

Embryonic and Larval Development of the Callionymid Fish, *Callionymus calliste*

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Abstract Eggs and larvae of *Callionymus calliste* were obtained from spawners in the aquarium. The fish makes belt-like egg masses in which individual eggs stick to each other and are arranged in a single layer, about 3 mm wide and 70 mm in maximum length. The eggs averaged 0.60 mm in diameter and had the characteristics common to the genus. The larvae had the following characteristics: a row of melanophores along the edge of the ventral fin fold; and vacuoles on the dorsal and ventral fin folds.

Callionymid fishes are one of the dominant groups of fishes in coastal areas of Japan, and their eggs and larvae appear abundantly in plankton samples. However, information is lacking on how to identify them. Eggs and larvae of Japanese callionymid fishes have been described on the material collected from the sea without strict identification of species (Kamiya, 1916; Mito, 1962; Takai and Yoshioka, 1979), except for those of three species which were spawned in an aquarium (Takita, 1980). More information is still needed for species identification of the egg and larva.

Callionymus calliste Jordan et Fowler* is rather rare, and nothing has been known about it beyond a systematic description. Living specimens of this species were collected in July, 1979, and reared in an aquarium, in which they spawned. Observations on the embryonic development and larvae were done on that material.

Spawning behavior and the process of maturation are the subject of another paper (Takita et al., in preparation).

Egg and embryonic development

The fish spawned for seven days beginning July 31. For the first six days they spawned being located under dim light for the convenience of the observation, and on the last day in complete darkness. When observed under dim light, they formed irregular buoyant egg masses composed of two to dozens of eggs. In com-

plete darkness, they made buoyant belt-like egg masses in which individual eggs stuck to each other in a single layer, about 3 mm wide. Eggs were fertilized and developed normally in both egg masses. The belts differed in size from a fragment to 70 mm long and twisted irregularly. The egg mass was not enveloped in any kind of material, and no special layer was recognized on the chorion under the photomicroscope at 100× magnification. The adhesion of the eggs was weak, and the egg mass was easily separated into small fragments (Fig. 1) or individual eggs. Once the eggs were separated from each other, they would not adhere again. All the egg masses naturally separated into individual eggs before hatching, even in still water, which suggests that the eggs lose adhesion during the incubation.

The individual egg ranged in size from 0.58 to 0.62 mm ($X=0.60$ mm) in diameter, and had the following characters common to those of the same genus: buoyancy; transparency; hexagonal pattern on chorion; narrow perivitelline space; absence of an oil globule; segmentation of yolk only near the embryo in early develop-

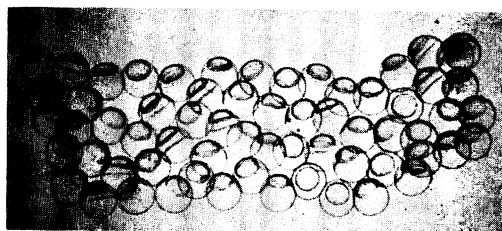


Fig. 1. Egg mass of *C. calliste*.

* Nakabo (1982) has reviewed genera of Callionymidae, and new genus name, *Paradiplogrammus* is proposed for this species.

mental stages and only near the surface after closure of blastopore (McIntosh and Masterman, 1897; Ehrenbaum, 1905; Kamiya, 1916; Mito, 1962; Russell, 1976; Takai and Yoshioka, 1979; Takita, 1980). The pattern on the chorion (0.010~0.015 mm) is as minute as those of *C. richardsoni* and *C. ornatipinnis* (Takita, 1980) but more obscure than that of these two species.

Embryonic development of eggs from a spawning on August 3 is shown in Table 1 and Fig. 2. The elapsed time from spawning was calculated assuming that the eggs were spawned at 9:30 p.m., although it took about one hour for all the fish in the aquarium to complete spawning. Melanophores were not recognized on the yolk sac, whereas there are some on those of *C. flagris*, *C. richardsoni*, and *C. ornatipinnis* (Takita, 1980). The eggs hatched in about 11 hr after spawning at water temperatures of 28.5~30.5°C. Normal larvae hatched out of both the belt-like egg mass and the irregularly formed egg mass.

Larvae

The morphological characteristics of the larvae and their changes at 28.5~30.5°C are illustrated in Fig. 2.

The newly hatched larva was 1.20 mm in total length. The mouth was not open and the

heart was not formed. No pigmentation could be observed on the eyes. The body dorsally had melanophores, and in some individuals the melanophores were also present ventrally at the central part of the tail. No melanophores were on either fin fold or yolk sac. Xanthophores were on the apex of the head and the sides of the body, but none were on the posterior part of the tail. They were also arranged in rows along the edges of the dorsal and ventral fin folds. In some cases, they formed a patch on the posterior dorsal surface of the yolk sac.

