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Development of Eggs, Larvae and Juveniles of the Labrid Fish, *Halichoeres poecilopterus*, Reared in the Laboratory

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Abstract Embryonic, larval and juvenile development of the labrid fish, *Halichoeres poecilopterus*, is described using a laboratory-reared series. The eggs, measuring 0.60–0.72 mm in diameter, were pelagic and spherical with a single oil globule (0.12–0.16 mm in diameter). Hatching occurred 18 h 48 min after spawning. The newly-hatched larvae, measuring 1.46–1.70 mm TL, had 8–11+16–18 myomeres. A conspicuous melanophore appeared on the dorsal finfold 8 h after hatching, at ca. 2 mm TL. The yolk was completely absorbed 3 days after hatching, at 2.52–2.72 mm TL. Flexion of the notochord started at ca. 6 mm TL and was finished at ca. 8 mm TL. Aggregate numbers of all fin rays were completed at ca. 14 mm TL. Squamation was almost completed at ca. 20 mm TL.

Halichoeres poecilopterus (Temminck et Schlegel) is a very common coastal labrid fish ranging from southern Hokkaido to Kyushu in Japan and from the Korean Peninsula to China (Araga, 1984). The development of embryos and hatched larvae of this species, following artificial fertilization, has already been reported by Kamiya (1925). In addition, naturally occurring larvae and juveniles have been studied by Masuda and Tanaka (1962) and Kojima (1988). However, information is lacking concerning continuous ontogeny from egg to juvenile. In this paper, the embryonic, larval and juvenile development of this fish is described in detail from a reared series, and Kamiya's description is reviewed. It is the fourth report in an ongoing study of the fishery biology of labrid fishes.

Materials and Methods

The parental fish consisted of 10 females (125–165 mm SL) and 25 males (130–190 mm SL) caught by angling in Ago Bay, Mie Prefecture (34°16–17′N, 136°48–49′E) from April 30 to May 31, 1987. They were maintained in a 10 k*l*-capacity concrete tank, with an egg-collecting system, at Fisheries Research Laboratory, Mie University (FRLM). Sea water was continuously poured into the tank at ca. 75 *l*/min.

Spawning in the tank was observed almost every day from June 3 to September 10. Spawning occurred regularly in the morning, most frequently between 8:00 and 9:30 (Kimura and Kiriyama, 1992). The eggs were gathered into an egg-collecting net.

After spawning, eggs in the net were transferred into a gauze net cage (30×25×30 cm) suspended in a larval rearing tank (500 *l*-capacity black polyethylene tank) containing weakly aerated sea water. The incubating temperature ranged from 21.9 to 24.7°C.

Just after hatching, the larvae were released from the net cage and reared in still water for three days. Subsequently, the sea water was supplied at rates of 27–800 m*l*/min.

Cultured marine chlorella, *Nannochloropsis oculata*, (ca. 2×10^5 cells/m*l*) and trochophore larvae of the oyster, *Crassosterea gigas*, (ca. 60 inds./m*l*) were added daily to the breeding water from 3 days after hatching. Subsequently, rotifers, *Brachionus plicatilis*, *Artemia* nauplii, wild zooplankton, and artificial foods were given to the larvae in accordance with their growth.

Larvae and juveniles were sampled periodically from the larval rearing tank, being anesthetized with 10–100 ppm ethylene glycol monophenyl ether for morphological observations and measurements. Thereafter they were preserved in 5% buffered formalin (diluted with sea water) and deposited in FRLM. Some specimens were stained with alizarin red S to observe their fin rays and scales.

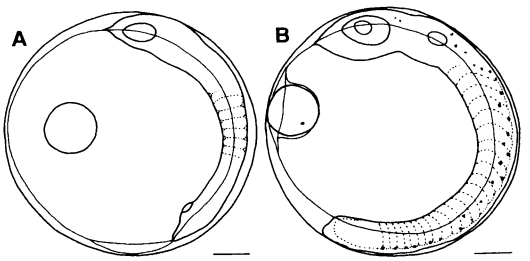

Fig. 1. Development of eggs of *Halichoeres poecilopterus*. A, 10 h 36 min after spawning; B, 16 h 14 min. Scales indicate 0.1 mm.

