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

by

DR. H. C. DELSMAN.

(Laboratorium voor het Onderzoek der Zee).

17. The genus Stolephorus (with 60 figures).

The oblong shape of the egg of *Engraulis encrasicholus*, first described by WENCKEBACH in 1887 [2]), makes it one of the easiest recognizable among fish eggs. In 1901 NISHIKAWA [3]) showed a similar elongated egg for the Japanese *Engraulis japonicus*. The former egg has a length of 1.3—1.9 mm and a breadth of 0,7—1,2 mm, the latter a length of 1.2—1.6 mm and a breadth of 0.55—0.7 mm. Neither of the two contains an oil-globule.

In 1913 KUNTZ [4]) states that the egg of *Anchovia mitchilli* is likewise elongated, though much less than in both of the species first mentioned. In *Anchovia argyrophana* and *brownii,* however, he and RADCLIFFE [5]) find the elongation to be more pronounced again. The same holds for the egg of *Anchovia epsetus,* according to HILDEBRAND [6]). Besides, all the species mentioned have in common the segmented yolk so characteristic of the eggs of herring- and eel-like fishes. None of them contains an oil-globule.

From the above it appears probable that the elongated shape is characteristic for the genera *Engraulis* and *Anchovia* (or, better, *Engraulis* and *Stolephorus,* cf. nr. 12 of this series, Treubia Vol. XI p. 276).

My investigations, however, have not fully confirmed this conclusion. In nr. 12 of the present series I have shown that the eggs of all the Indian *Engraulis* species studied by me are round or nearly so. The elongated eggs found in the plankton of the Indian seas all prove to belong to the genus *Stolephorus.* In the latter genus only do we find eggs of an elongated shape in the ripe ovaries.

Quite a number of varieties of these elongated eggs occur in the Java Sea, especially along the coasts of Java, Sumatra and Borneo. The yolk is segmented, as in other clupeoid eggs. Some of them contain an oil-globule, others not.

---

1) cf. Treubia Vol. II p. 97, Vol. III p. 38, Vol. V p. 408, Vol. VI p. 297, Vol. VIII p. 199 and p. 389, Vol. IX p. 338, Vol. XI p. 275, Vol. XII p. 37 and Vol. XII p. 367.

2) K. F. WENCKEBACH, 1887, Verslag omtrent op de ansjovis betrekking hebbende onderzoekingen. Verslag Staat Nederl. Zeevisscherijen over 1886.

3) T. NISHIKAWA, 1901, On the Development of Engraulis japonicus. Journal of the Fisheries Bureau (Tokyo), Vol. X nr. 1.

4) A. KUNTZ, 1913, The Embryology and larval Development of Bairdiella chrysura and Anchovia mitchilli. Bulletin Bureau of Fisheries, Vol. XXXIII.

5) A. KUNTZ and L. RADCLLIFFE, 1917, Notes on the Embryology and larval Development of twelve Teleostean Fishes. ibid. Vol. XXXV.

6) S. F. HILDEBRAND and L. E. CABLE, 1930, Development and Life history of fourteen Teleostean Fishes at Beaufort, N.C. ibid. Vol. XLVI.

A few of them have an egg-membrane with a little knob at the place of the micropyle. Only one of them reaches to the size of the egg of the European anchovy.

The number of varieties which may be distinguished among these eggs is greater than the number of *Stolephorus* species enumerated e.g. by WEBER and DE BEAUFORT who in this respect follow BLEEKER in his "Atlas ichthyologique". The two authors distinguish the following five species:

Stolephorus zollingeri „ *heterolobus*	length not above 100 mm, origin of anal behind dorsal.
„ *indicus* „ *commersonii* „ *tri*	length more than 100 mm, origin of anal under dorsal.

For the average numbers of vertebrae in these species my assistant Dr. HARDENBERG has found:

	trunk		tail		total	
Stolephorus zollingeri	23.2	+	19.4	=	42.6	(3.8)
„ *heterolobus*	21.9	+	19.8	=	41.8	(2.1)
„ *indicus*	21.9	+	20.8	=	42.8	(1.1)
	(21.0	+	20.0	=	41.0)	(1.0)
„ *commersonii*	20.0	+	18.9	=	38.9	(1.1)
„ *tri*	19.0	+	19.0	=	38.0	(0)

The species have been arranged in such a way that we see the number of trunk vertebrae decrease gradually and approach more and more to that of the tail vertebrae. This is shown at once by a look at the figures in brackets indicating the difference between the number of trunk and of tail vertebrae. The anus thus moves forward in this series.

In the same series we see the total number of vertebrae decrease gradually from 42.6 to 38.0. *Stolephorus indicus* only forms an exception, having the highest number of vertebrae of all. *Stolephorus indicus* is also the species attaining the largest size. Dr. HARDENBERG, however, also found a smaller variety of this species characterized by a lower number of vertebrae, viz. 21,0 + 20.0 = 41.0 which fits in better in the above series.

Taking into account also what the examination of the ripe ovaries teaches us about the shape of the egg, we can conveniently divide these Indian *Stolephorus* species into three groups. In the first place *Stolephorus indicus* and *commersonii* evidently form a natural group, as follows from the fact that in both these species the ripe ovarial eggs show the little knob so characteristic of the pelagic eggs shown in fig. 1 nr.3 and 4. A second group is formed by the small and slender species *Stolephorus zollingeri* and *heterolobus*, characterized by a relatively high number of trunk vertebrae, i.e. a relatively backward situation of the anus, causing also the anal fin to begin behind and not under the dorsal fin.

The third group includes provisionally the species *Stolephorus tri* only which occurs in and near river mouths. It has the relatively lowest number of trunk vertebrae, the shortest trunk.

After I had found that the number of different kinds of elongated eggs surpasses that of the species of *Stolephorus* distinguished up till now, a renewed study of these species seemed desirable. At my request Dr. HARDENBERG has taken up this study. He has found, as suggested by my results, that the number of species is indeed higher than was known thus far.

As regards the group with the highest relative numbers of trunk vertebrae, Dr. HARDENBERG got a species surpassing in this respect the two mentioned above. It has the following numbers of vertebrae:

$$24 + 18 = 42 \quad (6)$$

and seems to occur only in the more oceanic waters of the eastern part of the archipelago, the south coast of Java etc. (It is also possible that it is this species which has been called *zollingeri* by BLEEKER who obtained it from Makasser (Celebes). The type specimen has been lost [1])).

The middle group, with the knobbed eggs and an intermediate number of trunk myotomes, also proved to contain more species than have been distinguished thus far. Besides *Stolephorus commersonii* and *indicus* at least one new species must be distinguished which we propose to call *Stolephorus insularis* because it seems to be a species characteristic e.g. of the islands between Bangka and Singapore though by no means restricted to this area. For the number of vertebrae Dr. HARDENBERG found as an average:

$$20.1 + 18.9 = 39.0 \quad (1.2).$$

In samples from other places somewhat different numbers were found, viz.

$$20.0 + 20.0 = 40.0 \quad (0)$$
$$21.0 + 20.0 = 41.0 \quad (1)$$
$$20.1 + 19.8 = 39.9 \quad (0.3).$$

which is probably to be explained from the existence of varieties or subspecies.

The eggs with a knob are characteristic of all these species.

Finally we have to deal with the group with the lowest number of trunk vertebrae, the species and varieties of which have thus far been united under the name *Stolephorus tri.* We will see that the eggs of this group are characterized by the presence of an oil-globule and occur in or near river mouths. Quite a number of varieties of these eggs could be distinguished and on closer investigation Dr. HARDENBERG found that indeed the species *Stolephorus tri* is by no means homogeneous but comprises several varieties or even species.

Thus I met regularly three varieties of these eggs in the aestuary-like mouth of the Rokan where an intensive fishery is carried on by the Chinese fishers of the important fisher-place Bagan Si Api Api. And indeed Dr. HARDENBERG succeeded in distinguishing three types of *Stolephorus*. One of these seems to be *Stolephorus tri* sensu stricto. The other two represent at least one separate species, comprising two sub-species. We propose to call this species *Stolephorus baganensis*. A slightly different type was obtained from the Musi mouth which seems to Dr. HARDENBERG to belong also to this species.

[1]) BLEEKER, Bijdrage tot de kennis der Clupeoiden. Verh. Batav. Genootschap XXIV, 1852, p. 39.

For *Stolephorus tri* the following average numbers of vertebrae were found:
19.0 + 19.0 = 38.0 (from Amphitrite Bay, south of the Rokan)
19.0 + 18.8 = 37.8 (from Cheribon).
For *Stolephorus baganensis* Dr. HARDENBERG found:
18.8 + 19.6 = 38.4 (from Bagan)
19.1 + 18.8 = 37.9 (from Bagan, the other variety: var. *megalops*)
19.2 + 20 = 39.2 (Musi-river, slender variety)
19.0 + 19.4 = 38.4 (from Batavia)
19.0 + 19.5 = 38.5 (from Cheribon).

It is evident that *Stolephorus tri* and *baganensis* do not differ much as regards the numbers of vertebrae. In *St. baganensis,* however, we see as a rule the number of trunk vertebrae sink below that of the tail vertebrae, as is the case in no other *Stolephorus* species (but characteristic of the genus *Engraulis*). The only exception is the var. *megalops.*

This, then, is a rough sketch of the results of Dr. HARDENBERG'S investigations which I hope will be soon published more fully.

We now turn again to the eggs.

