FISH EGGS AND LARVAE FROM THE JAVA SEA

by

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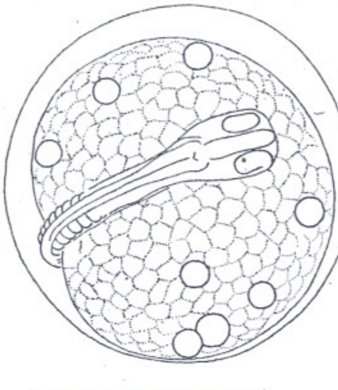
2. Chirocentrus dorab (Forsk.)

with 9 figures.

One of the easiest recognizable pelagic eggs is the one which proved to belong to *Chirocentrus dorab*. This is a herring-like fish of a very elongated shape, attaining a length of a meter and more, though as a rule, as far as I could judge from specimens from the Java Sea, it does not exceed some 60 or 70 cm. in length [1]). To its strongly compressed, sharp belly it owes the Malayan names "golok-golok" or "parang-parang", which both mean "chopping knife". It ranges from the East coast of Africa and the Red Sea to New Britain (Australia), and from Japan to Queensland. In the Java Sea it is a common fish. The eggs may be easily recognized by several peculiarities. In the first place they belong to the large variety, measuring from 1590—1670 μ when in the living condition. Thus the average diameter is nearly the same as that of the egg of *Fistularia* (cf. nr. 1 of this series, in *Treubia* Vol. II). In the second place the egg membrane is not smooth but has on its surface a network of fine ridges which give it a honey-comb appearance. A similar disposition is found in the egg of the european Dragonet *(Callionymus lyra)* and in the Java Sea I met with three or four kinds of eggs showing the same peculiarity, one of them having about the same diameter as that of *Chirocentrus*. The latter, however, differs from all these in that the network is much finer, too fine, indeed, to be reproduced in fig. 1, the meshes barely having a diameter of 15 μ. They can be illustrated only by increasing the scale of enlargement, as in fig. 2.



1m.M.

Fig. 1. Egg of *Chirocentrus dorab*, the honey-comb-like design of the egg membrane being left out.

1) According to the statements of certain authors it may attain a length of fully 12 feet (cf. D. G. STEAD, Fishes of Australia, Sydney, 1906). This statement, however, seems hardly reliable.

A third peculiarity is the segmented yolk, so characteristic for the eggs of herring- and eel-like fishes, and which always gives a strong indication as to the direction into which we have to look for the origin of any pelagic egg.

Finally a number of small oil-globules distributed irregularly in the yolk make this egg one of the most easily recognizable among the numerous kinds occurring in the Java Sea.

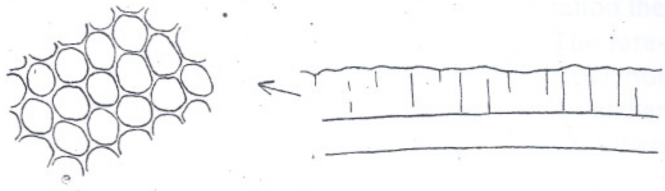


Fig. 2. Part of the egg-membrane stronger enlarged (440 ×).

In different eggs I counted from 7 to 19 of these oil-globules, the number being very variable.

I can not say how long the period of incubation is. On several occasions I have collected a considerable number of these eggs from the horizontal surface catches mentioned in the first of this series of articles, but they all showed the rudiment of the embryo already, so that I could not guess their age. Probably, however, the incubation will not take more than $1^1/_2$ or 2 days. The time of hatching was always the same, viz. between 8 and 9 o'clock in the evening of the day they had been caught, though sometimes a few might hatch a little earlier or a little later. From this circumstance we may conclude that there is also a fixed spawning time, although I could not make out at which time of the day this is.