Development

Eggs. Embryonic development is shown in Table 1 and Fig. 1. The eggs were buoyant and spherical in shape, measuring 0.60–0.72 (av. 0.66) mm in diameter, with a colorless transparent chorion, slightly yellowish yolk, and a single oil globule, measuring 0.12–0.16 (av. 0.14) mm in diameter. The perivitelline space was narrow. Punctate melanophores were distributed dorsally on the embryo and on the oil globule.

Larvae and juveniles. *Morphology.*—The newly-hatched larvae, measuring 1.46–1.70 mm TL, had 8–11+16–18 myomeres (Fig. 2A). The anterior tip of the yolk sac extended beyond the snout. The yolk and oil globule were completely absorbed at ca. 2.6 mm TL 3 and 4 days after hatching, respectively (Fig. 2D).

The finfold of the newly-hatched larvae was comparatively low, the central portion subsequently becoming higher at ca. 2 mm TL (Fig. 2B). In larvae of ca. 7 mm TL (Fig. 3A), the finfold divided into dorsal, anal and caudal portions, concurrent with the loss of the abdominal portion. Needle-like projections appeared on both the dorsal and ventral margins of the finfold at ca. 2 mm TL (Fig. 2B) and further developed up to ca. 3 mm TL (Fig. 2E), thereafter decreasing gradually (Fig. 2F), to disappear completely at ca. 4.6 mm TL. Minute granules appeared on almost the entire surface of the finfold at ca. 5 mm TL, subsequently decreased with growth (Fig. 3A, B), and disappeared at ca. 12 mm TL.

Flexion of the notochord started at ca. 6 mm TL and was completed at ca. 8 mm TL (Fig. 3B).

Fin development.—The anlage of the pectoral fin appeared 1 day after hatching, at ca. 2.5 mm TL (Fig. 2B). The rays started to form at ca. 7 mm TL (Fig. 3A), the full complement (12–13) being present at ca. 11 mm TL. Segmentation of the rays occurred at ca. 14 mm TL.

The anlage of the caudal fin appeared at ca. 5.2 mm TL. The rays started to develop at ca. 6.3 mm TL, the full complement (7+7) being present at ca. 12 mm TL. Segmentation occurred at ca. 8.4 mm TL (Fig. 3B). The fin became truncated at ca. 14 mm TL.

The anlagen of the dorsal and anal fins appeared at

Table 1. Embryonic development of *Halichoeres poecilopterus* at a temperature of 23.4°C

Time elapsed after spawning	Developmental stages observed
29 min	Elevation of blastodisc
48 min	2-cell stage
1 h 3 min	4-cell stage
1 h 16 min	8-cell stage
1 h 36 min	16-cell stage
1 h 53 min	32-cell stage
3 h 58 min	Blastula stage
7 h 49 min	Gastrula stage
8 h 48 min	Beginning of embryo formation
9 h 29 min	3 myomeres
10 h 36 min	Formation of optic and Kupffer's vesicles. 7 myomeres (Fig. 1A)
11 h 29 min	Closure of blastopore
13 h 39 min	Appearance of melanophores on the embryo
14 h 11 min	Appearance of melanophores on the oil globule. 18 myomeres
15 h 29 min	Formation of optic lens. 23 myomeres
16 h 9 min	Disappearance of Kupffer's vesicle
16 h 14 min	Formation of optic capsule. 26 myomeres (Fig. 1B)
16 h 39 min	Beginning of heart pulse. Beginning of tail formation
18 h 48 min	Beginning of hatching

