figs. 31 and 32 were among them.

They have a length of 22 and 27,5 mm. resp. If we compare them with the foregoing figures we note in the first place that the height is increasing and that the fins have all developed the full number of fin rays, being about 19 for the dorsal as well as for the anal fin. The dorsal fin is moving forward and in fig. 32 its anterior end has come right above the ventral fins. The myotomes are growing downward, gradually enveloping the gut from the left and the right side, a process which has practically been completed in fig. 32.

If now we count the number of myotomes in front of the anus we find in the two larvae 34 for both, so more than in the younger stages described before. The only explanation I can give for this discrepancy is that we are dealing with different species. If, e.g., the two larvae of figs. 31 and 32 belong to the tembang, which has 40 trunk myotomes in the larva and about 30 trunk vertebrae in the adult, the larvae of figs. 28, 29 and 30 might belong to the tembang ètok or the mata bĕlo, which have 37 trunk myotomes in the larva and about 28—26 trunk vertebrae in the adult. This explanation would account for the whole difficulty, if the larva of fig. 31 were of equal length as the one of fig. 30. It is, however, considerably longer and so we might have expected a still lower number of trunk myotomes than in the larva of fig. 30, which makes the difference still greater. Yet I do not know any other explanation so far than the one given above, unless we assume that the larvae of figs. 28—30 belong to a species with a still lower number of trunk vertebrae as e.g. the sĕlanget *(Dorosoma chacunda)*, with 26, or the tembang putih, with 24 trunk vertebrae. This, however, is neither probable, as we shall see that in the newly hatched larvae of the sĕlanget the number of preanal myotomes is not more than 33—34, whereas the number of fin rays of the dorsal fin in fig. 30 is greater than that of the tembang putih (15—16).

Another series of *Clupea*-larvae is shown in the figs. 33—35. They were caught near Bagan Si Api Api, a well-known centre of fisheries on the East coast of Sumatra, where the fish-fauna is quite different from that of the Java-Sea. The most common *Clupea*-species here is the large trubuk *(Clupea macrura)*. I am not sufficiently acquainted with the fish-fauna of this region to state what smaller *Clupea*-species occur here, but in the catches examined by me I never saw any except the mata bĕlo *(Clupea kanagurta)*. So it seems to me most probable that the larvae shown here are either those of the trubuk, of which I do not know the egg as yet, or those of the mata bĕlo.

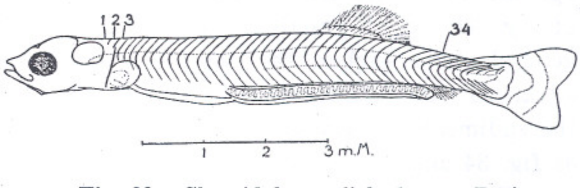
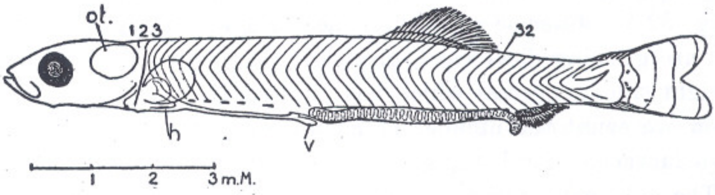


Fig. 33. Clupeid larva fished near Bagan Si Api Api (Sumatra). Length 9 mm.

As regards the number of trunk myotomes they tally fairly well with the larvae shown in figs. 28—30, which we have supposed to belong to the tembang ètok or the mata bĕlo. In the larva of 9 mm. we count 34 myotomes in front of the anus, in the larva of 11½ mm. 32 — the same number as in the larva of 11 mm. shown in fig. 29 — and in the larva of 16 mm. 31, thus showing again a gradual decrease. The trụbuk, indeed,



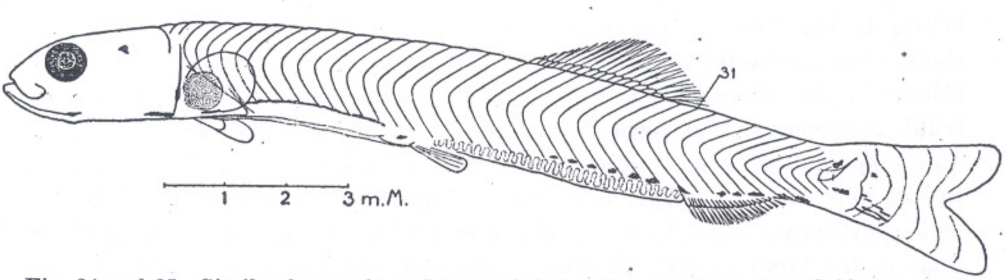


Fig. 34 and 35. Similar larvae from Bagan Si Api Api. Length 11 ½ and 16 mm. resp.

belongs with the mata bĕlo to the sub-genus *Alosa* in which the number of trunk vertebrae appears to be relatively low. For the trubuk as well as for the mata bĕlo we don't find more than 26—27 at any rate. This is in fair accordance with the numbers found for the trunk myotomes in the two kinds of larvae.

Now if we further compare the corresponding stages of these two kinds of larvae, those from Bagan appear to be somewhat further advanced in development than those from the Bay of Batavia. Thus the larva of fig. 29 and of fig. 34 are of practically the same length, but in the latter we see the general shape higher, the development of the dorsal and anal fin further advanced, the transverse folding of the inner gut wall more pronounced, and the rudiment of the ventral fins has appeared. In alle these respects the larva of fig. 34 agrees more with that of fig. 30 which, however, is longer.

The number of trunk myotomes only appears to be the same in stages of corresponding length. In the stage of 9 mm. from Bagan (fig. 33) we count 34 trunk myotomes and the same number was found in a stage of 9¼ mm. from the Bay of Batavia, as has been mentioned above. In the figs. 29 and 34 we find a difference of 1 myotome, and in figs. 30 and 35 the same number is present in both.

Resuming, we may say, that it seems fairly evident that the larvae of figs. 27, 31 and 32 belong to the tembang *(Clupea fimbriata)*, but that we are less sure regarding the nature of the larvae of figs. 28—30 and 33—35 which evidently belong to a species with a smaller number of vertebrae. In all Clupeid-larvae the number of trunk myotomes lies between 40 and 30, whereas in Engraulid larvae as will be shown in a later publication, this number lies between 30 and 20. Another characteristic by which the two kinds of larvae may often be easily distinguished is the earlier appearance of guanin cristals *(tapetum lucidum)* in the eyes of the Engraulid larvae, by which the deep black of the eyes turns into a silvery hue.

Finally a few general remarks regarding the growth of the fins may be added. The first fins to appear are the dorsal and the caudal fin. The number of fin rays in the first rudiment of the former is less than in the adult fish. It increases by the addition of new rays at the anterior end, thus in caudo-rostral direction. The reverse is the case with the anal fin, where new rays are appearing at the posterior end.

The caudal fin, as is well known, appears first at the under side of the tail and assumes a terminal position only afterwards. It has 19 fin rays, all soft, and divided into pieces by interruptions at regular intervals. By their regular arrangement these interruptions of the 19 fin rays form transverse lines across the tail, which may be more or less curved. These transverse lines have been indicated in figs. 33—35. We see at once that their number increases during the growth of the larva by the addition of new ones at the hind border of the tail. They first appear as two lines in the two flaps of the tail, as shown in fig. 34, and afterwards unite in the middle. From this it is evident that the growth of the fin rays is a terminal one, new articulations being constantly added at the extremity.