FISH EGGS AND LARVAE FROM THE JAVA-SEA [1])

by

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3. A pelagic Scombresocid egg

with 12 figures.

Our knowledge of the eggs of the Synentognathi, comprising the Scombresocidae, or skippers, the Belonidae, or garfishes, the Hemirhamphidae, or halfbeaks, and the Exocoetidae, or flying fishes, is still fairly imperfect. This is due, no doubt, to the circumstance that the majority of these fishes is restricted to the warmer seas, with only a few representatives in European waters. What we know about the eggs shows, however, that in general they are fairly large and demersal, not pelagic, however typical surface-dwellers the fishes themselves may be.

Thus the American silver gar *(Tylosurus longirostris)* has eggs with a diameter of fully 3,5 mm, which are attached to weeds etc. by means of long filaments springing in great numbers from the surface of the egg membrane (RYDER, 1882). The same holds good for the European gar(*Rhamphistoma belone* (L)), where the diameter of the eggs is 3—3,5 mm (EHRENBAUM, 1904). With the Indian *Tylosurus melanotus* (BLKR.) I found the eggs showing the same peculiarity. The diameter amounted here to 4 mm.

These same filaments were found by HAECKEL (1855) in the ovarial eggs or *Scombresox rondeleti* VAL.

Similar were the extruding eggs from ripe female specimens of *Hemirhamphus dussumieri* C. V. which were landed at the fish-market (Pasar ikan) here. The presence of long filaments, formerly observed by HAECKEL (1855) already in the ovarial eggs of *Hemirhamphus commersoni* CUV. and *H. far* RUPP, and by RYDER (1882) in those of *H. unifasciatus*, show that in this genus also the eggs as a rule are fastened to plants or other objects.

Of the flying fishes, finally, it seems hardly credible that none of the species would have pelagic eggs, several of them occurring in great number in the midst of the oceans, far from the land or from shallow banks. Yet at least a good many of them seem to have demersal eggs too. Thus, at a certain time of the year (July—October) flying fishes occur in great numbers near Makassar (Celebes) and fasten their eggs to palm-leaves put out into the sea at some distance from the coast by the natives for the purpose of alluring the fish [2]).

[1]) cf. Treubia Vol. II, p. 97, and Vol. III, p. 38.

[2]) cf. Tijdschrift voor Nederlandsch-Indië, 1854, p. 314.

The eggs gathered at the fish-market there by Dr. VAN KAMPEN in December 1908 show the same filamentous threads as those of the Belonidae and the Hemirhamphidae. The diameter is 1,5 mm (species unknown). The same seems to be the case with the flying fishes which, from October to July, gather in great numbers round the shores of the isle of Barbados (West Indies). Here also, as BOEKE (1907, p. 92) observes, the eggs adhere to each other, forming clusters which are attached to weeds and stones.

The most complete observations relating to the eggs of flying fishes are those recently published (1923) by HORNELL and his assistant RAMASWAMI NAYUDU. According to these investigators the flying fishes are caught along the Coromandel Coast much in the same way as near Makassar, but from the end of May till the middle of July. Bundles of leaves at the extremity of a long coir rope are cast loose in the sea by the fishermen and the flying fishes gather round them and often attach their spawn to them. The eggs of this *Cypsilurus* spec. have a diameter of 1.7 — 1.8 mm. and are provided with long filaments by means of which they are attached to the leaves. According to RAMASWANI NAYUDU there may be distinguished three kinds of filaments, viz. a stout and long one, which is the egg's main anchoring cable, a tuft of 7 to 16 tiny short ones at the opposite pole, and 4 to 6 medium-sized ones which form side stays.

HAECKEL (1855) also found the filaments in examining the ovarial eggs of *Exocoetus exiliens.*

A few cases have been reported of eggs probably belonging to Synentognaths and which are pelagic. Thus GÜNTHER (1889) in his Report on the Pelagic Fishes collected by the Challenger Expedition, mentions (p. 34) and figures (plate 5, fig. E) a pelagic egg caught in the tropical Atlantic and which, by the presence of a great number of filaments on the egg-membrane, appears to belong to some Scombresocid, perhaps, as GÜNTHER suggests, to an *Exocoetus.* The diameter was 2,5 mm. In this case the filaments covering the egg-membrane are shorter than the diameter of the egg, having a length of not yet fully half the diameter.