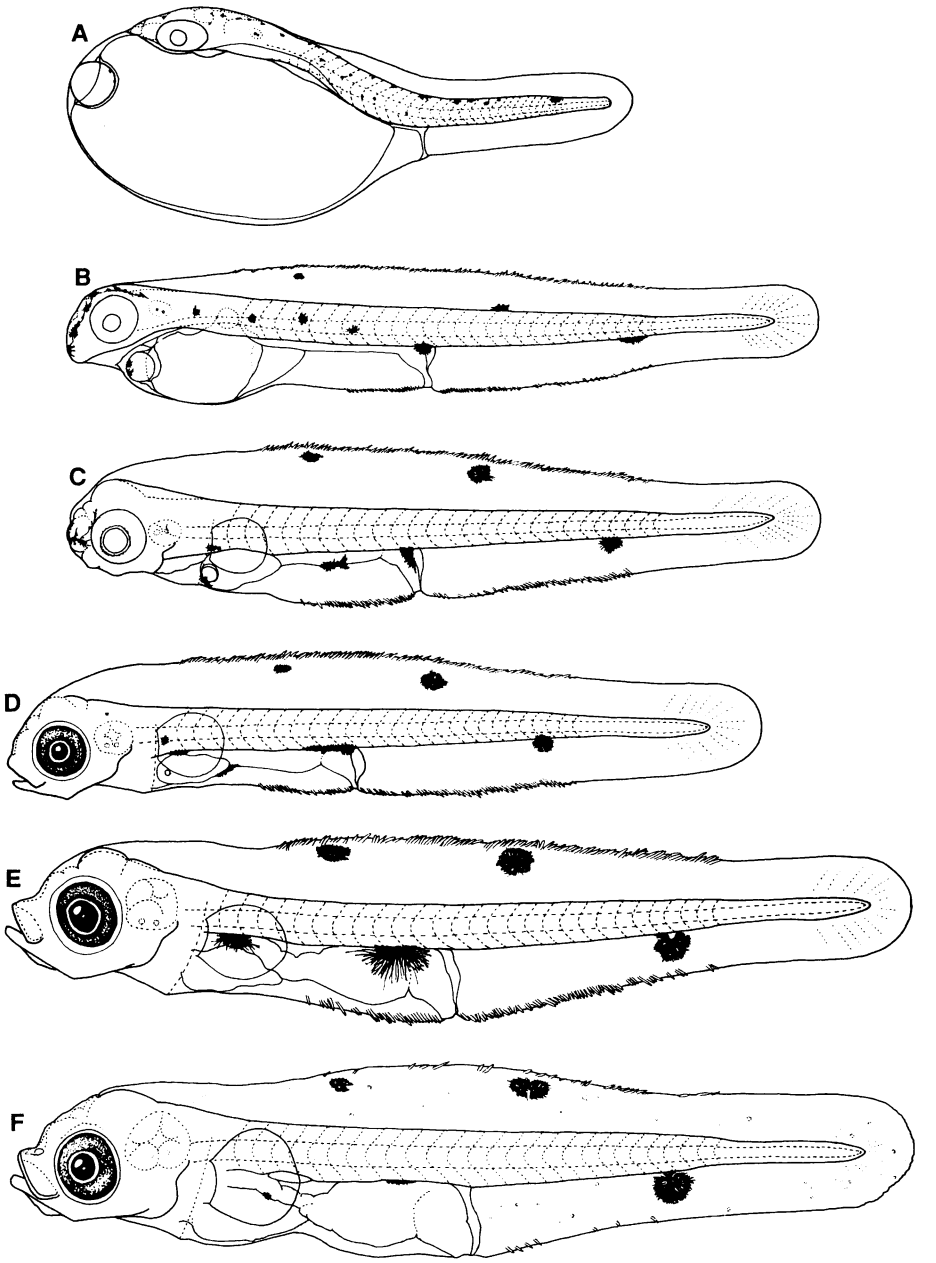

Fig. 2. Yolk sac and preflexion larvae of *Halichoeres poecilopterus*. A, yolk sac larva, just after hatching, 1.60 mm TL; B, yolk sac larva, 1 day, 2.44 mm TL; C, yolk sac larva, 2 days, 2.60 mm TL; D, preflexion larva, 3 days, 2.60 mm TL; E, preflexion larva, 8 days, 2.92 mm TL; F, preflexion larva, 14 days, 3.82 mm TL.