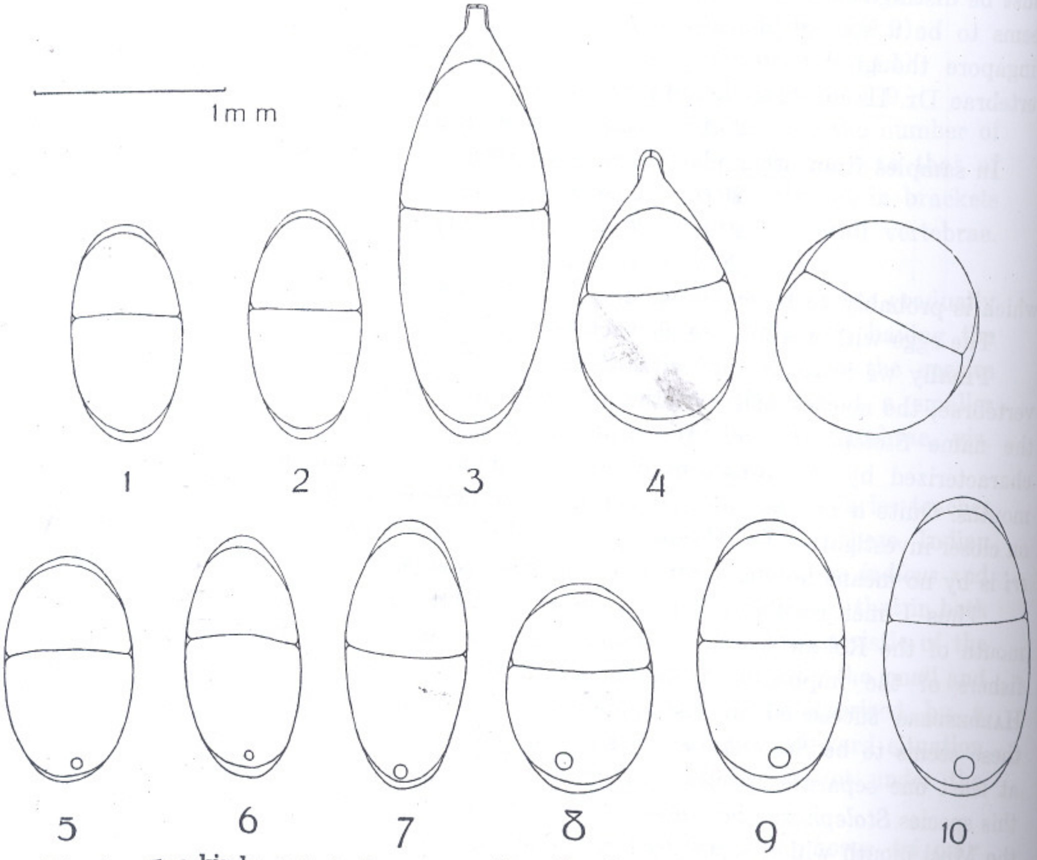


Fig. 1. Ten kinds of *Stolephorus* eggs from the Java Sea, × 26. The egg without a number belongs to *Engraulis mystax.* For further identification of the eggs cf. p. 240.

Let us begin with the *Stolephorus* eggs provided with a terminal knob at the animal end of the egg-membrane. The shape of this knob may be seen from figs. **1, 2** and **3**. It is hollow, but its wall is thicker than the rest of the egg membrane. The terminal wall is pierced by a fine canal, the micropyle. These eggs contain no oil-globule and are found at a somewhat greater distance from the coast than the eggs with an oil-globule. From the examination of ripe ovaries it is evident that the eggs with a knob belong to the group *Stolephorus indicus-commersonii-insularis.*

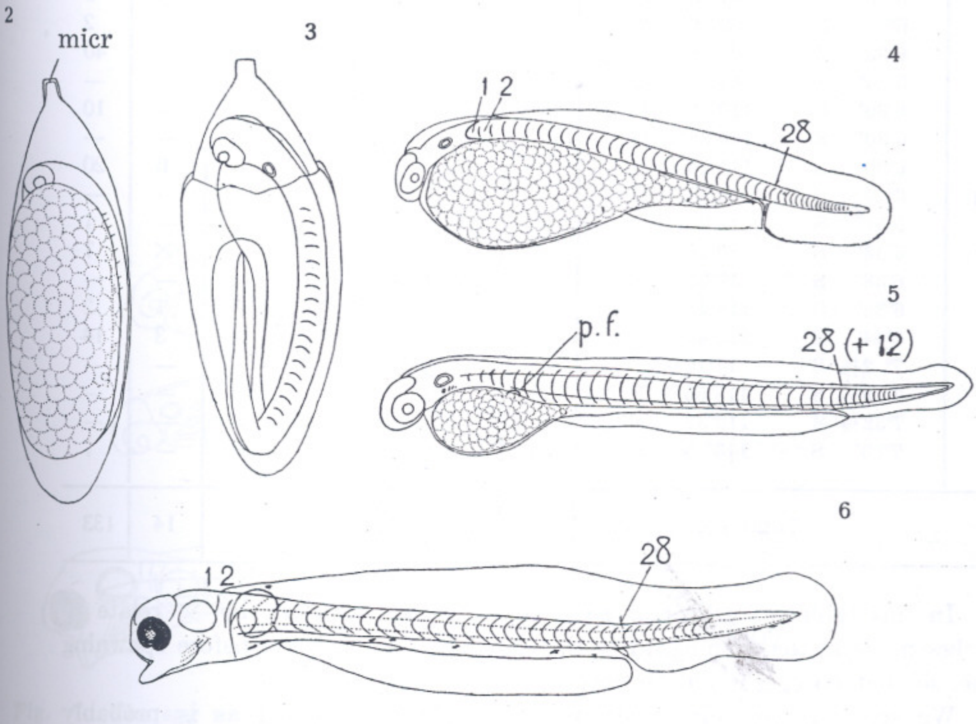


Fig. 2. The egg nr. 3 at 9 a.m., × 26. *micr.* = micropyle.
Fig. 3. Similar egg hatching, × 26.
Fig. 4. Newly hatched larva, × 26. 1, 2 the anteriormost myotomes.
Fig. 5. Larva of 18 hours, × 26. *p.f.* rudiment of the pectoral fin.
Fig. 6. Larva of the third morning after hatching, × 26. Yolk resorbed, eyes black.

However, I have thus far been able to distinguish two varieties only of these eggs. The most common one of these two is the following (nr. 3 of fig. 1):

Egg nr. 3. A knob at the animal pole. Length 2—2.25 mm, breadth 0.67—0.8 mm. In rest lying horizontally beneath the surface or, at a slight disturbance of the water, floating with the knob down (in general pelagic eggs float with the head of the embryo directed downward). This egg is common at some distance from the coast, it was found frequently e.g. in the catches made during the periodical cruises of **1919—1920** (cf. Treubia II p. **106**). They were distributed over these 6 × 21 catches (vertical hauls) as follows:

Station			July 1919	September 1919	November 1919	January 1920	March 1920	May 1920	Total per Station
A	5°50′ S	106°10′ E	—	—	—	2	—	—	2
B	5°48½′ S	106°36′ E	—	×	—	×	—	—	—
C	5°44′ S	107°15′ E	—	—	2	1	—	—	3
D	5°42′ S	107°50′ E	×	8	3	2	1	2	16
E	6° 0′ S	107°58½′ E	4	4	—	—	1	—	9
F	6° 0′ S	109° 0′ E	—	×	—	—	—	2	2
G	6°35′ S	109°16′ E	—	34	6	—	—	×	40
H	6° 0′ S	110° 0′ E	×	—	—	—	—	—	—
I	6°30′ S	110° 7′ E	—	3	3	—	4	—	10
K	6°30′ S	110°38′ E	—	—	—	—	—	—	—
L	6°20′ S	111°16′ E	1	—	13	—	—	6	20
M	6° 0′ S	111°30′ E	—	—	—	×	—	—	—
N	5°51′ S	112°22′ E	—	1	—	—	—	—	1
O	6°33′ S	112°20′ E	7	—	×	—	—	×	7
P	6°38′ S	112°39′ E	—	—	—	—	—	—	—
Q	6°38′ S	113°11′ E	—	1	×	—	—	1	2
R	6°44′ S	113°43′ E	—	—	7		4	3	14
S	7° 2½′ S	114°16½′ E	—	—	—	×	—	—	—
T	7°39½′ S	113°55½′ E	—	—	—	—	×	—	—
U	7°32½′ S	113°32′ E	—	—	—	—	—	—	—
V	7°20′ S	113° 5′ E	1	6	—	—	—	—	7
		Total per month	13	57	34	5	10	14	133

In this table — indicates: no eggs. The places marked by × relate to catches made in the evening, after the eggs have hatched and before spawning time, so that no eggs could be expected here.

We see that spawning goes on the whole year round, as is probably the case with most tropical fishes. For the rest the numbers are too small to warrant any further conclusions regarding spawning places, seasonal periodicity etc. I only should like to draw attention to the fact that on the four stations most distant from the coast, viz. F, H, M, N, no eggs or hardly any were caught. Also in Madura Strait (stations S, T, U, V) these eggs appear to be rare.

The second egg with a knob at the animal side (nr. 4) is much shorter, pear-shaped. Length about 0.8—0.9 mm. It is much rarer than the foregoing egg and thus far has never been found in considerable numbers but always a few specimens only. Thus I met this egg between the Thousand Islands and the Java coast (27.VI.1921 and 9.I.1922), north of Bantam (21.XI.1925) and near Amphitrite Bay (Sumatra, 17.I.1925 and 24.X.1926).

Spawning in all *Stolephorus* species, as in so many fishes, occurs at night, before midnight