Two, probably even three, other kinds of similar pelagic eggs were found by LOHMANN (1904) among the material collected by the Plankton Expedition (1889) of HENSEN and by the German South Polar Expedition (1901—1903). The first of these (cf. fig. 12) has a diameter of $1{,}5^5$—1,9 mm (1566—1915 μ) and the number of filaments is less than in the egg described by GÜNTHER. Their length does not equal the diameter of the egg. Among the second kind of eggs the diameter proved subject to great variability, the smallest having a diameter of 1,2 mm, the largest of 2,5 mm. Probably, therefore, we are dealing with two different kinds. The filaments of the egg-membrane are represented here by short spines only.

For the sake of completeness it may be observed here, that the small *Dermogenys pusillus* v. HASS., a fresh-water Hemirhampid, and the other species of this genus and of related genera *(Nomorhamphus, Hemirhampodon, Zenarchopterus)* are viviparous.

During my cruises with the investigation steamer "Brak", I often found the egg now to be described. I regularly found it in the most Easterly part of the Java Sea, East of the isle of Bawean, never in the Western half. I always found only one or a few in a haul, never large numbers.

The diameter of this egg is exactly 2 mm. and the surface of the egg membrane is provided with a great number of short, blunt spines. Thus the egg belongs to the largest pelagic fish eggs found in the Java Sea [1]). It is, no doubt, related to the Scomberesocid egg(s) nr. 2 of LOHMANN but the spines are shorter and blunter still.

As is generally the case with large eggs, the development takes a long time, viz. more than 5 days (many pelagic eggs in the Java Sea hatch within 24 hours!). This may be illustrated by the following observations.

In a surface haul made September 26, 1921, at 2 — p. m. and at 6° 11′ S. and 112° 50′ E., I found not less than 7 specimens of this egg, all in the same stage of development. The blastoderm, extending round the yolk, had reached the equator of the egg. Evidently spawning had taken place during the preceding night. Even in this early stage the first indication of the embryonal rudiment was visible.

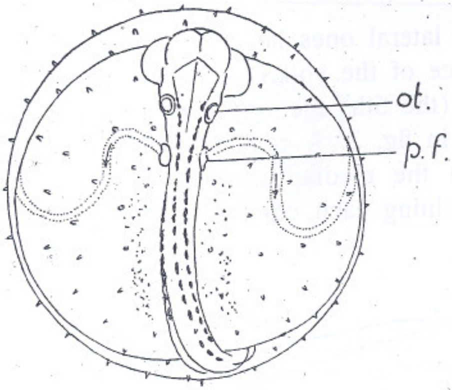
In the course of the day the blastoderm border, proceeding over the surface of the yolk, contracted gradually, assuming at last a very elongated, pear-like, shape, with the pointed end in the direction of the embryonal rudiment. At 8 p. m. it closed. The embryo then extended round 1/3 only of the circumference of the egg. The first somites had become visible, their number amounting to 8-10.

The next morning the embryo extended over nearly 180°, the heart was seen beating feebly, but bloodvessels, so well developed in older eggs, could not yet be discovered. Only in the afternoon the two lateral bloodvessels on the surface of the yolk began to appear, though no blood could yet be seen flowing in them.

An egg of the third day, 3-p. m., is reproduced as fig. 1. Pigment spots have appeared on the yolk at the left and right of the embryo, as well as on the embryo itself. The ear vesicles and the rudiments of the pectoral fins may be clearly recognized. Most conspicuous, however, is the course of the blood-vessels which, as may be observed at once, shows a striking similarity to that observed by RYDER (1882) in the silver gar.

As RYDER observes, the blood-system at first shows a very simple arrangement. The blood flows from the heart (which lies under, and partly in front of, the rudiment of the head) backwards through an arterial

[1]) Among the eel eggs of the Java Sea there is one kind with a diameter of 4 mm. This is due, however, to the wide egg membrane. Among the other eggs of the Java Sea there is one of a *Trichiurus*-species and one of yet unknown origin with a diameter of $2^1/_2$ mm. each and a few kinds of *Trichiurus*-and Tetraodontid eggs with a diameter of 2 mm or nearly so. Finally there is also a Clupeoid egg of sardine-like type with a very wide egg-membrane of which the diameter amounts to fully 2 mm. The other eggs known until now are smaller.