ca. 7 mm TL (Fig. 3A). The rays started to develop at ca. 8 mm TL (Fig. 3B), the full complements (D: 22–24; A: 15–18) being present at ca. 11 mm TL. The spines of both fins were completed, along with segmentation of the rays, at ca. 18 mm TL.

The anlage of the pelvic fin appeared at ca. 8 mm TL. The rays started to form at ca. 11 mm TL, the full complement (I, 5) being present at ca. 14 mm

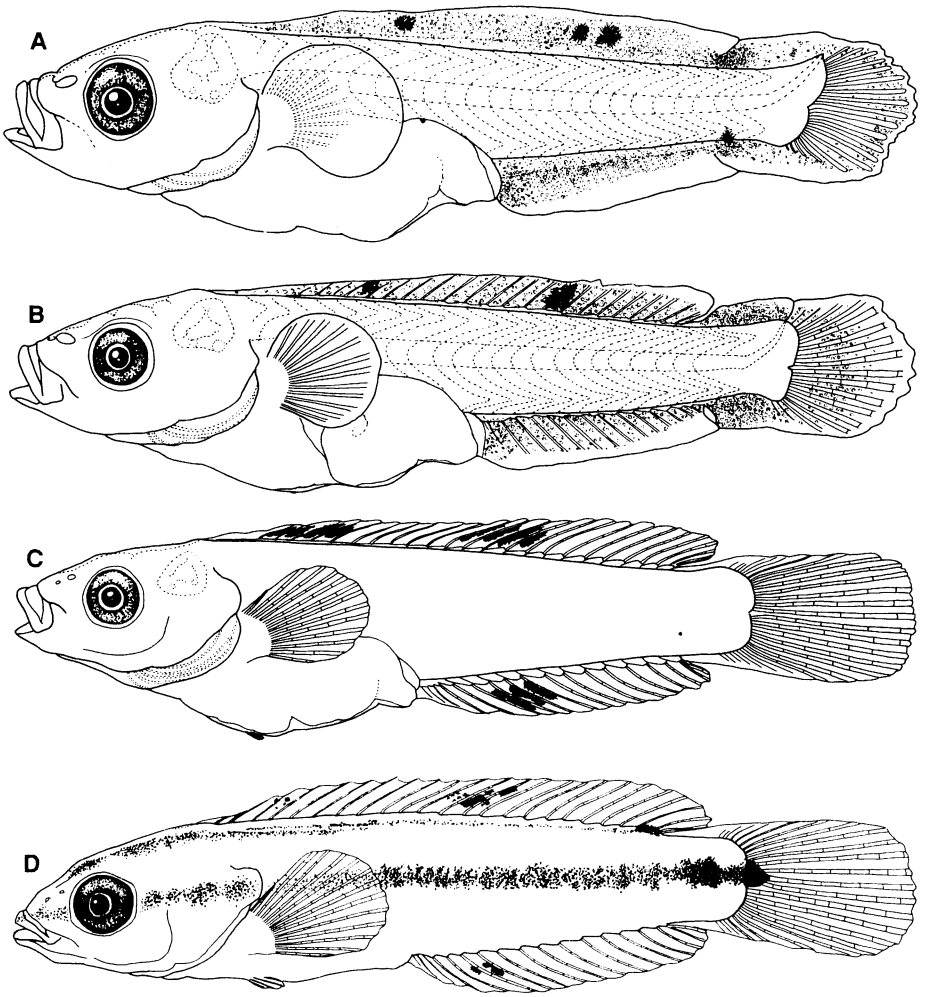

Fig. 3. Flexion and postflexion larvae, and juveniles of *Halichoeres poecilopterus*. A, flexion larva, 23 days after hatching, 7.00 mm TL; B, postflexion larva, 30 days, 8.35 mm TL; C, juvenile, 33 days, 16.7 mm TL; D, juvenile, 35 days, 16.4 mm TL.