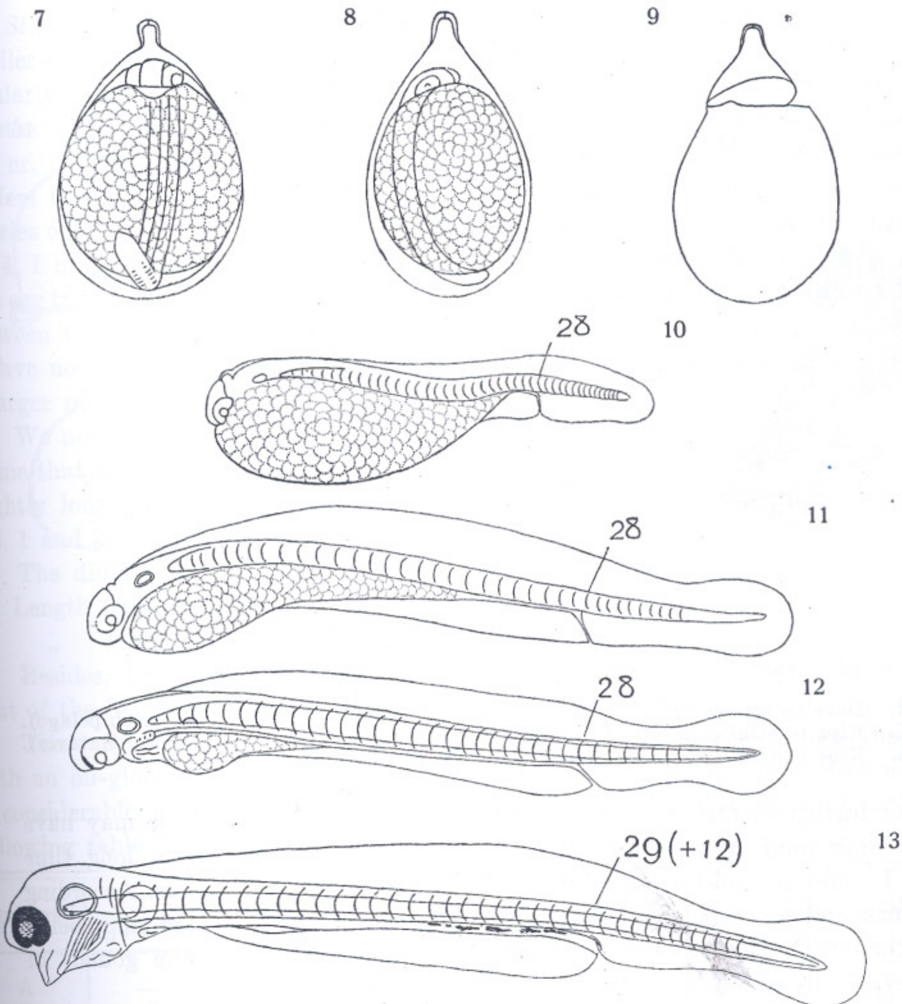


Fig. 7. The egg nr. 4, × 26. Amphitrite Bay, 17.I.'25.
Fig. 8. Similar egg from near the island of Dapur, × 26. 27.VII.'21.
Fig. 9. Similar egg after hatching, × 26.
Fig. 10. Newly hatched larva, × 26 (from the egg of fig. 8).
Fig. 11. Larva of 12 hours, × 26 (from the egg of fig. 8).
Fig. 12. Larva of 24 hours, × 26 (from the egg of fig. 8).
Fig. 13. Larva with yolk resorbed and black eyes (from the egg of fig. 7).

At 6 a.m. the two varieties of eggs mentioned above show a germinal disc surrounding the animal half of the egg. In the course of the morning the yolk blastopore closes and the larvae hatch at 6—7 p.m., after less than 24 hours. For the numbers of myotomes in the larvae I found in the longer egg $28 + 12 = 40$
and in the shorter egg $27 — 29 + 12 = 39 — 41$.

In the adult of this group the number of trunk vertebrae varies between 20 and 22. We see, then, that a forward movement of the anus during development over a distance of about 6—7 myotomes must be assumed.

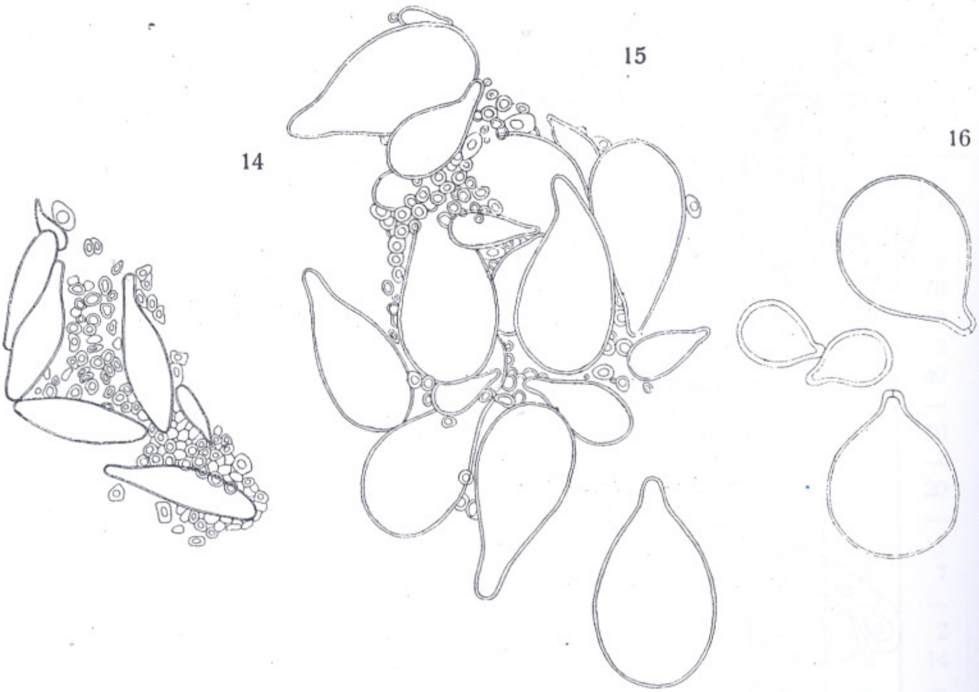


Fig. 14. Developing ovarial eggs of *Stolephorus insularis*, × 26 (Lingga archipelago).
Fig. 15. Ripe ovarial eggs of *Stolephorus commersonii*, × 26 (Pasar ikan, Batavia).
Fig. 16. Ripe ovarial eggs of *Stolephorus indicus*, × 26 (Musi mouth).

For further identification of the two pelagic eggs mentioned we may have a look once more at the ripe ovarial eggs. It has taken a fairly long time before I could get hold of an adult specimen of *Stolephorus indicus*. According to WEBER and DE BEAUFORT this species may attain a size of 145 mm, being more than with any other *Stolephorus* species. But examining the gonads of samples of this size I found that they were not ripe yet.

By chance I got a sample of 173 mm which was caught from the landing-stage at the fisher-village of Soengsang, at the mouth of the Musi-river (Sumatra). It proved to be a female and fairly mature. The ovarial eggs are shown in fig. 16. A look at them renders it evident that the egg nr. 4 must be ascribed to *Stolephorus indicus*.

Stolephorus commersonii is not rarely seen at the fish-market of Batavia, though never in considerable quantity. The adult specimens are known as t e r i g l a g a h. This is also one of the bigger species of *Stolephorus*, though smaller than *St. indicus*, attaining a length of about 120 mm. The ovarial eggs are shown in fig. 15. They are slightly more elongated than those of *Stolephorus indicus*.

Considerably more elongated are the ovarial eggs of *Stolephorus insularis* n.sp. (cf. above). They are shown in fig. 14. It seems hardly doubtful that the egg nr. 3 must be ascribed to the last named species and this assumption is supported by the following reflexion.

St. insularis seems to occur at some distance from the coast and round smaller islands, as mentioned above. In this same region the eggs nr. 3 are found regularly. *St. commersonii* and *indicus* seem to occur nearer the coast and in river mouths and in small shoals only. It seems, therefore, fairly evident that the egg nr. 3 belongs to *St. insularis*. As to the eggs of *St. commersonii* I must confess that I do not know them as yet. From the examination of the ripe ovaries one might suppose that they are intermediate in shape between nr. 3 and nr. 4. I have, however, thus far not been able to distinguish other varieties of this egg type than the two mentioned above, unless one would assume a difference between the eggs shown in fig. 7 and 8. These eggs not being very common I have not yet had the opportunity to verify this suggestion by the study of a larger number.

We now turn to the other eggs without an oil-globule. It has often seemed to me that two varieties may be distinguished among this group, the one being slightly longer than the other whereas the breadth is nearly the same (fig. 1 nrs. 1 and 2 and fig. 17).

The dimensions are as follows:

a. Length 0.98—1.14 mm, breadth 0.51—0.55 mm.
b. „ 1.10—1.22 mm, „ 0.53—0.57 mm.

Besides, the egg-membrane of the shorter variety has a more ellipsoid, that of the longer variety a somewhat more rhomboid shape.

These eggs too are found somewhat further from the coast than those with an oil-globule. In the catches of the periodical cruises of 1919—1920 e.g. a considerable number of these eggs is often present. This is shown by the following table in which the two varieties have been combined together.

Stations	1 (July'19)	2 (Sept'19)	3 (Nov'19)	4 (Jan'20)	5 (March'20)	6 (May'20)	Total
A	—	—	—	91	—	—	91
B	3	—	—	—	12	5	20
C	1	—	3	—	—	34	38
D	×	1	—	—	1	15	17
E	14	2	—	—	—	145	161
F	38	×	2	—	—	2	42
G	2	8	1	—	—	×	11
H	×	—	61	—	—	—	61
I	16	1	1	—	15	20	53
K	1	51	1	6	1	3	63
L	17	8	43	—	—	—	68
M	—	—	3	×	—	9	12
N	—	—	—	—	—	—	—
O	3	—	×	—	—	×	3
P	—	—	—	—	—	5	5
Q	—	—	×	—	—	5	5
R	—	—	14	1	1	—	16
S	—	—	—	—	1	1	2
T	—	—	28	×	—	—	28
U	—	—	—	—	×	—	—
V	—	6	—	—	15	1	22
	95	77	157	98	46	245	718

This table shows again that spawning evidently goes on the whole year round.

Some of the catches contain large numbers of these eggs. In order to find out whether the two varieties may always be separated from each other with certainty I have made a few length curves of the richest catches, as shown in fig. 17.

17

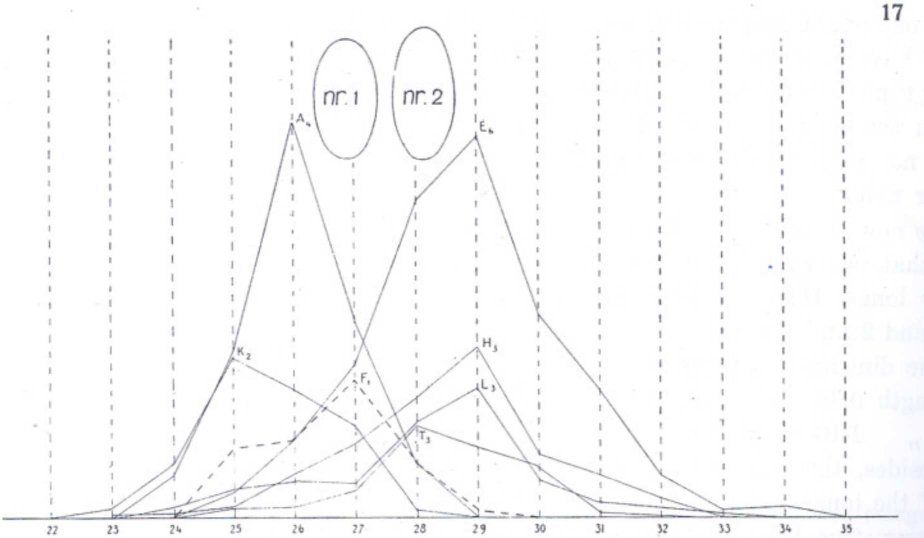


Fig. 17. Frequency curves of the lengths, in degrees of my ocular micrometer (1 degree = 40,8 μ), of the eggs nr. 1 and 2 occurring in the richest catches during the periodical cruises of 1919 - 1920 (cf. Treubia Vol. II, p. 106).