A half-day-old larva (measuring 1.40 mm) had a heart and pectoral fin buds. Some melanophores on the body moved to the sides. No chromatophores were posteriorly on the tail. The xanthophores on the dorsal fin fold were concentrated at two points near the dorsal edge and the ones on the ventral fin fold were at one point near the ventral edge.

In a one-day-old larva (1.57 mm) the mouth had opened and an air-bladder with thick melanophores on the back and the pectoral fins were formed. The head had its characteristic swelled feature on the top. A spine-like pattern appeared on the edges of dorsal and ventral fin folds. The body melanophores had moved ventrally, and were arranged in a row on both lateral sides and ventral edge. There were

Table 1. Embryonic development of *C. calliste*.

Time elapsed from spawning*		Water temp. (°C)	Developmental stages observed
hr	min		
0	55	28.5	Thirty-two cells stage.
2	30	29.4	Late morula through blastula stage.
3	00	30.5	Early gastrula stage. Fig. 2A.
4	15		Beginning of embryo formation. Germ ring has nearly reached half of the yolk diameter in lateral view. A little before the stage of Fig. 2B.
5	15	29.4	Formation of eye vesicle and two or three myomeres. Some already have Kupffer's vesicle. A little before the stage of Fig. 2C.
6	40		Closure of blastopore
7	15	28.6	Beginning of tail formation. Appearance of xanthophores on embryo and yolk sac.
7	40		Appearance of melanophores on the back of embryo. A little before the stage of Fig. 2D.
8	30		Optic lens and otocyst formation. Fig. 2E.
11	00		Hatching.

* The elapsed time from spawning was calculated assuming that the eggs were spawned at 9:30 p.m. on August 3, 1979.