TL. Segmentation occurred at ca. 16 mm TL.

Pigmentation.—The newly-hatched larvae had 20 or more punctate melanophores on the dorsal contour (Fig. 2A). These melanophores subsequently moved toward the ventral side (Fig. 2B), developing branches but decreasing in number. They were restricted to the pectoral fin base and anal finfold in larvae of ca. 2.6 mm TL (Fig. 2C). The body melanophores had disappeared completely 4 days after hatching, at ca. 2.6 mm TL (Fig. 2C), but several stellate melanophores appeared subsequently, mediolaterally on the caudal peduncle at ca. 13–18 mm TL. These extended anterio-posteriorly, forming a mediolateral band from the tip of the snout to the caudal fin base (Fig. 3D). Punctate melanophores appeared dorsolaterally on the head from the supraocular area to the posterior end of the dorsal base (Fig. 3D). Thereafter, a row of stellate melanophores formed a ventrolateral band along the anal fin base to the pectoral fin base. Punctate melanophores were scattered between the black bands at ca. 18 mm TL. Melanophores appeared on the area anterior to the pectoral fin base, but the ventrolateral band faded away gradually at ca. 20 mm TL.

A branched melanophore appeared on the anterior part of the dorsal finfold 8 h after hatching, at ca.

2 mm TL, a similar pigment cell appearing on the posterior part of the finfold 2 days after hatching, at ca. 2.6 mm TL (Fig. 2B). These cells developed up to ca. 3 mm TL and remained throughout the larval period. However, the anterior cell divided into 3 cells at ca. 11 mm TL, and the posterior one into 2 cells at ca. 7–11 mm TL (Fig. 3A). Moreover, these groups of cells increased in number, forming 4 black marks between the first and forth spines at ca. 15 mm TL, and 4 or 5 marks between the first and eighth soft rays at ca. 16 mm TL, respectively (Fig. 3C). Thereafter, they started to disperse and disappear at ca. 18–19 mm TL. Numerous punctate melanophores were scattered on the dorsal fin at ca. 18 mm TL.

A single melanophore on the anal finfold developed up to ca. 5 mm TL (Fig. 2B–F), but subsequently became small and disappeared at ca. 8.2 mm TL (Fig. 3B). In some specimens, however, this melanophore moved to the ventral contour of the caudal peduncle at ca. 7 mm TL, before its disappearance (Fig. 3A). A branched melanophore appeared on the anterior part of the anal fin at ca. 8–11 mm TL. This increased in number, forming 2 or 3 black marks between the second and sixth soft rays at ca. 12–16 mm TL (Fig. 3C). Thereafter, they divided into many small melanophores and disappeared at ca. 18 mm TL. Numerous punctate melanophores were scattered on the anal fin at ca. 18 mm TL.

Melanophores appeared on the caudal fin base at ca. 14 mm TL and extended into a semicircle in juveniles of ca. 15–18 mm TL (Fig. 3D).

An internal, branched melanophore appeared on the posterior corner of the alimentary canal just above the anus 8 h after hatching, at ca. 2 mm TL, subsequently developing and extending onto the canal at ca. 3 mm TL (Fig. 2B–E). Another internal melanophore appeared ventrally on the anterior part of the canal at ca. 2.6 mm TL (Fig. 2C), to move to the dorsal side at ca. 3 mm TL (Fig. 2E). Thereafter the two melanophores became smaller, at ca. 4–5 mm TL, and disappeared (at ca. 4.4 mm TL, posterior; at ca. 8.2 mm TL, anterior) (Fig. 3B).