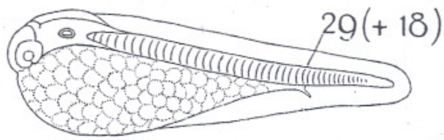
The lengths are expressed in stripes of my ocular micrometer. The two varieties may be clearly separated in the catches A4 and E6, being the two largest catches. Also in some of the smaller catches they may be distinguished: K 2, H 3 and L 3. The catches F 1 and F 3, however, leave room for doubt, whether we are dealing here with the longer or the shorter variety, or with a mixture of the two, in which case, however, a curve with two summits might have been expected.

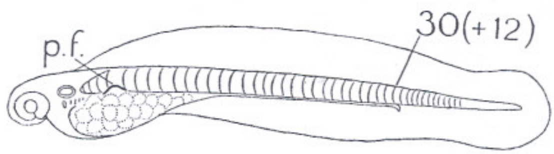
That the two varieties exist seems to be supported by the numbers of the prae-anal myotomes of the larvae hatching from them.

Those from the shorter eggs were found to have 27—28, mostly 28, prae-anal myotomes, those from the longer eggs 28—30 (mostly 29). The larvae from these two eggs have a very characteristic feature in common which distinguishes them from the larvae from all the other elongated eggs. The terminal part of the gut does not extend to the border of the unpaired fin fold as is the case with nearly all other fish larvae. The vent is not situated on the border of this fold but either on the left or on the right side, close beneath the inferior border of the myotomes (cf. figs. 19—21 and 23—25).

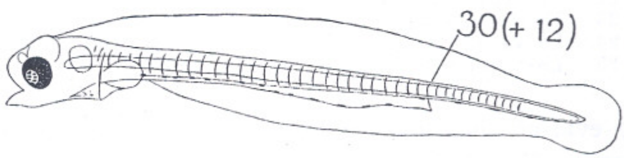
I have the impression that the longer variety may be called the more oceanic of the two. I found it often near and in Sunda Strait (29.VII.'22, 18

19





20



21

Fig. 18. The egg nr. 2, at 9 a.m. (7.IV.'24), × 26.
Fig. 19. Newly hatched larva, × 26.
Fig. 20. Larva of the next morning, × 26.
Fig. 21. Larva of the second day, 7 p.m., × 26.

21.VII.'24, 18—19.X.'26) and in Bali Strait (12.V.'24), also along the south coast of Java, e.g. near Trouwers Island (5.V.'26) and in the Wijnkoops Bay (9.V.'26) where I caught it over a depth of 2—3000 metres. Characteristic is this variety further for Malacca Straits, the Riouw- and Lingga-archipelago and the other islands between Bangka and Singapore where I find it quite regularly. Many were caught near the island of Bawean (north of Surabaya) in May 1924, together with the eggs of the l a j a n g (*Decapterus kurra*). In September 1928 and April 1929 I also found several of these eggs in the Bay of Batavia.

In the waters round the islands between Bangka and Singapore the most typical *Stolephorus* species are *St. insularis* and *St. zollingeri*.

The egg of the former has a terminal knob on the egg membrane. It is found regularly in the catches made in this region, together with the egg nr. 2. Thus the conclusion seems obvious that at least the latter and perhaps also the shorter variety, nr. 1, belongs to *St. zollingeri*. This tallies very well with the fact that *St. zollingeri* is a species with a high number of trunk vertebrae and that the larva from the egg has the highest numbers of trunk myotomes found among *Stolephorus* larvae. We find for the

number of vertebrae in the adult: 23.2 + 19.4 = 42.6
„ „ myotomes in the larva: 29 + 13 = 42.

Here, also, a forward movement of the anus over a distance of about 6 myotomes must be assumed.

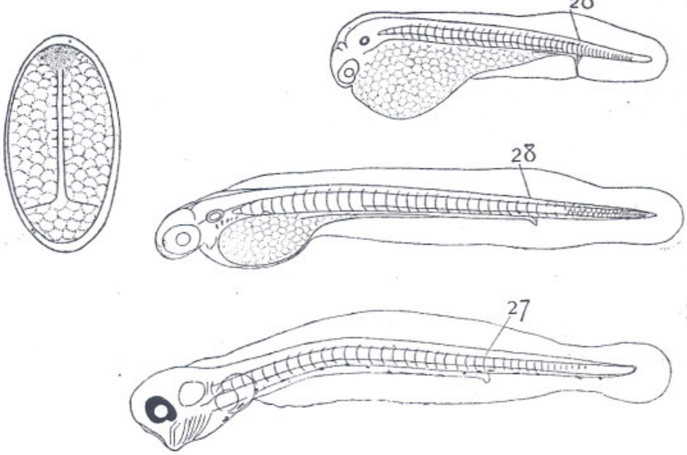


Fig. 22. The egg nr. 1, at 8 a.m., × 26.
Fig. 23. Newly hatched larva, at 6 p.m., × 26.
Fig. 24. Larva of the next morning, 6 a.m., × 26.
Fig. 25. Larva of the second morning, 6 a.m., × 26.

It seems fairly evident, then, that at least the longer variety of this egg belongs to *Stolephorus zollingeri*. The egg has a wide distribution and is a very common one outside the troubled coast waters.

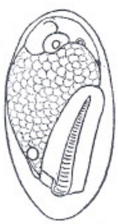
What about the shorter variety? In looking for the origin of the latter I was at first inclined to ascribe it to *Stolephorus heterolobus*, the other small species with a relatively high number of trunk vertebrae. But continued observations have led me to an other conclusion, viz. that *St. heterolobus* has an egg with a small oil-globule to be described next. For the moment, therefore, I can suppose only that there are two varieties of *St. zollingeri*, perhaps as difficult to be distinguished from each other as are the eggs themselves.

Regarding the new *Stolephorus*-species with 24 + 18 vertebrae, as mentioned above, I have not yet succeeded in finding the eggs. The species has not yet been found in our special exploration area, the Java Sea and southern China Sea. The ripe ovarial eggs have the usual elongated shape, without a knob or any other characteristic feature.

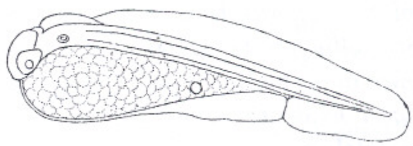
We finally have to deal with the eggs with an oil-globule. They are so characteristic of the coast region and the river mouths that I did not find any of them in the catches from the periodical cruises 1919—1920 which have nearly all been made at a somewhat greater distance from the coast. Along the north coast of Java, however, and in the bay-like rivermouths of Sumatra and Borneo, quite a number of varieties may be observed, often differing only slightly from each other. This makes it often difficult to decide whether we are dealing with the eggs of definite races, or merely with variations due to external circumstances and passing gradually into each other. The only characteristics to judge from are the dimensions of the egg, the diameter, and sometimes the colour, of the oil-globule, and the number of trunk myotomes in the larva hatching from the egg. All these values, however, are subject to fluctuations. Examination of the ripe ovarial eggs gives us indications of relative value only. The dimensions differ from those of the free eggs which swell up immediately before spawning. At the most we get an impression that the egg of a given species in a thick and short one, or a slender one. The oil-globule is not yet visible in the ovarial egg.

That a number of constant types may be discerned among the eggs with an oil-globule is beyond doubt. Often two or three of these types are found mixed in the catches in a certain locality and, however insignificant the differences may appear, the two (or three) may be separated with great accuracy by the above characteristics. To the latter may be added the fact that there is often a constant difference in the stage of development and the time of hatching also.

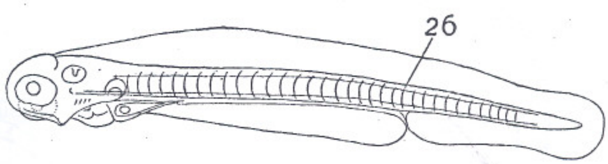
26



27



28



29

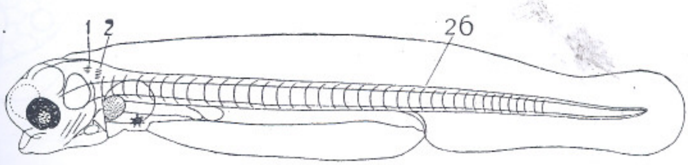


Fig. 26. The egg nr. 6, at 6 p.m., shortly before hatching, × 26.
Fig. 27. Newly hatched larva, × 26.
Fig. 28. Larva of 24 hours, × 26.
Fig. 29. Larva of the second day after hatching, × 26.

With one exception all of these eggs seem to belong to what has thus far been called *Stolephorus tri.* This exception is the egg nr. 6 which after all probability must be ascribed to *Stolephorus heterolobus.* The description of this egg is as follows:

Egg nr. 6. Length 1.10—1.26 mm, breadth 0.57—0.65 mm, characterized by a small yellow oil-globule with a diameter of 0.05 mm, this being the smallest oil-globule found among these eggs and at the same time easily recognizable by its bright yellow colour. The larva hatching from these eggs has 26—27 prae-anal myotomes.

Truly from this fairly low number of trunk myotomes in the larva one would not have supposed that this egg belongs to *Stolephorus heterolobus,* with its 21.9 + 19.8 = 41.8 vertebrae. At any rate the forward movement of the anus would cover a distance here of 4—5 myotomes only, against ± 6 in the species dealt with first.

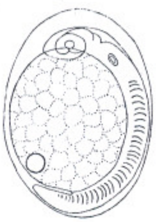
The egg nr. 6, however, is by far the commonest *Stolephorus* egg along the coast of Java and in the Bay of Batavia. In these same places *St. heterolobus* is by far the commonest *Stolephorus* species. It was often found abundantly in places where the fishers did not catch anything but *Stol. heterolobus.* Along the east coast of Sumatra and between the islands off this coast the species and the eggs are absent but near Singapore both reappear.

