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Development of Larvae and Juveniles of the Atherinid Fish, *Atherion elymus*, Reared in the Laboratory

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Abstract Embryonic, larval and juvenile development of the atherinid fish, *Atherion elymus*, was described on the basis of a series of laboratory-reared specimens. The eggs were almost spherical in shape, measuring 0.90–1.05 mm in diameter, with numerous chorionic filaments. Hatching occurred between 13 and 17 days after spawning at water temperatures of 20.5–21.4℃. Newly hatched larvae measured 3.95–4.70 mm NL and had 4+37 myomeres. Flexion of the notochord started at 7.0–7.5 mm NL. Aggregate numbers of all fin rays were completed at 10.7–11.5 mm SL, when the larvae reached the juvenile stage. Squamation was almost completed at 18.5–20 mm SL. The larvae of this species can be distinguished from those of *Hypoatherina tsurugae* and *H. bleekeri* by having a few melanophores just before the tip of the notochord both dorsally and ventrally, and having punctate melanophores on the lateral median.

Atherion elymus Jordan et Starks is a small atherinid fish distributed in the West Pacific, commonly inhabiting coastal waters exposed to the open sea in southern Japan (Yoshino, 1984).

The embryonic development of this species has already been described by Nakamura (1936) and Takita and Nakamura (1986b). The former author stated that the species laid adhesive eggs without chorionic filaments; whereas the latter reported that the fish spawned entangling eggs with numerous filaments like those of other atherinid fishes as reported by White et al. (1984). Also the hatched larvae were sketched by those authors.

Although the wild larvae and juveniles of the species were already described by Uchida (1927) and Nakamura (1936), their descriptions did not provide enough information to distinguish the larvae of the species from those of other Japanese atherinids, especially in the preflexion and flexion stages. In this paper, a detailed description on the larval and juvenile development of the fish, from a series of reared specimens, is given as a part of the study on the early life histories of Japanese atherinid fishes.

Materials and methods

The parental fish consisted of 79 females (44–53 mm in standard length (SL)) and 52 males (44–52 mm SL). They were caught with a small seine net on the coast of Zaga Island in Ago Bay, Mie Prefecture (34°16′20″N, 136°48′30″E) on June 9, 21, and July 15, 1986. They were kept in a 1,000 *l*-capacity black polyethylene tank containing sea water.

Just after spawning had occurred, the eggs deposited on the bottom of the tank were transferred to a 500 *l*-capacity black polyethylene tank containing weakly aerated running sea water (260–800 m*l*/min). Incubating temperature ranged from 20.5 to 21.4℃.

After hatching, sea water containing cultured marine chlorella, *Nannochloropsis oculata*, was daily added to the breeding water at a density of ca. 2×10^5 cells/m*l*. The larvae were fed with rotifers, *Brachionus* sp., during the first several days. Subsequently *Artemia* sp. nauplii, wild zooplanktons (nauplii, copepodids, copepods, zoea larvae) and artificial foods were fed to the larvae in progression with their growth.

Larvae and juveniles were sampled periodically from the larval rearing tank, and anesthetized with 10–100 ppm ethylene glycol monophenyl ether for morphological observation. Subsequently they were preserved in 5% buffered formalin (diluted with sea water). After iridescent pigments had disappeared, observation of the melanophores and measurements of the specimens were carried out. And then the specimens were stained with alizarin red S to observe the fin rays and scales.

The wild larvae and juveniles were collected with small spoon nets during the period from June to

August, 1986, at the same as well as in close vicinity of the places where the parental fish were caught.

Results

Spawning. Spawning in the tank was observed during the period from June 10 to July 16. The parental fish usually laid many eggs on the day after their collection. Spawning time was confined from 5: 00 to 6:00.

Eggs. The eggs were demersal, almost spherical in shape, measuring 0.90–1.05 mm in diameter, with a colorless transparent chorion and a slightly yellowish yolk. There were 5 or 6 comparatively large oil globules measuring 0.08–0.16 mm in diameter, and numerous tiny ones measuring ca. 0.01 mm or less in diameter in the yolk. The perivitelline space was narrow. The chorionic filaments gathering at two tufts were present bipolarly. Each tuft consisted of ca. 40–55 filaments.

Embryonic development is shown in Table 1. Hatching occurred between 13 and 17 days after spawning.