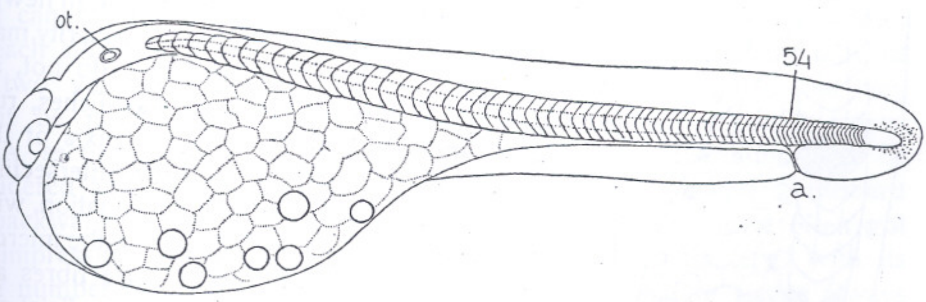


Fig. 3. Newly hatched larva, enlargement as fig. 1. *ot.* ear-vesicle, *a.* anus.

An examination of the newly hatched larva confirms at once our surmise that we are in this case dealing with an egg belonging to a fish related to the herrings. The backward situation of the anus, together with the general appearance of the larva and the segmented yolk, put this beyond doubt. The postanal part of the body, as shown in fig. 3, is less than $^1/_7$ of the total length though, in somewhat older larvae, this proportion gradually changes in favour of the tail, being 1 to $5^1/_2$ e.g. in fig. 4. The head is

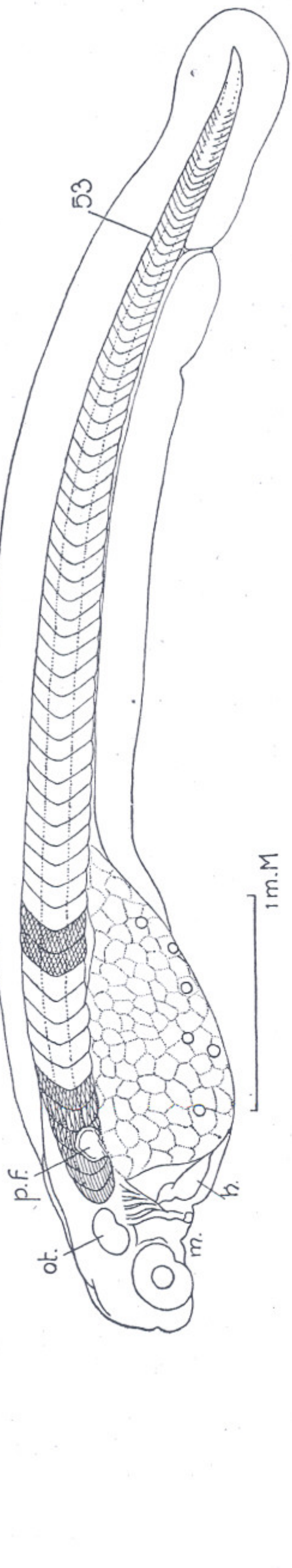


Fig. 4. Larva 48 hours after hatching, enlargement as fig. 1. h heart *m*; mouth; *p.f.* pectoral fin.

in close contact still with the voluminous yolk sack, neither mouth opening nor under jaw or gill-slits are present as yet. The eyes are without pigment. The rudiment of the organs of equilibrium are present as two vesicles, each with two statoliths in it. The beating of the heart has begun within the egg already.

A considerable lengthening occurs during the first hours after hatching, so that soon after the embryo nearly reaches the length of the one reproduced in figure 4, which, however, is old already 48 hours. The yolk decreases gradually, the oil-globules become smaller. The head is freeing itself from the yolk, the rudiments of the gill-slits and of the mouth become visible. The beginning of the pectoral fins makes its appearance between the 3rd and the 4th myotome (Fig. 4, p.f.).