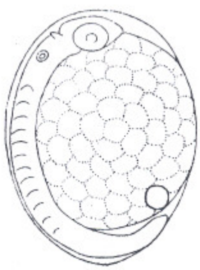
Continued observations of this kind have convinced me that nr. 6 cannot be else than the egg of this species. The examination of the ripe ovarial eggs of *St. heterolobus* does not disprove this conclusion, at least they show no knob and are of a similar elongated shape as those of *St. zollingeri.*

So the eggs of *Stolephorus heterolobus* and *zollingeri* are of nearly equal size — that of *St. zollingeri* being slightly smaller — but differ from each other by the presence of a small yellow oil-globule in the egg of *St. heterolobus.* *Stolephorus zollingeri* evidently lives further from the coast and in clearer water than *St. heterolobus.*

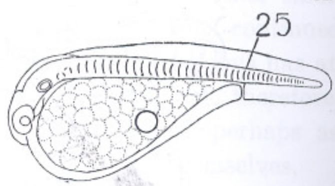
31

30

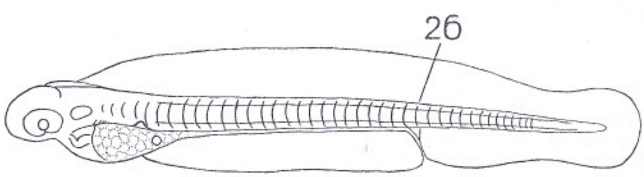




32



33



34

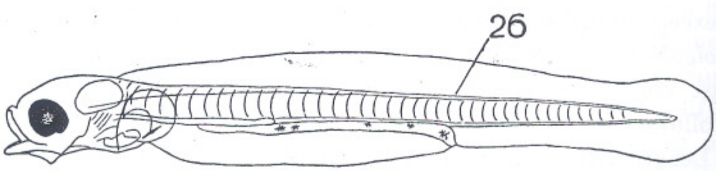


Fig. 30. The egg nr. 8 at 3.30 p.m., × 26.
Fig. 31. Big variety of the egg nr. 8, from the Kumai mouth, × 26.
Fig. 32. Newly hatched larva, at 5 p.m., × 26.
Fig. 33. Larva of the next morning, 8 a.m., × 26.
Fig. 34. Larva of the second morning, 7 a.m., × 26.

This holds equally for the occurrence of the eggs.

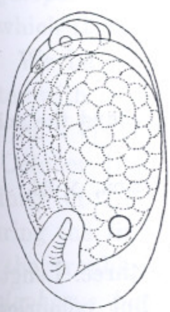
The remaining eggs with an oil-globule probably all belong to varieties of *Stolephorus* thus far designated as *Stolephorus tri,* evidently the littoral species "p a r e x c e l l e n c e". This species seems to be rich in varieties, some of which might be given the rank of separate species. All these eggs have a bigger oil-globule than *Stol. heterolobus.*

Let us begin by considering three of them, which I have found regularly in the more or less brackish water of the estuary-like mouths of the Rokan and the Indragiri (east coast of Sumatra). These estuaries have a very characteristic fish fauna which, especially for the Rokan mouth, is very completely known now, thanks to the investigations of Dr. HARDENBERG.

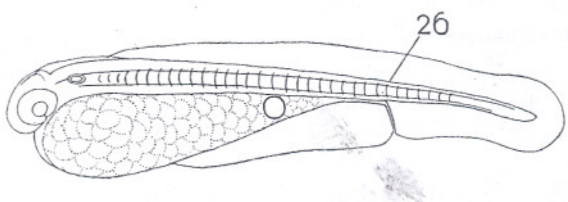
The three varieties of *Stolephorus* eggs found in this region are:

Egg nr. 8. This is a particularly short and thick variety. Length 1.00—1.17 mm, breadth 0.81—0.72 mm, oil-globule slightly brownish, diameter 0.10 mm, preanal myotomes of the larva (25—)26. Sometimes eggs of this type are found with a clear yellow oil-globule. Of the three eggs to be mentioned here this is the one occurring furthest inward, in water having a salinity of from 29 to about 28⁰/₀₀.

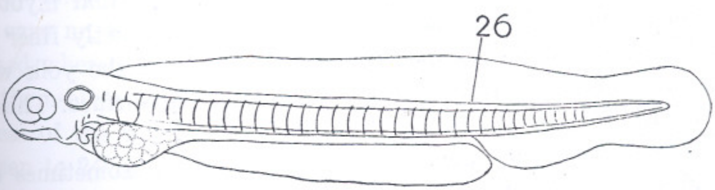
Further outward, where the salinity of the water approaches 30⁰/₀₀ this egg is replaced by the other two.



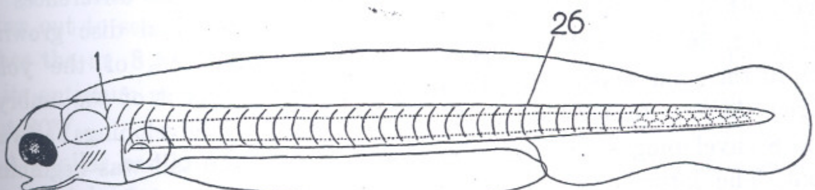
35



36



37



38

Fig. 35. The egg nr. 10, at 7 a.m. (10.I.'29, near Bengkalis), × 26.
Fig. 36. Larva a few hours after hatching, at 7 p.m., × 26.
Fig. 37. Larva of 12 hours, × 26.
Fig. 38. Larva of the second morning, × 26.

Egg nr. 10. Length 1.47—1.71 mm, breadth 0.75—0.82 mm, the oil-globule is slightly brownish, with a diameter of 0.12 mm. Pre-anal myotomes of the larva 26. This is the biggest of all the *Stolephorus* eggs, yet it does not quite equal in size the egg of the European anchovy (cf. above). It is often found together with the third variety.

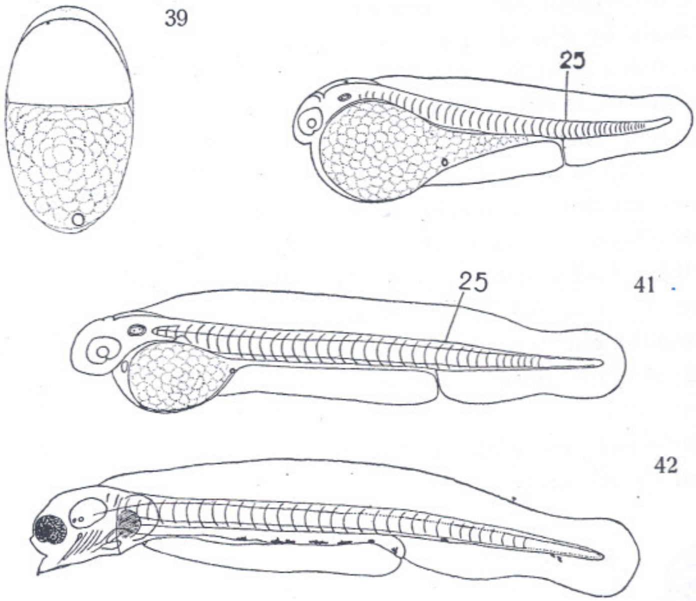


Fig. 39. The egg nr. 5, between 8 and 9 a.m., germinal disc growing round the yolk, $\times$ 26.
Fig. 40. Newly hatched larva, $\times$ 26.
Fig. 41. Larva of the next day, with rudiment of pectoral fins, 6.30 a.m., $\times$ 26.
Fig. 42. Larva of the second morning, 6.30 a.m., $\times$ 26.

Egg nr. 5 which seems to me to be the most common of the three. Length 1.1—1.25 mm, breadth 0.6—0.7 mm, oil-globule not brownish but colourless or slightly yellowish, with a diameter of nearly 0.08 mm. Pre-anal myotomes of the larva 25. The segmentation of the yolk in this egg is distinctly finer than in nr. 8 and nr. 10. This is evident especially in the centre of the yolk where in all these eggs the segmentation is coarser than along the surface. This egg is found in water with a salinity of 27—30$^0/_{00}$.

Often two of these egg types were found mixed together, sometimes even all three. At a given hour of the day they showed constant differences in development. At daybreak the eggs 8 and 5 show a germinal disc growing round the yolk, in 5 enveloping about $^1/_6$, in 8 about $^1/_3$ of the yolk, whereas in 10 the yolk blastopore just closes and the rudiment of the embryo has appeared. At 8 a.m. I found in 5 the germinal disc enveloping halfway the yolk, in 8 enveloping ¾ of the latter, whereas in 10 the tail was beginning to grow out. The latter egg is also the first to hatch viz. at 2—2.30 p.m., whereas 8 follows at 5 and 5 at 7 p.m.

I think these differences must be explained by assuming that spawning takes place at different hours of the night.

During our visits with the investigation steamer to the estuaries of the Rokan and the Indragiri (Amphitrite Bay) the three varieties of eggs described above were quite regularly found in the surface catches. Now, as mentioned above, the fish fauna of the Rokan mouth — the operation field of the important, mostly Chinese, fishing port Bagan Si Api Api — is completely known. At my request Dr. HARDENBERG, during a stay of a month in January 1929 and during a shorter visit in October of that year, paid special attention to the *Stolephorus* species.

Besides *Stolephorus tri* he soon distinguished a separate species, the *St. baganensis* mentioned before, occurring on the whole more inland, in more brackish water than *St. tri.* This may be easily confirmed by comparing the catches of "jeremals" placed more inland with those situated more seaward in the river mouth.

St. baganensis differs from *St. tri* at first sight by its shape and pigmentation.

At my request looking further for a third variety, Dr. HARDENBERG found what seems to us may be most conveniently considered as a subspecies of *St. baganensis,* with bigger eyes and therefore designated as *St. baganensis,* var. *megalops.* Thus we have three eggs and three fishes. Which egg now belongs to which fish?

We have seen that the egg nr. 8 is the one occurring furthest inland, in water with a salinity of 20—28$^0/_{00}$, as is shown e.g. by the following instances. During a visit to the mouth of the Panei-river (just north of the Rokan mouth) in October 1929 we anchored at a place where at low tide the water had a salinity of 7.7$^0/_{00}$ only. As the water flowed in, the salinity rose gradually. During the first hauls with the egg net no eggs were brought up, but, thanks to the troubled water, each haul contained a number of young and older *Stolephorus baganensis* (as a rule fishes of this size are not caught by the net, they know how to evade it). After the salinity had risen to about 17$^0/_{00}$ a few eggs nr. 8 appeared in the catch and in the next catches their number increased whereas at the same time the number and especially the size of the fishes themselves decreased. The latter phenomenon may be due to the greater clearness of the water, so that the fish could evade the net. After the salinity had risen to 24$^0/_{00}$ the first egg nr. 5 appeared among the nr. 8. It was nearly high water then and it had become too late to continue the series by steaming further out to sea. We did so the next morning and saw then in the successive catches the nr. 8 gradually being replaced by nr. 5 as the salinity rose. Nr. 8 had its optimum at a salinity of about 27$^0/_{00}$ (already mixed with nr. 5), nr. 5 about 30$^0/_{00}$.