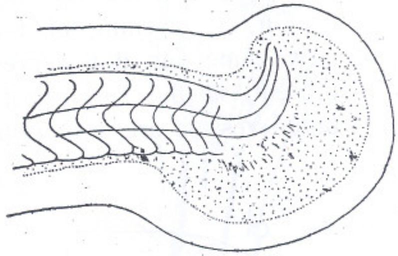


Fig. 1. 1a. Egg on the third day, × 24; *ot.* ear vesicles, *p.f.* pectoral fin.
Fig. 1a. The tail stronger enlarged, × 39.

channel through the body of the embryo between the notochord and the intestine, and forwards again through a median vessel over the ventral surface of the yolk. Besides, there may be noted on either side of the embryo a small vessel leaving the aorta at the place where the rudiment of the pectoral fins begins to appear, and runnung forward over the yolk on either side of the head to the venous sinus in front of the latter. It is the latter two lateral vessels we see in fig. 1, but only after they have attained a much greater development than was originally the case. The area of the yolk surface which they enclose between themselves and the head has become much wider and the vessels which, after springing from the sides of the embryo, originally showed an obliquely forward directed course, thus taking the shortest way to the heart, in front of the head, now soon curve backwards, in exactly the same way as has been described and shown by RYDER for the silver gar (l. c. fig. 12), thus making a wide convolution before taking their course to the heart.

The blood is now clearly seen flowing. In the tail, which I have figured separately (fig. 1a), in a somewhat stronger enlargement, the notochord and the medullary tube are seen bending upwards already.

Three days older still is the egg shown in fig. 2. In the eye a first trace of black pigment begins to develop and in the tail (not visible in fig. 2) the first fin rays have appeared. As a rule these processes occur only a considerable time after hatching in other pelagic larvae. Both the median

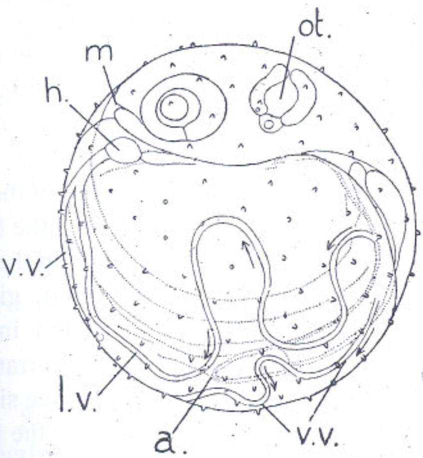


Fig. 2. Egg shortly before hatching, × 24
a. anus, *h*, heart, *l. v.* lateral vessels, *m.* mouth, *ot.* ear vesicle, *v. v.* ventral vessel.

ventral blood vessel and the two lateral ones have assumed now a strongly meandering course over the surface of the yolk.

In the evening of this day (the 5th) the egg-membrane burst and the larva came out. It is represented in fig. 3. A considerable yolk-mass is still present, at the surface of which the median ventral and the two lateral blood-vessels are seen running, joining each other just behind the heart, after