Characteristic of all the larvae of *Clupea*-like fishes which I have reared until now from pelagic eggs taken in the Java Sea is the crossed arrangement of the muscle fibres in the myotomes, as I have tried to denote in Fig. 4. In newly hatched larvae already this peculiarity may be noted. The muscle fibres do not, as is the case e. g. in eel-like fishes, run parallel to the longitudinal axis of the animal, but in two directions intersecting each other. A closer examination with higher and deeper focussing of the microscope teaches that the muscle fibres are arranged in three layers, a superficial one restricted to the lower half of the myotome, a middle layer reaching from the upper to the lower border of the myotome, and a deeper one restricted to the upper half. In the middle layer the muscle fibres run in a direction from the anterior lower to the posterior upper corner of the myotome, in both the superficial and the deeper layers in the reverse direction. Only in the anterior myotomes, close behind the ear vesicle, can this crossed arrangement not be noticed.

In all these respects, then, our larva agrees with those of the *Clupea*-species and related forms, of which I have reared a fairly large number from the eggs. For further determination we will have to take into consideration the number of myotomes. The total number gives slight indication only. The foremost myotome, close behind the auditory vesicle, can easily be made out, not so, however, the hindmost. In the tail the myotomes become gradually smaller and smaller, finally to pass into the undifferentiated tail knob. Though often it may be possible still to determine the hindmost myotome, yet we are not sure that during the development of the larva no new ones are added.

From this it appears advisable to direct our attention first to the praeanal or trunk myotomes. What relation is there between their number and the number of trunk vertebrae in the adult fish? I could find only very little on this subject in the literature at hand. It is much to be regretted that EHRENBAUM, in the numerous figures of his "Nordisches Plankton, Eier und Larven von Fischen", nowhere indicates accurately the number of myotomes, hardly ever does he mention it in fact. Perhaps a more thorough examination of the literature than was possible to me would reveal some more observations on the subject, but the literature at my disposal is far from complete. Moreover my impression is that the majority of the authors have not paid much attention to the number of myotomes. In general a vertebra originates at the limit of two myotomes, but is has not yet been ascertained for Teleosteans, as far as I know, what occurs in the occipital region of the skull and how many vertebrae are incorporated into the latter. I feel sure, however, that the number of myotomes corresponding to vertebrae which are incorporated into the skull cannot be great, for in the larvae I always found only three myotomes on each side in front of the rudiment of the shoulder girdle, and only of the two vertebrae forming between these could it be imagined that they might be incorporated into the skull, although this is not certain either.

A second question is, whether the situation of the anus may be considered as fixed or whether a certain displacement of the latter in forward or backward direction is possible. In rearing my larvae I have often got the impression that the situation was fixed. In *Fistularia*, e. g., with its large number of myotomes, I found the anus in succeeding stages always under the 50th myotome.

However, as follows from SCHMIDT's observations [1]) on eel-larvae, this cannot be relied upon. He found especially in species of *Conger* during the development a strong increase of the number of the prae-anal myotomes. In *Conger vulgaris* e. g. this number was 89 in a larva of 9 mm, 100 in one of 12,5 mm. and 125 in one of 74 mm. In still older larvae, up to 130 mm, it showed a slight decrease, to 121. Simultaneously with

[1]) J. SCHMIDT, 1913, On the identification of Muraenoid Larvae in their early ("preleptocephalic") stages, in: Meddelelser fra Kommissionen for Havundersögelser, Fiskeri Bd. IV. 2.

the increase of the number of trunk vertebrae, that of the post-anal vertebrae decreases from more than 57 to 35. Thus we have to deal evidently with a movement of the anus in the direction of the tail. The same was observed in larvae of *Conger mystax*. In other species, however, as e. g. in *Muraena helena*, the situation of the anus proved to be much more constant. In four larvae of this species, with a length of 9, 12, $17^1/_2$ and $44^1/_2$ mm, the number of prae-anal myotomes proved to be constantly 80, a number reached in the egg already. Truly, in an adult specimen 70 prae-anal vertebrae only were counted.

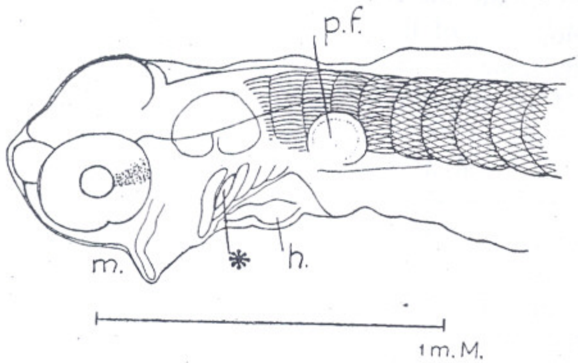


Fig. 5. Head of a slightly older larva, with the yolk nearly absorbed. The first gill-slit (*) has broken through, the under jaw is growing out.