A similar result was obtained during a series of hauls made near Bagan Si Api Api in June 1923. We had anchored at 0° 1′ N 105° 49′ E.

At high water and during the beginning of the ebb flow we caught only the big nr. 10, soon after mixed with nr. 5 (salinity 29‰). The first nr. 8 appeared at a salinity of 28 ‰. In the last haul of the series at nearly low tide (salinity 27‰, water troubled) nr. 8 dominated, still mixed with a few nr. 5 and an occasional nr. 10.

Also during other observations, e.g. in the mouth of the Koemai (Borneo), the impression was confirmed that nr. 8 is the egg occurring furthest inland and that nr. 5 and nr. 10 are found somewhat more seaward, often mixed, but as a rule nr. 10 reaching still somewhat further outward than nr. 5. Thus during a series of hauls in the Rokan mouth in October 2nd, 1929, I saw nr. 5 gradually being replaced, when steaming out to sea, by nr. 10. Not rarely, however, one may find not only two but even all three species mixed together in one catch, though not in equal quantities, the one having its optimum where the others reach the border of their distribution area.

From the fact that the eggs nr. 8 and nr. 10 are evidently more closely related mutually than to nr. 5 we may suggest that these two belong to the two races of *St. baganensis* and that nr. 5 belongs to *Stolephorus tri.*

From the fact that nr. 8 is the egg occurring furthest inward we may conclude that it belongs to *Stol. baganensis* proper and, consequently, that the egg nr. 10 belongs to the big-eyed race of the latter. Examination of the ripe ovaries shows that the eggs in *St. baganensis* are short and thick indeed, the length being as a rule 1½ × the breadth, or even less, whereas the ovarial eggs of *St. tri* are slender, the length being 2 × the breadth or more. Thus I think our identification of the three eggs occurring in the river mouths of Sumatra's east coast (and also of Borneo) is fairly reliable.

We come to the conclusion that

the egg nr. 8 belongs to *Stolephorus baganensis* proper,
" " nr. 10 " " " " var. *megalops*,
" " nr. 5 " " " *tri.*

A comparison of the numbers of trunk myotomes of the larvae (25—26) with the numbers of trunk vertebrae in the adult fishes (± 19) shows that a forward movement of the anus over a distance of 6—7 myotomes finds place during development.

Three other eggs with an oil-globule are characteristic of the north coast of Java between Batavia and Cheribon. One of these is the egg of *Stolephorus heterolobus,* mentioned above. The other two are:

Egg nr. 9. Length 1.26—1.43 mm, breadth 0.70—0.77 mm, with a slightly brownish (not yellow) oil-globule having a diameter of 0.11 mm. Prae-anal myotomes of the larva 26.

Egg nr. 7 Length 1.30—1.47 mm, breadth 0.53—0.57 mm, with a colourless oil-globule of 0.08 mm. Pre-anal myotomes of the larva 26—27. The three eggs nrs. 6, 9 and 7 were often found mixed together in catches along the coast between Batavia and Cheribon. In that case nr. 9 proved always in a slightly further advanced stage of development than the other two. Thus, e.g. in a catch of April 26th, 1929, near Cheribon, at 6.30 a.m., the yolk in the eggs

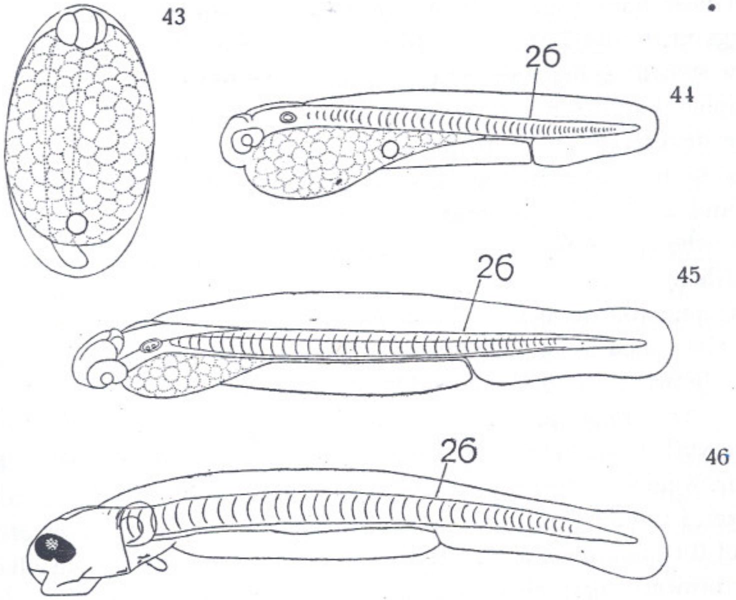


Fig. 43. The egg nr. 9, at 1 p.m., × 26.
Fig. 44. Newly hatched larva, 7 p.m., × 26.
Fig. 45. Larva of the next morning, 6.30 a.m., × 26.
Fig. 46. Larva of the second morning, 6.30 a.m., × 26.

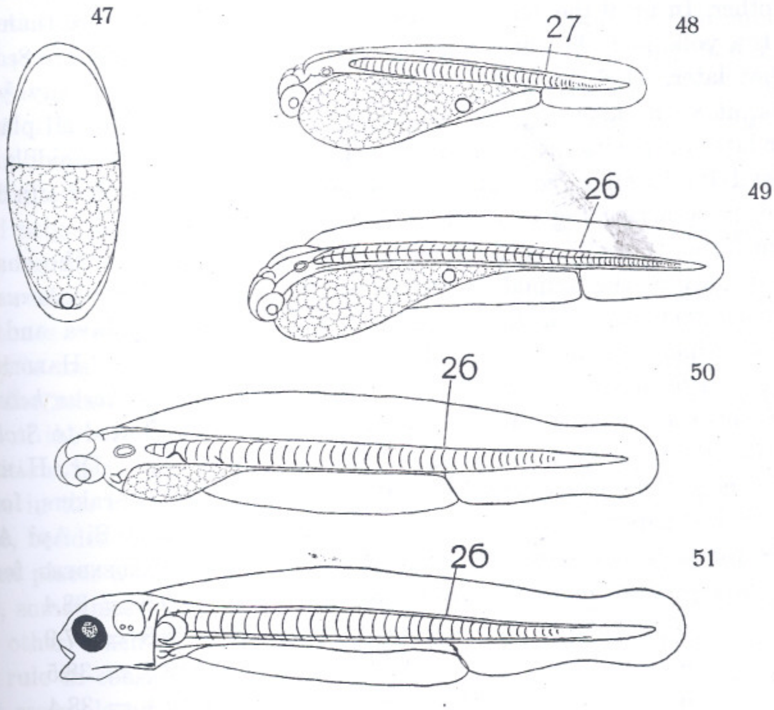


Fig. 47. The egg nr. 7, at 9 a.m., × 26.
Fig. 48. Newly hatched larva, 6 p.m., × 26.
Fig. 49. Larva at 9 p.m., × 26.
Fig. 50. Larva of the next morning, 9.30 a.m., × 26.
Fig. 51. Larva of the second morning, 9.30 a.m., × 26.

nr. 9 had been more than halfway grown round by the germinal disc, whereas in the eggs nr. 6 and 7 the latter formed a small cap only at the animal pole. Evidently spawning had occurred later here. At 9 a.m. the yolk in nr. 9 has been completely grown round by the germinal disc, in nrs. 6 and 7 halfway only. A similar difference, then, as we found among the eggs of Bagan. The egg nr. 7 has been caught in the Bay of Batavia also (11.I.'23, 18.VII.'24 and 6.-7.IX. and 25.IX.'28), whereas nr. 9 was caught near Surabaja (8.V. and 6.X.1930) where, however, it was smaller than along the Krawang coast and near Cheribon.

If we compare nrs. 9 and 7 with the three kinds of eggs (nrs. 5, 8 and 10) from the river mouths of Sumatra's east coast, then a certain likeness cannot be denied between nr. 9 on the side and nrs. 8 and 10 on the other side. All three are of relatively big size, have a coarsely segmented yolk and an oil-globule with a diameter of 0.1 mm or more. In size nr. 9 holds the middle between nr. 8 and nr. 10 as shown by a look at fig. 1. This seems to hold also for the size of the oil-globule. I found at least for nr. 8 a diameter of 0.10 mm, for nr. 9 of 0.11 mm and for nr. 10 of 0.12 mm. The oil-globule in all three has a slightly brownish or pink colour.

Another point of similarity is the advanced stage of development of these eggs at daybreak. We have seen that in nr. 10 the blastopore just closed at daybreak and the rudiment of the embryo reaches from one pole of the egg to the other. In nr. 9 the germinal disc at 6 a.m. has grown more than halfway round the yolk and the blastopore closes at 8 a.m. The egg nr. 8, truly, is somewhat later. At 6 a.m. the germinal disc has grown round only ⅓—¼ of the yolk, at 8 a.m. about ¾, and closing of the blastopore will find place about an hour later than with nr. 9. In this respect also nr. 9 holds the middle between nrs. 8 and 10. In all three, however, the stage of development is further than in the eggs occurring together with them, viz. nrs. 5, 6 and 7.

The latter three all have at daybreak a germinal disc in the shape of a small cap only at the animal extremity of the egg. Which *Stolephorus* species now are characteristic for this part of the north coast of Java and for the Bay of Cheribon? Samples from Cheribon were found by Dr. HARDENBERG to consist of *St. baganensis* as well as of *St. tri*, besides *Stolephorus heterolobus.*

It seems evident, then, that the egg nr. 9 must be attributed to *Stolephorus baganensis*. Perhaps we are dealing here with another race. Dr. HARDENBERG found indeed differences, especially in the number of the gill-rakers, for which I refer to his paper. The numbers of vertebrae in Bagan Si Api Api and Cheribon races do not show any great differences. Dr. HARDENBERG found for

Stolephorus	*baganensis*	from Bagan	18.8 + 19.6 = 38.4
"	"	var. *megalops*	19.1 + 18.8 = 37.9
"	"	from Cheribon	19.0 + 19.5 = 38.5
"	"	from Batavia	19.0 + 19.4 = 38.4

I have not often determined the salinity of the water in which the egg nr. 9 was fished. On April 25th, 1929, I found 29.6‰, on May 7th, 1925, 31.5‰.