Erythrophores were present on the tip of the upper jaw, on the area anterior to the pectoral fin base, on the gut, and posteriorly on the tail at ca. 3.6 mm TL, and on the posterior margin of the opercle and on the otic capsule at ca. 5 mm TL. They continued to develop up to ca. 10 mm TL, but had disappeared completely at ca. 20 mm TL. Punctate erythrophores appeared on the body between the black bands, on the dorsal and anal fins, and on the caudal fin base in juveniles of ca. 18 mm TL.

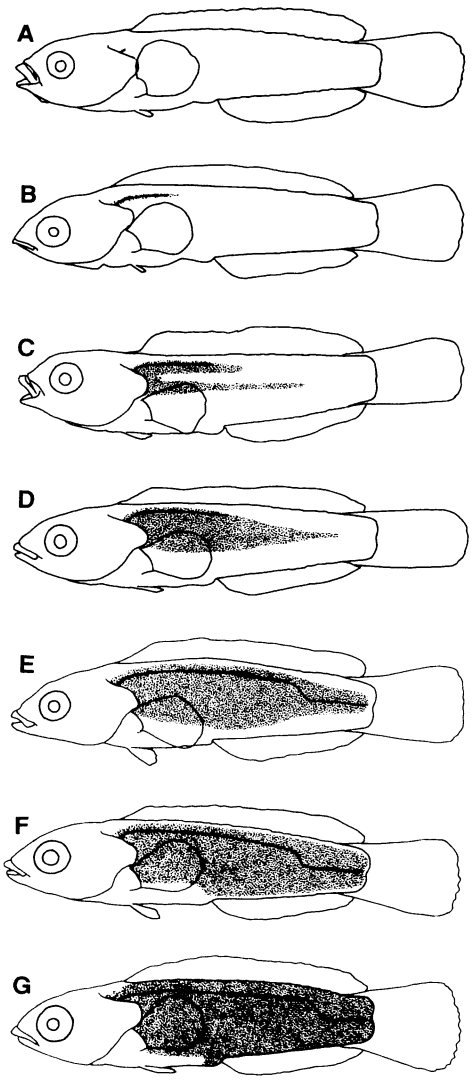

Fig. 4. Diagrammatic illustrations of the squamation sequence in reared juvenile *Halichoeres poecilopterus*. Shaded areas and solid lines indicate the squamated areas and the lateral lines, respectively. A, 16.6 mm TL; B, 16.4 mm TL; C, 17.5 mm TL; D, 16.4 mm TL; E, 17.5 mm TL; F, 19.2 mm TL; G, 21.4 mm TL.

Xanthophores appeared on the caudal fin base at ca. 16 mm TL, and on the dorsal and anal fins at ca. 17 mm TL. Those on the latter formed orange-colored bands, being mixed with erythrophores. Ad-

ditional xanthophores appeared between the black bands on the body at ca. 18 mm TL.

Leucophores appeared around the dark spot on the caudal fin base at ca. 16 mm TL. White bands on the dorsal and anal fins formed along the orange-colored bands, and punctate, iridescent leucophores appeared on the body at ca. 18 mm TL.

Squamation.—The squamation sequence, which started at ca. 15 mm TL, is shown in Fig. 4. At first a few pored scales appeared on the shoulder, just posterior to the opercle (Fig. 4A). These lateral line scales rapidly increased in number and extended to just above the posterior margin of the pectoral fin (Fig. 4B). Another row formed along the lateral median below the lateral line (Fig. 4C), the scaled area on the body subsequently extending dorsoventrally (Fig. 4D). In juveniles of ca. 18 mm TL, the caudal peduncle was squamated and the lateral line completed (Fig. 4E). The body was covered with scales except for the predorsal region, pectoral fin base, belly, and bases of the unpaired fins, at ca. 20 mm TL (Fig. 4F). The unpaired fin bases subsequently became squamated, and scales appeared on the area anterior to the pectoral fin base and on the throat. Following this, the scaled areas on the left and right sides of the body joined around the anus (Fig. 4G).