Yolk-sac larvae. The newly hatched larvae measuring 3.95-4.70 mm in notochord length (NL) contained the remnants of the yolk. The larvae possessed 4+37=41 myomeres. The head was round and the mouth was fully developed. The tail elongated and the anus was situated just behind the yolk sac (Fig. 1A-1).

Three large conspicuous melanophores were present on the top of the head (Fig 1A-2). Some branched melanophores were distributed on the dorsal surface of the abdominal cavity. A few punctate melanophores were located just before the tip of the notochord both dorsally and ventrally. In some specimens, the melanophores on the ventral side were very small, so they easily disappeared immediately after fixation. The larvae swam actively in the surface layer of the rearing tank, and showed weak phototaxis.

Preflexion larvae. Absorption of the yolk was completed 2 or 3 days after hatching, when the larvae attained to ca. 5.0 mm NL. Branched melanophores appeared in the otic capsule about the same time of yolk absorption. Punctate melanophores appeared along the lateral median of the tail (Fig. 1B-1). These melanophores were present in all specimens when the larvae reached ca. 8.0 mm NL, and increased in number with growth.

Flexion larvae. The notochord started to flex when the larvae attained to 7.0–7.5 mm NL. The caudal rays started to form. Melanophores appeared on the caudal base. They increased in number and spread posteriorly on the caudal rays with growth. In larvae of 8.0–8.5 mm NL, the second dorsal fin appeared and anal rays formed. Melanophores appeared on the opercular region and along the dorsal median of the trunk and tail (Fig. 1C-1).

Postflexion larvae. Notochord flexion was completed when the larvae attained to ca. 9.0 mm SL. The pelvic buds, first dorsal spines, and pectoral rays appeared. In larvae over 10.0 mm SL, the second dorsal, anal, and caudal rays started to segment.

Table 1. Embryonic development of *Atherion elymus*.

Time elapsed after spawning	Developmental stages observed
30 min	Elevation of blastodisc.
1 h 30 min	2-cell stage.
2 h	4-cell stage.
2 h 30 min	8-cell stage.
3 h	16-cell stage.
20 h	Blastula stage.
30 h	Beginning of embryo formation.
33 h	Closure of blastopore.
35–40 h	Formation of optic vesicle.
50–60 h	Formation of optic lens. 4 myomeres.
52–63 h	Formation of otic capsule.
63–66 h	Beginning of heart pulse.
4 days	Formation of pectoral fin.
5 days	Formation of finfold.
8–10 days	Opening of mouth. Appearance of iridophores on the eyes.
13 days	Beginning of hatching.