I am sorry I cannot find any information on this subject with regard to the herring-like fishes. At my request Dr. REDEKE, of Helder, has been so kind to send me a number of larvae of the Zuidersea-herring. As Dr. REDEKE informs me, HEINCKE in his „Naturgeschichte des Herings" (1898), which I myself have not at my disposal here, gives for the average number of caudal vertebrae of this herring 13,9 (l.c. tab. 115). The total number of vertebrae being about 55,5 for the Zuiderseaherring, we find for the trunk vertebrae 55,5—14 = 41,5 on an average. Now I found in 3 newly hatched larvae, one with a yolk sack still and all measuring about 8 or 9 mm, 47 prae-anal and ± 15 post-anal myotomes, and in an older larva, measuring nearly 20 mm, 45 trunk and ± 15 caudal myotomes. It is evident from these observations and from what is found in the adult form, that in the Zuiderseaherring the anus moves forwards during development.

In newly hatched larvae of *Chirocentrus dorab* I found 53—54 prae-anal myotomes, and the same number in larvae of 48 hours, as represented in fig. 4. I did not succeed in rearing them much further, but slightly older stages were found in the catches. It appeared that in the next following stages a slight increase of the number of trunk myotomes was to be noticed. In two slightly older larvae, with the eyes still unpigmented and the yolk wholly used up, I found 55, and in larvae of about the same length (6,8—7 mm), but with black eyes (Figs. 7, 8), 57—58 myotomes in front of the anus. Then the number begins to decrease gradually. In 3 larvae of $12^3/_4$ mm I found still 57, in one of $13^1/_2$ mm and one of 18 mm each 56—57 myotomes (it cannot be determined always with certainty, which myotome is to be considered as the last trunk myotome), in one of $20^1/_2$ mm. (Fig. 9) 54, and in one of 22 mm., 52 myotomes. I have not yet observed older larvae.

Thus the number of pre-anal myotomes and, as we may conclude from it, the situation of the anus are not constant here. Behind the anus I could, as a rule, count some 17 or 18 myotomes more, in a stage similar to that of fig. 9 up to 19, in which number the undifferentiated cell-mass at the end is not included (whereas, in counting the vertebrae of an adult fish it is customary to count the urostyl as one).

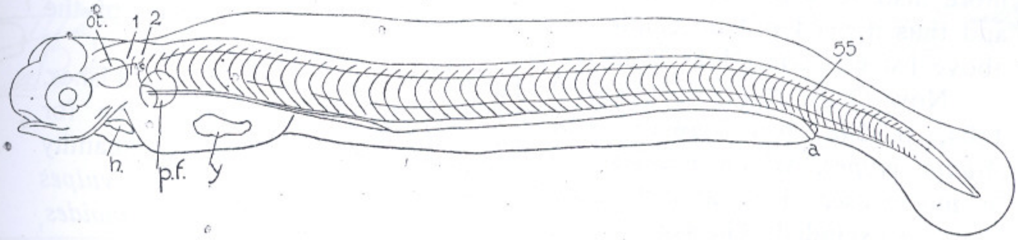


Fig. 6. Slightly older larva, enlargement as fig. 7, length 6,9 mm, *y* rest of the yolk.

Comparing the larvae now described with other larvae of herring-like fishes reared by me from eggs from the Java Sea, the number of myotomes appears to be a very large one. In four kinds of larvae, reared by me from four different kinds of eggs of the type of that of the European sardine I found 38—40 prae-anal and not more than 10—12 post-anal myotomes (as a rule less).