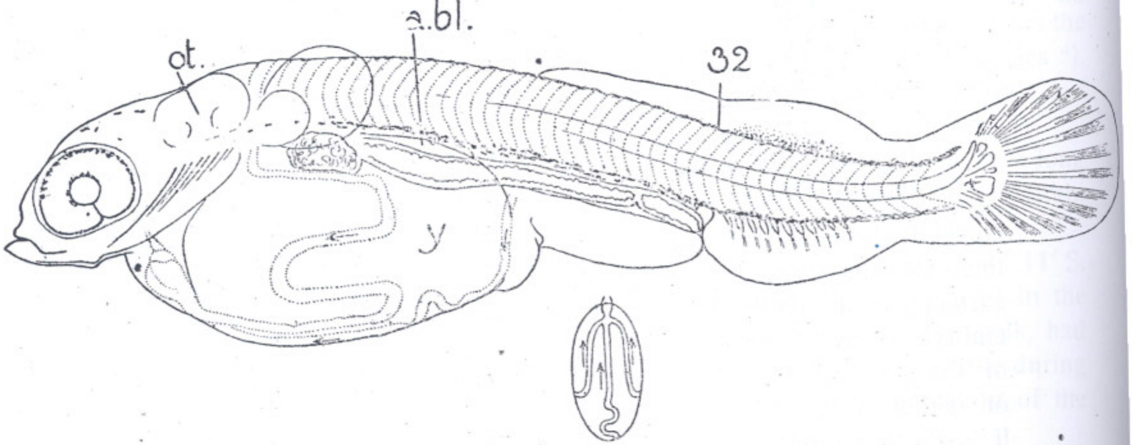


Fig. 3. Newly hatched larva, × 24. *a. bl.* air bladder, *ot.* ear vesicle, *y.* yolk. Below: the yolk with the blood vessels from the ventral side.

having run for some distance nearly parallel to each other, all three in forward direction. The eye just begins to be pigmented. A series of pigment spots is present also at the dorsal and the ventral border of the myotomes. The fin-rays of the tail are well developed, a stage reached in other pelagic larvae only several days after hatching. Also the beginning of the anal fin is visible. The unpaired median fin fold is present still dorsally as well as ventrally. Dorsally it does not reach so far forwards as is generally the case with newly hatched fish larvae, viz. to the head. A faint trace of the rudiment of the dorsal fin may also be discovered.

In front of the anus there could be counted 31—32 myotomes, in the tail some 16—17. The rudiment of the air-bladder is visible, also that of the liver.

One and two days old are the larvae shown in figs. 4 and 5. In the one the eyes are black, in the other the *tapetum lucidum* has developed, giving a metallic lustre to the eye. Dorsal and anal fin are developing, but in the pectoral fins no rays are present yet. The black pigment spots are arranged in two parallel dorsal rows, as may be seen already in fig. 1, and one single ventral row running along the ventral side of the tail but in front of the anus spreading over the peritoneum. In later stages the black peritoneum and its pigment cells may be seen only indistinctly through the muscle layer which envelops them. Also on the dorsal side of the head a number of pigment spots are present and a few scattered ones laterally on the gill-covers.

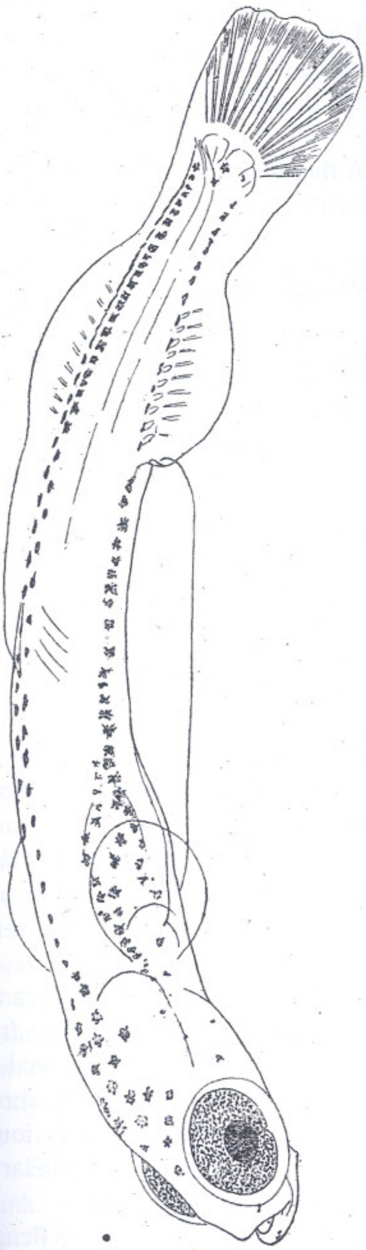


Fig. 4. Larva one day old, × 24.