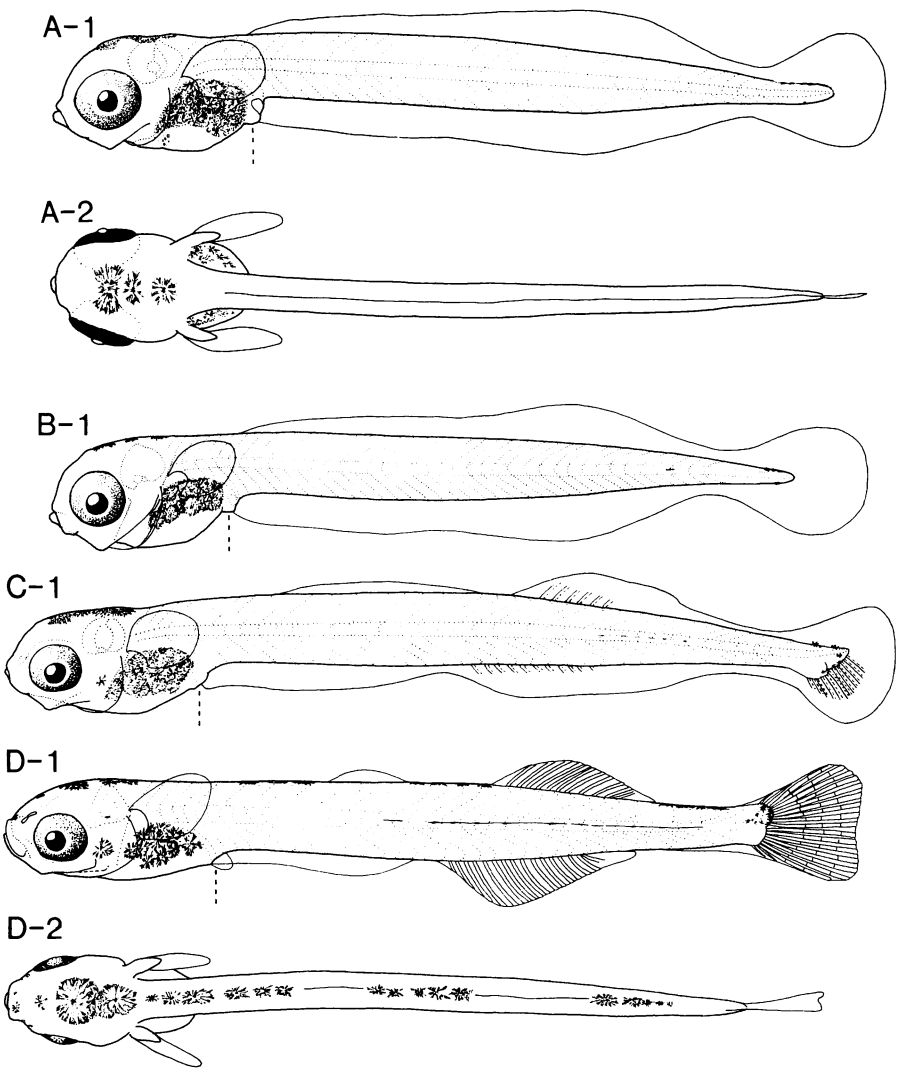

Fig. 1. Larvae of *Atherion elymus*. A, newly hatched yolk-sac larva, 4.5 mm NL; B, preflexion larva, 4.9 mm NL; C, flexion larva, 8.4 mm NL; D, postflexion larva, 10.0 mm SL. 1, lateral view; 2, dorsal view. Dashed vertical lines indicate the location of the anus.

Branched melanophores appeared on the snout, the tip of the lower jaw, and the dorsal surface of the head. A series of punctate melanophores on the lateral median elongated linearly. Branched melanophores on the dorsal median increased in number (Fig. 1D-1, D-2).

Juveniles. Aggregate numbers of all fin rays including the pelvic were completed in specimens of 10.7–11.5 mm SL. Body became wide. The origin of the second dorsal was situated above the 6th or 7th anal ray. The anus started to move backward (Fig. 2A-1). Melanophores on the head increased in number. Branched melanophores were located on the dorsal surface between the head and the caudal peduncle (Fig. 2A-2). On the ventral surface of the tail, a row of branched melanophores appeared along each side of the anal base. These melanophores increased in number and the rows elongated both forward and backward with growth (Fig. 2A-3). A series of punctate melanophores on the lateral median ran from the pectoral base to the caudal peduncle, showing a single black line. Subsequently these melanophores changed to branched ones and another series of branched melanophores appeared