Discussion

There are several differences between the above description of embryonic development and larval morphology and that of Kamiya (1925) (Table 2). In particular, the absence of both melanophores on the dorsal finfold and needle-like projections on the dorsal and anal finfold margins in Kamiya's larvae are significant. None of the specimens examined during this study agreed with Kamiya's description on these points. Needle-like projections on the finfolds can generally be observed in labrid larvae (Mito, 1962; Suzuki et al., 1981; Kimura and Nakayama, unpubl.), but were not illustrated for any of the larvae of the four labrid species examined by Kamiya (1925). It is likely that he disregarded them. However, the difference seen in melanophore distribution is a different matter, because the dorsal finfold melanophores were very conspicuous in our specimens. The clearly-drawn pigmentation patterns of Kamiya's *H. poecilopterus* larvae bear a close resemblance to those of larval *Pseudolabrus japonicus*, described by Mito (1962), Ikeda and Mito (1988), and Kimura and Nakayama (unpubl.). Kamiya (1925) identified his material as "akabera *Halichoeres poecilopterus*," the Japanese name, "akabera," being used locally for both *H. poecilopterus* and *P. japonicus* (Yasuda and Takagi, 1981). It is probable that the larvae examined by Kamiya (1925) were *P. japonicus*, rather than *H. poecilopterus*.

The juvenile morphology described here agrees well with the description of Masuda and Tanaka (1962) and Kojima (1988), although the latter was not certain of the identity of his 7.2 mm SL specimen. It is now apparent that his specimen was indeed *H. poecilopterus*.

The arrangement of melanophores on the dorsal finfold in *H. poecilopterus* seems to be a feature of this species, because few labrid larvae show similar pigmentation on the finfold (Mito, 1962; Suzuki et al., 1981; Ikeda and Mito, 1988; Kimura and Nakayama, unpubl.). Although the larva described by Mito (1962) (as Labrina No. 11) was similar to *H. poecilopterus*, it clearly differed from the latter in having melanophores on the posterior end of the yolk, on the dorsal finfold origin, and midlaterally on the tail. Larvae of the tribe Julidini from the Great Barrier Reef, described by Leis and Rennis (1983)

Table 2. Some differences between the egg and larval morphology of *Halichoeres poecilopterus* given here and that described by Kamiya (1925)

Character	Present study	Kamiya (1925)
Egg diameter	0.60–0.73 mm	0.73–0.76 mm
Melanophores on oil globule	Present	Absent
Length of 1-day-old larvae	2.34–2.71 mm TL	2.66 mm TL
Length of 4-day-old larvae	2.50–2.68 mm TL	2.77 mm TL
Arrangement of melanophores on the body of newly-hatched larvae	Random	Systematic, in 2 rows
Melanophores on dorsal finfold	Present	Absent
Melanophores on caudal peduncle	Ventral contour only	Both dorsal and ventral contours
Needle-like projections on finfold	Present	Absent

also closely resemble *H. poecilopterus*, and little difference can be seen in their finfold pigmentation. However, confusion of *H. poecilopterus* with the former is improbable, owing to their non-overlapping distributions.

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キュウセンの卵および仔稚魚

木村清志・桐山隆哉

水槽内で自然産卵させたキュウセンの卵を飼育し，卵内発生過程や卵，仔稚魚の形態を記載した．卵は直径 0.60–0.72 mm の球形分離浮遊卵で，単一の油球をもつ．水温 23.4°C で受精後約 19 時間で孵化した．孵化仔魚の全長は 1.46–1.70 mm で，筋節数は 8–11＋16–18 であった．孵化 8 時間後に背部膜鰭上に特徴的な黒色素胞が出現した．卵黄は孵化 3 日後で完全に吸収された．脊索の屈曲は全長約 6 mm で開始し，約 8 mm で完了した．鰭条総数は全長約 11 mm ですべての鰭で定数に達した．鱗形成は全長 15 mm 前後で始まり，全長約 20 mm で体の大部分が被鱗した．

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