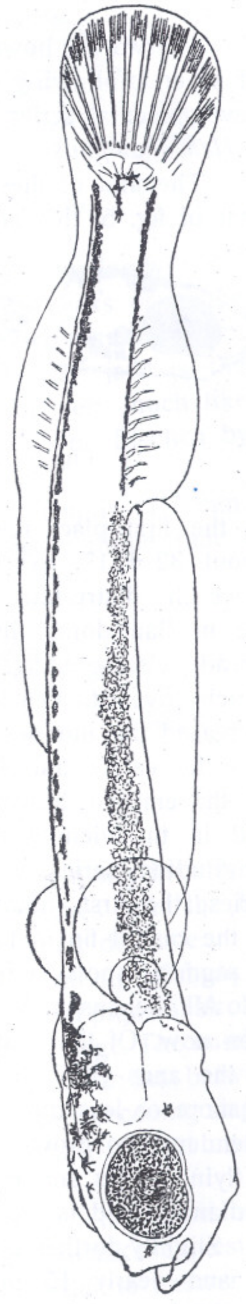


Fig. 5. Larva two days old, × 24.

So far could I rear the larvae hatched from the eggs. As in all my experiments on pelagic fish eggs, the larvae perished soon after the yolk had been completely absorbed.

I was at first inclined to the view that I was dealing here with the egg of some kind of *Exocoetus,* the more so, as in the same catch I found a few young flying fishes.

Afterwards, however, I have collected from the material of this, and also of several following cruises, a number of larvae constituting a fairly complete developmental series and which allow me to state that we are dealing with a *Hemirhamphus*.

The first of these is shown in fig. 6. Although considerably larger than that of fig. 5, this larva yet closely agrees with the latter in several respects.

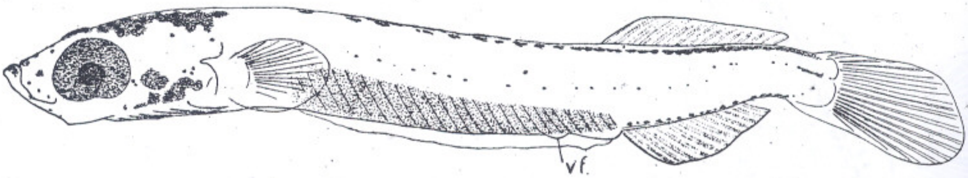


Fig. 6. Pelagic larva, × 16. *vf.* rudiment of ventral fin.

In the first place the number of myotomes may be mentioned, which was about 32 + 17, exactly the same as in the larva of fig. 3. In the second place the distribution of the black pigment shows a great similarity. Along the median dorsal line we find again the double row of pigment spots already visible in fig. 1. The black peritoneum is visible through the myotomes which cover it. The large, branched pigment cells of the head have slightly increased in number, especially on the gill-cover, yet their arrangement may be easily traced back to that of the foregoing stage. Along the sides of the embryo, however, a longitudinal series of small spots has appeared and in the vicinity of the tail there is the beginning of another similar longitudinal series, situated, however, a little above the former. Of this latter series, the first initiation may be seen in a few pigment spots at the base of the caudal fin in fig. 5. We shall meet again both these longitudinal series of pigment spots in further advanced stages.

All the fins have developed further. In the pectoral fins, fin rays can be seen now. Of the ventral fins the first rudiment may be discovered in front of the anus *(vf.)*. In the dorsal fin I could count 15, and in the anal fin 13 more or less distinctly developed fin rays. The caudal fin, finally, shows a tendency to grow out asymmetrically in downward direction, as is found in flying fishes and in several halfbeaks and gars. A last remnant of the larval median fin-fold is still present along the ventral side of the larva.

Slightly further advanced are the stages shown in figs. 7 and 8 (length 13 and nearly 15 mm.) in which we see the lower jaw growing out and very small teeth developing as well in the upper as in the lower jaw. The asymmetry of the tail has become more pronounced, as is evident from fig. 8a. Already in the larva of fig. 7 ventral fins with 5 fin rays are present.

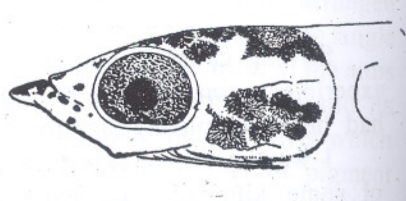


Fig. 7. Head of a slightly older pelagic larva, × 16.