In the larvae which I reared from an egg much resembling that of the European sprat were present only 29—30 prae-anal and about 16 post-anal myotomes. Besides those mentioned, there was found to be fairly common in the Java Sea an egg from which a clupeoid larva is hatched with 50 prae-anal and no more than 10 or 11 post-anal myotomes.

What indications have we of the number of vertebrae of the most common *Clupeiformes* in the Javasea? I found from my own researches the following numbers:

Albula vulpes (bandeng tjururut)	47 + 27 = 74.
Chirocentrus dorab (parang-parang)	44 + 29 = 73.
Megalops cyprinoides (bulan-bulan)	38 + 30 = 68.
Elops hawaiensis (bandeng lelaki)	46 + 21 = 67.
Dussumieria hasseltii (djapu)	41 + 17 = 58.
Clupea fimbriata (tembang)	29 + 16 = 45.
„ *kanagurta* (mata belo)	27 + 16 = 43.
„ *leiogaster* (lemuru)	29 + 14 = 43.
Chanos chanos (bandeng)	30 + 13 = 43.
Dorosoma chacunda (selanget)	25 + 16 = 41.
Clupeoides lile (tembang putih)	24 + 16 = 40.

We might also add:

Engraulis mystax (bulu ajam) 20 + 25 = 45
Stolephorus indicus (tri) 20 + 17 = 37

but I suspect these, and related, species to have eggs of the type of the european *Engraulis*, i. e. oblong, such eggs occurring in several types and in considerable number in the Javasea. Thus they can be left out of consideration here.

In the larvae with which this article deals we found a total number of more than 70 vertebrae — in the eldest larva figured (fig. 9) 54 + 19 = 73 — and thus it need not be emphasized that only the first four species of the above list can come into consideration.

Now GILBERT (c.f. BOULENGER, The Cambridge Natural History, Fishes, 1904, p. 548) has shewn a ribbon-shaped leptocephalus-like larva for *Albula vulpes*, which species is not caught in any considerable quantity in the Javasea. This larva does not resemble ours and thus *Albula vulpes* is to be excluded. The same holds good for the related *Megalops cyprinoides*, for which VAN KAMPEN (Bulletin du Département de l'Agriculture aux Indes Neerlandaises, nr. 20) describes and shows a similar larva. Thus we

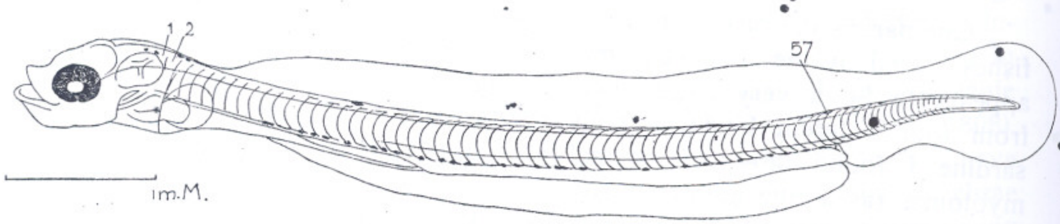


Fig. 7. Slightly older larva, with pigment-spots and black eyes. Yolk completely absorbed. Length 7 mm.

have to choose between *Chirocentrus dorab* and *Elops hawaiensis* only, of which the former is more closely related to the genus *Clupea* than the latter.

The decision between the two will be furnished by the number of fin rays of the anal fin. First, however, we will consider the further development.

Fig. 7 shows a pelagic larva in which the eyes have become black. This seems to occur, in the development of pelagic fish larvae, nearly always simultaneously with the complete absorption of the yolk-sac. In the rest of the body also black pigment has made its appearance. Especially at the under border of the myotomes, at the left and the right of the gut, a series of minute black spots is found, as we also find in species of *Clupea*. Dorsally a few more of these spots are found, especially at the anterior end of the trunk and on the head. These spots, however, are arranged in a single median series.

The under jaw has formed. The gill-cover grows out backwards.

In the stage of fig. 8 the rudiments of the dorsal and of the caudal fin begin to appear. The same holds good for the annular constrictions of the gut, which are well developed in fig. 9. These regular constrictions are as characteristic for the larvae of herring- and anchovy-like fishes as is the backward situation of the anus. On the jaws minute teeth appear (the adult *Chirocentrus* has wel developed teeth).