These salinities correspond to those at which on the Sumatra coast the egg nr. 10 is found. If, then, the egg nr. 9 must be ascribed to the Cheribon variety of *Stol. baganensis*, it seems only reasonable to suggest that the egg nr. 7 belongs to the Cheribon variety of *Stol. tri.*

Dr. HARDENBERG, truly, has not succeeded in finding any notable difference between *Stol. tri* from Bagan and from Cheribon. For the numbers of vertebrae e.g. he found in

Stolephorus tri from Amphitrite Bay 19.0 + 19.0 = 38.0
" " " Cheribon 19.0 + 18.8 = 37.8.

The two kinds of eggs, on the other hand, are fairly different in size, that of Bagan being much broader than that of Cheribon and Batavia.

In the egg nr. 5, truly, the length-breadth-relation seems to vary fairly considerably. It rarely approaches, however, the very slender shape of the egg nr. 7. In the size of the oil-globule nrs. 5 and 7 agree, the diameter being 0.07—0.08 mm, smaller than that of the *baganensis*-eggs but larger than that of the *heterolobus*-egg. And also in the colour of the oil-globule not being brownish but either colourless or slightly yellowish (nr. 5). The larvae hatching from nr. 7 have 26 myotomes, those hatching from nr. 5 25.

Although the positive indications are few in number and value, I see no other way than assuming that the egg nr. 7 belongs to *Stolephorus tri.*

I have distinguished, then, and recognized in the catches again and again, three varieties of *Stolephorus* eggs with an oil-globule from the east-sumatran rivermouths (nrs. 8, 9 and 10) and three from the coast of Java (nrs. 5, 6 and 7).

Afterwards I have extended my investigations to the river mouths of the south coast of Borneo, i.e. those of the Kumai, the Sampit and the Barito river. Here I found eggs which seemed to me to be identical with nrs. 8 and 10, i.e. the eggs of the two varieties of *Stolephorus baganensis* occurring in the Rokan mouth and neighbouring rivermouths. But I also found a number of eggs which seemed to me more difficult to identify with those known from the Sumatra and Java coast. They differed more or less from the types described above and sometimes seemed to hold the middle between two of these types so that I hesitated to make a choice between the two in trying to identify them. This holds for the relative dimensions (breadth-height) as well as for the size and the colour of the oil-globule.

Conditions in the river mouths of South Borneo not differing so very much from those in the river mouths of East Sumatra, one might expect to find in the former, besides the eggs nrs. 8 and 10 also the egg nr. 5. In reality I found at different places a number of different eggs holding the middle between nr. 5 and nr. 9, sometimes in their characters more approaching the one, sometimes more the other. Each of these types was found at a different place and time and as a rule in considerable numbers.

They resemble nr. 5 in that the diameter of the oil-globule is never more than 0.7—0.8 mm. In some the oil-globule was slightly colourless or yellowish, as in nr. 5 (*Stolephorus tri*). In other samples, however, it had that brownish or pink tinge which is characteristic of nrs. 8, 9 and 10 (*Stolephorus baganensis*).

Although the colour of the oil-globule is characteristic in many cases, yet it seems doubtful if we may attribute too much value to it. Thus the oil-globule of the egg nr. 8 is in general brownish but, as mentioned above, one may sometimes find specimens with an oil-globule of as clear a yellow as that of the egg nr. 6. No transitions between the two were found so that possibly we are dealing with a separate variety. But no other difference was found, not even in the number of myotomes of the larvae hatching from them, so that I am in doubt what to think about this.

I will first give now a list of the different eggs met at various occasions and holding the middle between or differing slightly from nrs. 5, 7 and 9.

52

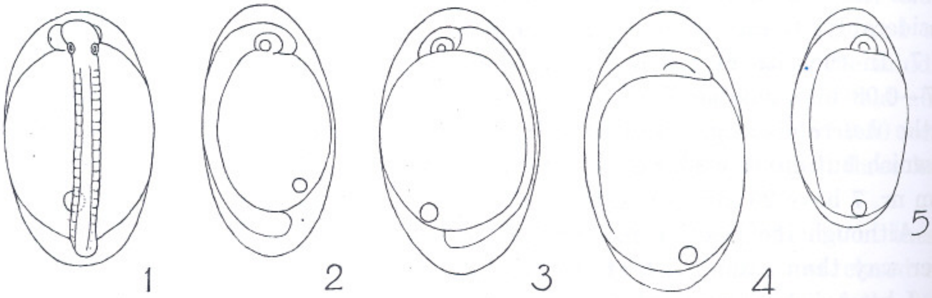


Fig. 52. Eggs from the Koemai-, Sampit- and Barito-mouths (South coast of Borneo).

Mouth of the Koemai (Borneo).

S e p t e m b e r 30th, 1928.

Dimensions 1.3 × 0.7^5 mm; oil-globule 0.07 mm, slightly yellowish.

Trunk myotomes of the larva 27 (Fig. 52 nr. 1).

A p r i l 26th, 1930.

Dimensions 1.2 × 0.66 mm; oil-globule 0.07 mm, slightly brownish.

Trunk myotomes of the larva 26—27 (Fig. 52 nr. 2).

A p r i l 27th, and September 30th, 1930.

Dimensions 1.3 × 0.8 m; oil-globule 0.07^5 mm, slightly yellowish or colourless.

Trunk myotomes of the larva 27—28 (Fig. 52 nr. 3).

Mouth of the Sampit (Borneo).

A p r i l 26th, 1930.

Dimensions 1.2^5 × 0.7 mm; oil-globule 0.07^5 mm, brownish.

Myotomes of the larva 27½—28 + 12 = 39½—40.

A p r i l 29th, 1930.

Dimensions 1.38 × 0.83 mm; oil-globule 0.07^5 mm, brownish.

Trunk myotomes of the larva 28 (Fig. 52 nr. 4).

Mouth of the Barito.

O c t o b e r 3rd, 1928.

Dimensions 1.1^5 × 0.6 mm; oil-globule 0.07^5 mm, slightly yellowish.

Trunk myotomes of the larva 27 (Fig. 52, nr. 5).

These are the observations of the south coast of Borneo. Also along the coast of Sumatra I have sometimes found somewhat diverging types of which the description is as follows.

Bengkalis.

January 9—10th, 1929.

Dimensions 1.2 × 0.72 mm; oil-globule 0.06^5—0.07^5 mm, colourless or slightly yellowish.

Amphitrite-Bay.

September 27th, 1929.

Dimensions 1.17 × 0.57 mm; oil-globule 0.07^5 mm, slightly yellowish.

Trunk myotomes of the larva 27.

Finally I mention a few eggs found near Surabaya:

Surabaya.

May 8th, 1930.

a. Dimensions 1.2 × 0.63 mm; oil-globule 0.06^5 mm, slightly yellowish. Trunk myotomes of the larva 26.

b. Dimensions 1.17 × 0.73 mm; oil-globule 0.09—0.09^5 mm, brownish. Trunk myotomes of the larva 26.

Of these two varieties the latter corresponds fairly well to nr. 9 and is mentioned as such on p. 236. The first named seems to resemble most the egg nr. 5. Also the number of trunk myotomes of the larvae tallies very well with what we found for the latter egg.

This is not the case with several of the dubious eggs mentioned above from the south coast of Borneo and the east coast of Sumatra. Here the number of trunk myotomes is often 27 and sometimes even amounts to 28, a number never found in any of the other eggs with an oil-globule.

Must we think here of another species of the *tri-baganensis*-group? Dr. HARDENBERG has found such a species in the Bay of Batavia, but always young specimens only. The average number of vertebrae is 20 + 19.4 = 39.4, i.e. one trunk vertebra more than is the rule with *Stol. tri.* No mature specimens, however, of this species have thus far been found.

From the south coast of Borneo (Kumai mouth) Dr. HARDENBERG got some samples of *Stolephorus* species which he found to consist of *Stolephorus indicus, commersonii* and *insularis* (eggs all with a knob) and of *Stolephorus tri* and *baganensis*. The short and thick *baganensis*-eggs were found in the inland part of the estuary, so that only *Stol. tri* remains for the other eggs.

In general, then, our impression is that variability is greatest among the *Stolephorus*-eggs with an oil-globule, i.e. those belonging to the coast forms, which evidently have thus far been called collectively *Stolephorus tri.* Closer investigation would probably show that this species should be split up into a number of local races or varieties. *Stolephorus baganensis* e.g. is clearly different from *Stol. tri* and is a.o. characterized by the fact that the number of trunk vertebrae is lower than that of the tail vertebrae (with the exception of the var. *megalops*). One sometimes get the impression that nearly every river mouth has its own local race or races. It is also very remarkable, how much richer the fauna of one river mouth is when compared with the other.

That of the Rokan and Panei mouths e.g. is very rich, that of the Musi mouth seems to be much poorer. Fishery is of much less significance here and also the pelagic fish eggs are much rarer. In a series of horizontal hauls made while approaching and entering the Musi mouth I did not find one *Stolephorus* egg with an oil-globule, not even when the salinity was getting such that in the mouths af the Indragiri, Rokan and Panei-rivers eggs of *Stolephorus tri* and *baganensis* certainly would have been present. Only in the outer catches, where the salinity was $30^0/_{00}$ or more, the eggs of *Stolephorus zollingeri* were numerous. A sample of i k a n t e r i from Muntok (island of Bangka, opposite the Musi mouth) proved indeed to consist of this species. The characteristic river mouth species, however, i.e. those with an oil-globule, seem to be absent in the Musi mouth, as is apparently the case with other fish species characteristic of the Rokan and Indragiri mouths. A study of the different river mouths round the Java Sea and of their fauna would be very interesting and would probably reveal considerable differences.