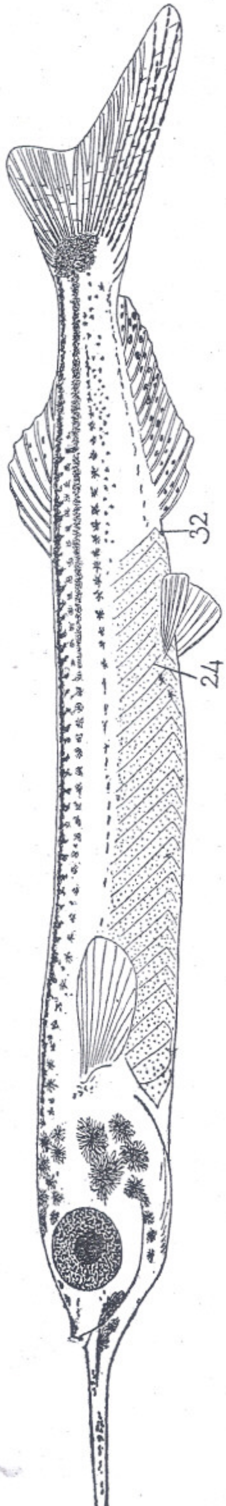


Fig. 10. Pelagic young fish, length 28,75 mm.

and GÜNTHER (1866) gives the following numbers:

Rhamphistoma belone	52 + 28
Xenentodon cancila	36 + 22
Tylosurus raphidoma	57 + 27

For Hemirhamphids I found:

Hemirhamphus melanurus	31 + 18
„ *far*	36 + 15
„ *dussumieri*	36 + 17
„ *Georgii*	37 + 18
„ *marginatus*	35 + 16

and GÜNTHER (1866) gives the following numbers:

Hemirhamphus unifasciatus	34 + 18
„ *far* (*commersonii*)	38 + 16

Finally Dr. L. F. DE BEAUFORT, at my request, kindly allowed a number of Röntgen photos to be made of Hemirhamphids in the Museum at Amsterdam. In these I counted the following numbers:

Hemirhamphus melanurus	32 + 19
„ *balinensis*	37 + 20
„ *quoyi*	24 + 17
„ *unifasciatus*	30 + 18
„ *marginatus*	35 + 16
„ *gaimardi*	29 + 18
„ *dussumieri*	36 + 17
Zenarchopterus buffoni	29 + 13

It will be seen at once that the results drawn from these three sources do not always wholly agree. Without exception, however, we find that the number of caudal vertebrae in Hemirhamphids never exceeds 20, and as a rule is not more than 17 or 18, whereas in Belonids it ranges from 22 to 28, even in those species with a relatively low number of trunk vertebrae.

From the foregoing we may safely conclude that the fish dealt with in this article, and in which the number of caudal myotomes was 17, is a Hemirhamphid.

If we now try to identify this *Hemirhamphus* with the key given by WEBER and DE

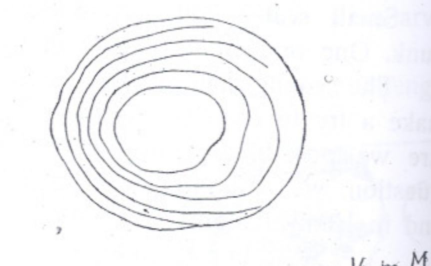


Fig. 10a. Scale from the tail.