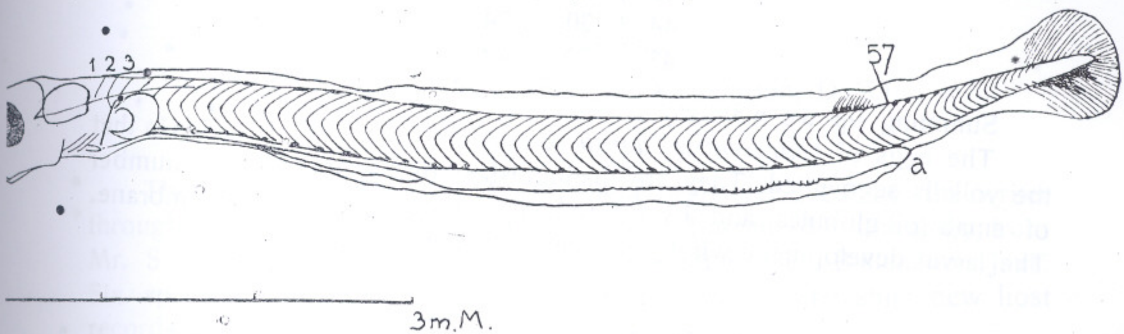


Fig. 8. Slightly older larva with rudiment of dorsal fin, length 6,8 mm.

In fig. 9 the dorsal and the caudal fin have developed further and the anal fin also begins to form. In the caudal fin 19 rays may be counted, a number found in *Chirocentrus* as well as in *Elops*. In the dorsal fin I counted 15 rays. For the adult *Chirocentrus* I found 13 large ones + 3

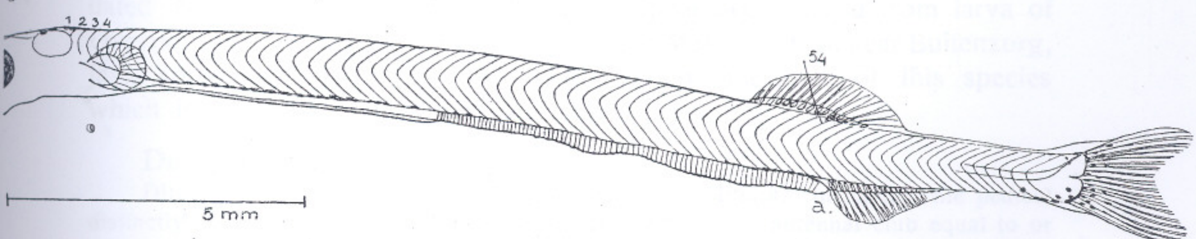


Fig. 9. Larva of 20,5 mm.

small ones in front, for *Elops* 24. In the anal fin of the larva 25 rays could be counted, but it was evident that behind these were more forming. In *Chirocentrus* this number amounts to 26—36, in *Elops* 15—16. Thus the decision between these two forms can no longer be in question: we are undoubtedly dealing with *Chirocentrus dorab.*

This conclusion is confirmed by the observation made by me afterwards that on the surface of eggs from the ovary of a full-grown *Chirocentrus* the same reticulate design, so characteristic for the pelagic eggs, might be discerned. I have not yet met with larvae longer than 22 mm. We must assume, however, that during further development the forward shifting of the anus, noted in the older of the larvae studied, continues, causing the anus which we have already seen moving forward from the 57th or 58th myotome to the 52th myotome finally to lie under the 43th, or 44th vertebra.

For the number of vertebrae I found in four specimens:

$$44 + 29 = 73.$$
$$43 + 30 = 73.$$
$$44 + 30 = 74.$$
$$43 + 29 = 72.$$

Summing up we may say:

The eggs of *Chirocentrus dorab* resemble those of the clupeids in that the yolk is segmented. They are distinguished by the presence of a number of small oil-globules and by the reticulate design of the egg-membrane. The larval development wholly conforms to the clupeid type.