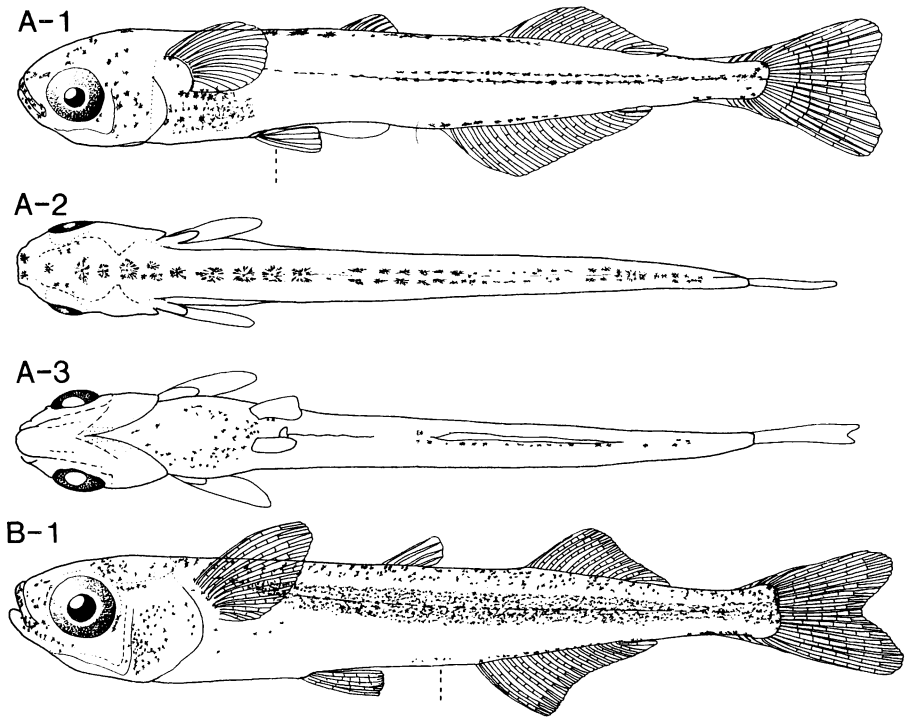

Fig. 2. Juvenile (A) and young (B) of *Atherion elymus*. A, 12.9 mm SL; B, 22.0 mm SL. 1, lateral view; 2, dorsal view; 3, ventral view. Dashed vertical lines indicate the location of the anus.

just above the lateral median. These two series of melanophores formed parallel black lines (Fig. 2A-1). When the juveniles attained to 13.0–13.5 mm SL, those two lines connected with each other to form a single longitudinal dark band. In the juveniles of 15.0–15.5 mm SL, a few scales first appeared midlaterally on the tail just before the caudal peduncle. Branched melanophores on the ventral surface of the body were arranged from the pelvic base to the caudal base. In the juveniles of 17.0–18.0 mm SL, migration of the anus was completed and the anus was located just before the origin of the anal fin like that in adults. Finfold completely disappeared.

Young. In the specimens of 18.5–20.0 mm SL, squamation was almost completed. External morphology of the body became the same as that of adults. Branched melanophores appeared on the marginal area of the scales on the dorsolateral surface of the body, and they increased in number with growth (Fig. 2B-1).

Discussion

Morphology of the eggs and hatched larvae of *Atherion elymus* obtained here agrees well with that described by Takita and Nakamura (1986b) in general. Thus, it seems that Nakamura's (1936) descriptions of the eggs and hatched larvae were based on different species as already indicated by Takita and Nakamura (1986b). Embryonic development after the blastula stage given here also corresponds well with that described by Takita and Nakamura (1986 b).

There are few morphological differences between reared specimens and wild ones except for the melanophores on the top of the head, which were slightly larger in the reared specimens than in the wild ones.

Comparing the juvenile morphology obtained here with that described by Uchida (1927) and Nakamura (1936), the following differences are observed. The melanophores on the ventral surface anterior to the anal origin are absent in Uchida's description whereas they are present at least in the speci-

mens larger than 13.5 mm SL in our result. In Nakamura's juvenile of 13.4 mm TL, the horizontal distance between the origins of the second dorsal and anal fins is somewhat shorter than that in our specimens. Moreover, the dark band along the lateral median in his juvenile is very narrow and appears linear. Accordingly his juvenile may be identified with *Hypoatherina tsurugae* (Jordan et Starks).

A. elymus can be distinguished from other atherinid fishes occurring in the coastal waters of central Japan, i.e. *H. tsurugae* (see Uchida, 1927) and *H. bleekeri* (Günther) (see Takita and Kondo, 1984; Takita and Nakamura, 1986a), by the following characters. In the larval stage, a few melanophores are present just before the tip of the notochord both dorsally and ventrally, and the melanophores on the lateral median are not branched but punctate. In the juvenile and young stages, the anal fin count is I, 15–16.

We succeeded in the rearing of *H. tsurugae* from the egg to young; detailed comparison between *A. elymus* and *H. tsurugae* will be published elsewhere.

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ムギイワシの仔稚魚

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水槽内で自然産出させたムギイワシ卵を飼育し，卵および孵化仔魚から若魚までの外部形態の形成過程を観察した．卵は直径 0.90–1.05 mm の球形で，卵膜の両極に 40–55 本のてん絡糸を有する．孵化仔魚の脊索長は 3.95–4.70 mm．7.0–7.5 mm で脊索の屈曲が始まる．標準体長 10.7–11.5 mm で鰭条総数が定数に達し，18.5–20 mm で体はほぼ完全に被鱗される．本種の仔魚は側中線上の黒色素胞が点状であることや脊索後端部の背腹両面に数個の黒色素胞が存在することなどの特徴によって，ギンイソイワシやトウゴロウイワシの仔魚と区別できる．

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