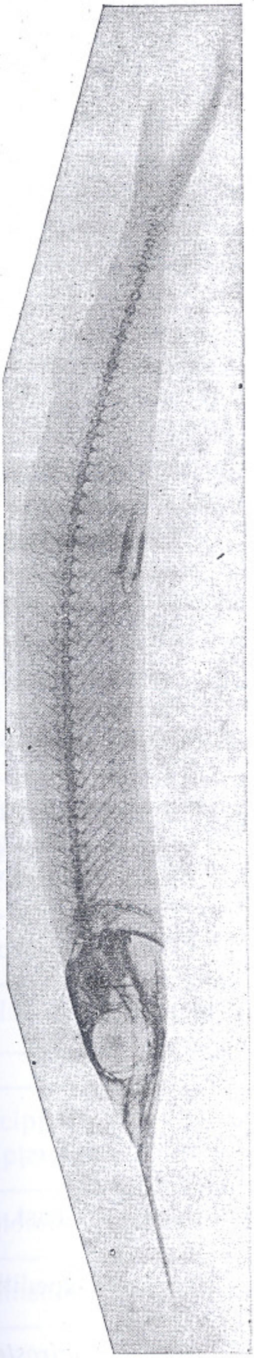


Fig. 11. *Hemirhamphus Quoyi* C. V., Röntgen-photo.

BEAUFORT in their „Fishes", part IV, p. 146, we come to the conclusion that we are dealing with *Hemirhamphus quoyi C. V.* This was also the opinion of Dr. DE BEAUFORT at Amsterdam, to whom I sent the oldest larva for identification. Dr. DE BEAUFORT added that, in his opinion, the possibility was not wholly to be excluded that we are dealing with the closely related *H. dussumieri* C. V. although the situation of the ventral fins tends more towards the former species.

If we compare the number of vertebrae in both species, being for:

Hemirhamphus quoyi 34 + 17,
and for „ *dussumieri* 36 + 17,

then we also come to the conclusion that the former species in this respect stands nearer to our larva, where the number of myotomes is 32 + 17, than the latter, although the agreement is not yet as perfect as we could wish.

If, finally, we look at the distribution of both species, we find that *Hemirhamphus dussumieri* is not rarely met with at the Pasar ikan at Batavia where I found a number of them in ripe condition, the eggs provided with long filaments, as mentioned already in the introduction to this article.

As to *Hemirhamphus quoyi* BLEEKER (1852) remarks: "Drie mijner 4 exemplaren vond ik in July 1851 te Batavia, alwaar deze soort echter zeer zeldzaam is." ("Three of my 4 samples were collected by me in July 1851 at Batavia where, however, this species is very rare"). In WEBER and DE BEAUFORT several samples are mentioned as being collected in the Eastern part of the Indian Archipelago, which conforms to my statement that the eggs were found regularly in the Eastern part of the Java Sea but never in the Western half. Neither is *H. dussumieri,* however, absent in the Eastern part of the Archipelago.

Not yet quite satisfied, and having no samples of *H. Quoyi* at hand here, I asked Dr. DE BEAUFORT to send me, if possible, a piece of the ovary of this species, which request he again kindly complied with. The egg membrane proved to be provided with filaments! Thus the question as to exactly which species we are dealing with remains undecided. If it should be *H. Quoyi,* then we ought to assume that the filaments present in the ovary afterwards get lost. Indeed, if we look at fig. 12, showing one of LOHMANN's eggs mentioned before, we have to assume only the thinner part of the filaments to break off to give the egg a great resemblance to the one described in the present article. Only further observations, however, will be able to settle this question. As, however, it may possibly take a long time before the opportunity to do so offers itself, I thought it best not to delay any longer the publication of the results obtained up to now.

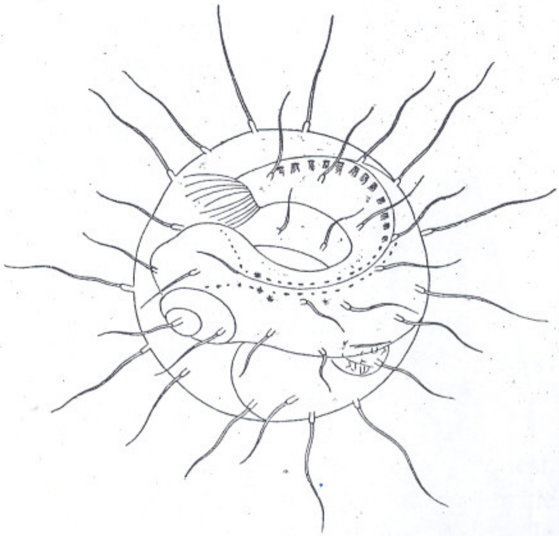


Fig. 12 LOHMANN'S Scombresocid egg. nr. 1

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