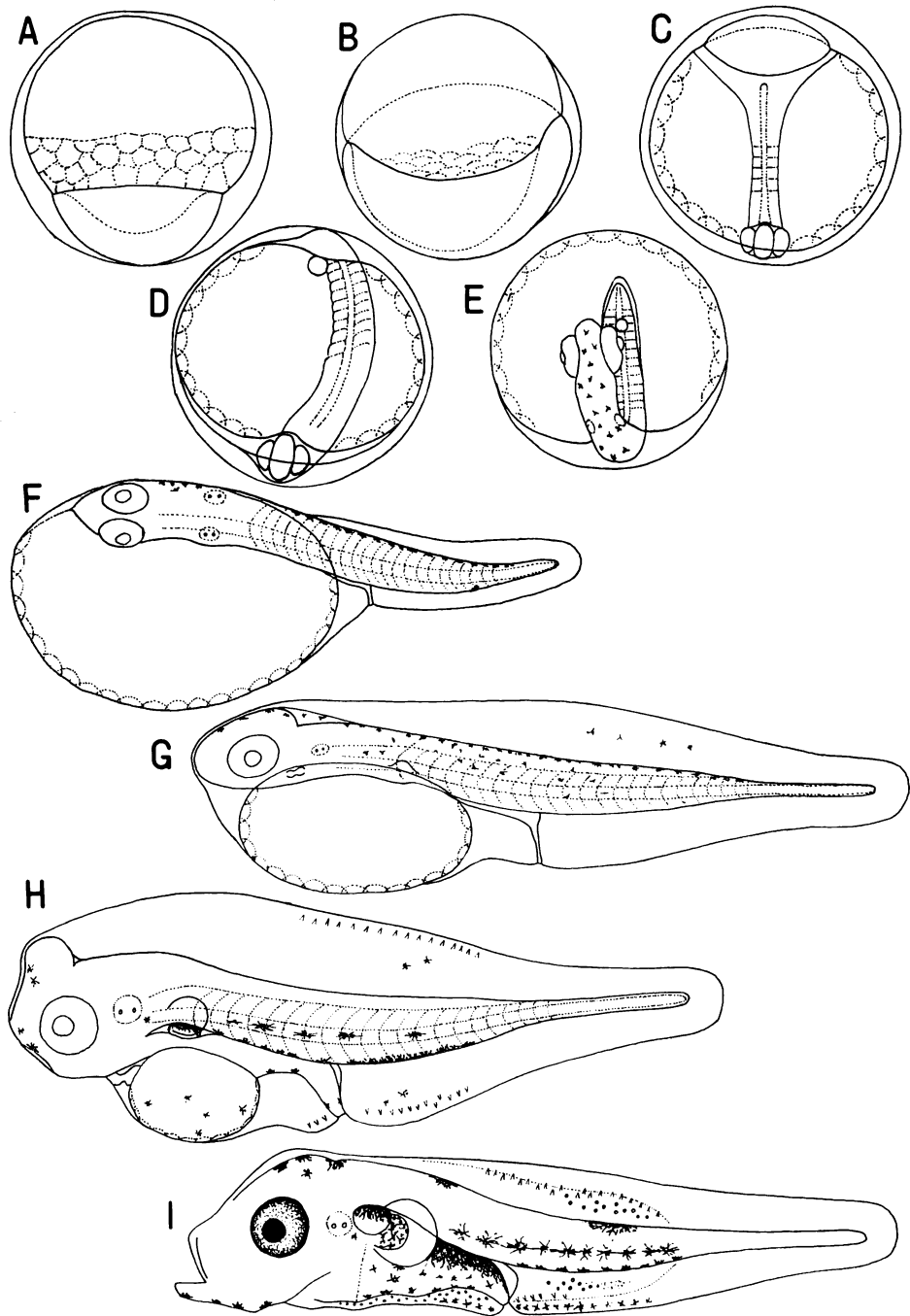


Fig. 2. Eggs and larvae of *C. calliste*. A: 3 hr after spawning. B: 4 hr 30 min. C: 5 hr 40 min. D: 7 hr 25 min. E: 8 hr 30 min. F: Newly hatched larva, 1.20 mm in total length. G: Half a day old, 1.40 mm. H: One day old, 1.57 mm. I: Two days old, 1.68 mm.

melanophores also on the snout and the yolk sac.

A two-day-old larva (1.68 mm) had black pigments on the eyes and the mouth began to function. Many melanophores were on the body, concentrated on the apex of the head, the lower jaw, two places on the back of the body, and the back of peritoneal cavity in addition to the places where they were on the one-day-old larva. One row of melanophores appeared along the edge of ventral fin fold. There were small vacuoles on both dorsal and ventral fin folds which formed a patch between the spine-like pattern and the body. The differences in the xanthophore distribution from the one-day-old larva were that they were now thick on the bases of pectoral fins and that they had disappeared from the dorsal fin, leaving only a single point on it. No chromatophores were on the posterior half of the tail.

Just after hatching the larvae floated upside-down just beneath the surface. Half a day after hatching they were in the mid water column. One day after hatching they swam actively with normal body orientation throughout the whole area of the tank. Death occurred within three days, probably due to starvation.

Discussion

Two unidentified species of pelagic eggs have been reported by Mito (1960), which were adhesive but were not embedded in a gelatinous substance. According to Mito (1963), one of them designated as "agglutinated egg, No. 2" has characteristics similar to those observed in eggs of *C. calliste*: absence of oil globule and spine-like pattern on fin folds of larva from the egg. However, several characters observed in the unidentified egg were not seen in *C. calliste* suggesting that the egg is a different species, although the egg may be taxonomically close to the Callionymidae.

Collionymus calliste made egg masses of different forms due to varying conditions. A belt-like egg mass occurred under entirely dark conditions and without disturbance from observers. An investigation is needed to learn how the fish makes such a delicate form in the darkness.

The eggs of *C. calliste* had the hexagonal pattern on the chorion similar to that of eggs of other callionymid fishes, and I did not recognize

any special adhesive layer on it. A detailed analysis on the structure of the chorion is needed to discern how the eggs adhere and how they lose their adhesiveness during incubation.

The fish lives in the intertidal zone and is supposed to spawn there (Takita et al., in preparation), where the water is apt to be rough. Under such circumstances, the egg mass could be easily broken. It is a question as to why the fish makes such a fragile egg mass.

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(Note: Title in parentheses are originally given in Japanese, and put into English by the author)

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ハナビスメリの卵発生と仔魚

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ハナビスメリを水槽内で産卵させ、卵、卵内発生と仔魚の観察を行った。

卵は一層をなしてたがいにくっつき、幅約 3 mm、最大の長さ 70 mm の帯状の卵塊として産み出された。個々の卵は球形、浮性で、平均卵径は 0.60 mm であった。卵の形態はこれまでに知られている同属の卵によく似ている。

仔魚は、同属の仔魚に共通して認められている形態のほかに、次のような特徴をもつ。すなわち、ふ化後 2 日目の仔魚の背・腹側膜びれに泡状組織があり、腹側膜びれには、その縁辺に黒色素胞の列がある。

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