We have, then, fairly well succeeded in identifying at least the principal types of *Stolephorus* eggs. The results may be briefly summarized as follows:

1° Eggs without oil-globule and with a knob on the egg-membrane.
- *a* longer variety (fig. 1, nr. 3). — *Stolephorus insularis*
- *b* shorter „ (nr. 4). — „ *indicus* or *commersonii*

2° Eggs without a knob and without oil-globule or with a very small oil-globule (diameter 0.05 mm).
- *a* without an oil-globule (nrs. 1, 2) — *Stolephorus zollingeri*
- *b* with a small, yellow oil-globule (nr. 6) — „ *heterolobus*

3° Eggs without a knob, and with an oil-globule of 0.07⁵—0.12 mm diameter.
- *a* diameter of oil-globule 0.07—0.08 mm (nrs. 5, 7) — *Stolephorus tri*
- *b* „ „ „ „ 0.10—0.12 mm (nrs. 8, 10) — „ *baganensis*

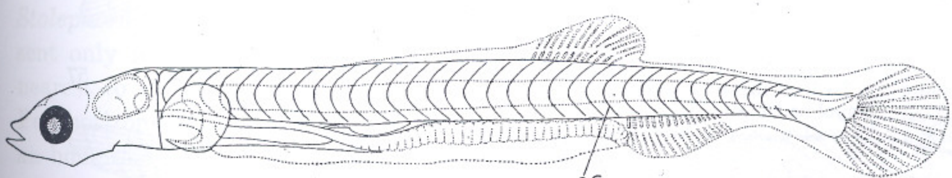
With all these eggs the incubation period is evidently less than 24 hours. Spawning, like in many other fishes, occurs in the course of the night, probably a few hours before midnight [1]). Hatching may occur as early as 2—2.30 p.m. (nr. 10), but as a rule finds place at 5—7 p.m. The stage at which the eyes get black is reached in the second night after hatching. In nr. 3, however, this stage is reached in the third night only, in nr. 4 in the course of the second day.

As regards the older stages of development, they are often found in great number in the catches. Distinction of the different species, however, becomes practically impossible. The number of trunk myotomes, e.g., diminishes with growing age, as we have seen, and thus cannot be relied upon. There are hardly any other characteristics by which to distinguish the different species. One particularity must be mentioned here.

[1]) HILDEBRAND (l.c.) finds for *Anchoviella epsetus* about 8 o'clock in the evening.

In *Stolephorus* larvae from Bagan with a length of from 18 to 24 mm, I observed a yellow-brownish colour in the root of the tail fin and a similar spot just behind the anus. In younger larvae they are not yet present and in older ones this colour disappears again. Each of these coloured areas makes the impression of not being caused by the presence of pigment cells but of a homogeneous coloured fluid. In larvae from other places and evidently belonging to other species I found in the same places, viz. at the tail root and just behind the anus, similar coloured areas but of a different colour. This colour was pink in *Stolephorus* larvae caught near Labuan (Sunda Strait), violet in other larvae fished near Bagan Si Api Api, and crimson in larvae caught near Tjimara (coast of Krawang, near Batavia). These different colours might allow us to distinguish the larvae of different species. But as they are present in larvae of a definite size only and moreover disappear in preserved specimens, it seemed to me not worth while to enlarge upon this matter any further.

53



54

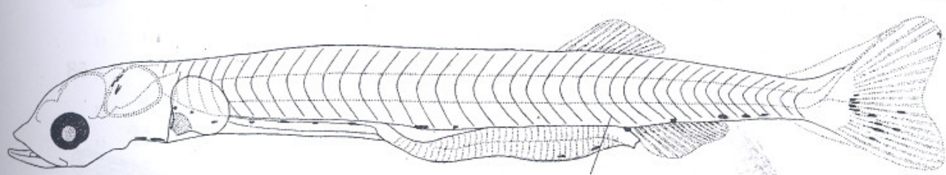
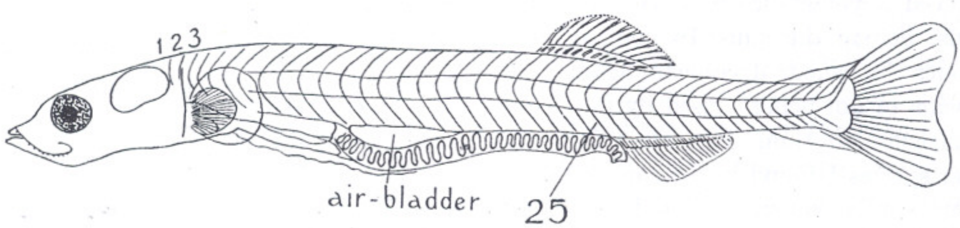


Fig. 53. *Stolephorus baganensis*. Larva from the plankton, mouth of the Panei-river, 5.X.1929. Length about 8 mm.
Fig. 54. Similar larva of another *Stolephorus* species, caught east of the Thousand Islands, length 8,4 mm.

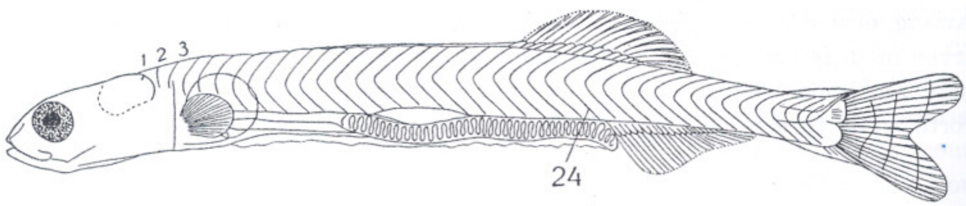
A few larvae of different lengths, as they are caught regularly in the egg-net, are shown in figs. 53—58. The smallest of these (fig. 53) belongs to *Stolephorus baganensis*, being caught together with the short and thick eggs of this species and in the brackish water where the eggs are found. The unpaired fins are developing and the number of pre-anal myotomes is 26, i.e. the same as in the newly hatched larvae. Fig. 54 represents a larva of 8.4 mm. It has 27 pre-anal myotomes and thus probably belongs to one of the less neritic species, with no oil-globule in the egg. It was caught also at some distance from the coast, between the Thousand Islands.

The larvae of figs. 55, 56, 57 and 58 probably all belong to *Stolephorus tri*. They were caught between the outer jeremals of Bagan Si Api Api, where the above named species is the most common. A comparison shows that the ventral

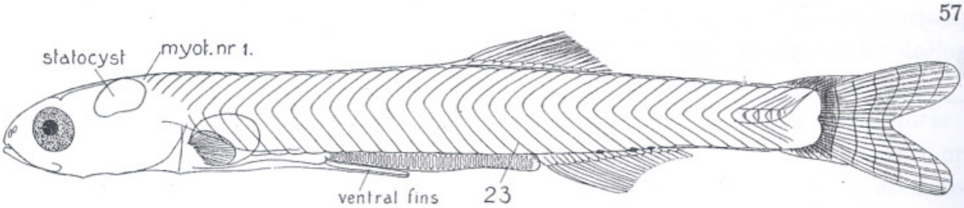
55



56



57



58

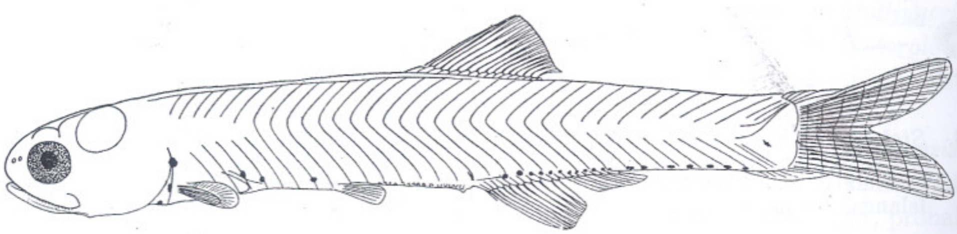


Fig. 55. Larva of *Stolephorus tri*? Caught between the outer jeremals of Bagan Si Api Api, length 8⅔ mm. June 1923.
Fig. 56. Similar young fish of 11½ mm.
Fig. 57. Similar young fish of 18 mm., with small scales on the root of the tail.
Fig. 58. Similar young fish, wholly scaled, of 25½ mm.

fins begin to develop at a stage of somewhat less than 18 mm. At about the same stage the peculiar brownish colour of the root of the tail fin and behind the anus appears. The number of pre-anal myotomes decreases quite gradually, so does the number of myotomes between the ventral fins and the anus after the former have appeared.

The maxillary lengthens to behind the eye. Small scales appear first at the end of the tail in the stage of fig. 57. Such a scale is represented in fig. 59.

In the stage of fig. 58 the whole body is scaled. Fig. 60 shows the scale of a fish of 24 cm length.

The study of the distribution of the *Stolephorus* eggs shows that the species of *Stolephorus* are all more or less restricted to a zone along the coast. In the centre of the Java Sea, e.g., no or hardly any *Stolephorus* eggs are to be found (the only exception being occasionally the egg nr. 2). In September of the year 1928 I made a series of surface hauls with the egg net, reaching in a straight line from the mouth of the Tjimanoek (north coast of Java) to the mouth of Koemai (south coast of Borneo). There were 27 stations in all. *Stolephorus* eggs were present only in the three hauls nearest to the Borneo coast. Per horizontal haul of half an hour there were found at

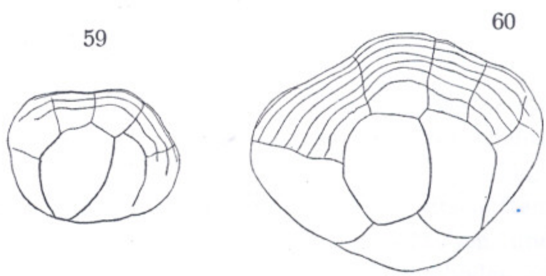


Fig. 59. Scale from the root of the tail of the young fish of fig. 57, × 26.
Fig. 60. Similar scale from a young fish of 24 mm, × 26.

Station				
nr. 1	(depth 20 m,	salinity 32.2‰)	3810	*Stolephorus* eggs
,, 2	(,, 15 m,	,, 32.6‰)	310	,, ,,
,, 3	(,, 32 m,	,, 32.7‰)	45	,, ,,
,, 4—23			no	,, ,,
,, 24	(,, 27 m,	salinity 33.9‰)	33	,, ,,
,, 25	(,, 20 m,	,, 33.8‰)	67	,, ,,
,, 26	(,, 14 m,	,, 33.3‰)	210	,, ,,
,, 27	(,, 8 m,	,, 32.9‰)	580	,, ,, .

In a similar series of hauls made in April 1930 and consisting of 34 hauls, *Stolephorus* eggs proved to be absent in the catches nrs. 7—26. Only in May 1931 I found nr. 2 also in the middle of the Java Sea.

The *Stolephorus* population evidently forms a belt along the coast line and within this zone the eggs without an oil-globule — mainly those of *Stolephorus zollingeri* and *insularis* (nrs. 1, 2 and 3) — are found more seaward, those with an oil-globule — belonging to *Stolephorus heterolobus, tri* and *baganensis* — more landward.