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Embryonic Development and Larvae of Three Gobiid Fish, *Trimma okinawae*, *Trimma grammistes* and *Trimmatom* sp.

Tomoki Sunobe

Fisheries Laboratory, Faculty of Agriculture, Kyushu University,
6–10–1 Hakozaki, Higashi-ku, Fukuoka 812, Japan
Present address: Natural History Museum and Institute, Chiba,
955–2 Aoba-cho, Chuo-ku, Chiba 260, Japan

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Abstract Embryonic development and larvae of three gobiid fishes, *Trimma okinawae*, *Trimma grammistes* and *Trimmatom* sp., are described. Eggs were elliptic, measuring 0.78–0.89×0.45–0.51 mm, 0.65–0.75×0.46–0.54 mm and 1.88–2.00×0.79–0.84 mm, respectively. The egg surface in *T. okinawae* and *T. grammistes* was smooth, but in *Trimmatom* sp., was covered with numerous minute processes. The total lengths of newly-hatched larvae were 1.98–2.08 mm, 1.66–1.72 mm and 3.01–3.12 mm in *T. okinawae*, *T. grammistes* and *Trimmatom* sp., respectively. *Trimmatom* sp. was reared until seven days after hatching, attaining 3.43–3.52 mm TL, as well as aquiring some red pigments and primordial hypural and caudal fin ray elements. Larvae of the other species died by the third day after hatching.

Trimma and *Trimmatom* are gobiid genera of small size, distributed in the Indo-Pacific region (Winterbottom, 1984). Species of these genera inhabit coral or rocky reefs and appear solitarily on the bottom or schooling in the water column (Winterbottom, 1984; Yoshino and Shimada, 1984).

Reproductive ecology and sex change of *T. okinawae* was reported by Sunobe and Nakazono (1990, 1993). The mating system of this species is polygynous, an individual changing its sex in both directions by alteration of its social dominance. As for phylogenetic relationships, Winterbottom and Burridge (1992) hypothesized that *Trimma* and *Trimmatom* form a monophyletic group with *Priolepis*.

Although embryonic development and larvae of *Trimma grammistes* were described by Shiobara and Tanaka (1994), those of *Trimma okinawae* and *Trimmatom* sp. have not been reported thus far. In this paper, development of eggs and larvae of *T. okinawae*, *T. grammistes* and *Trimmatom* sp., are described and morphological characteristics of embryos and larvae discussed. Comparisons are made with data of *T. grammistes* and *Priolepis*, reported by Shiobara and Tanaka (1994), Sonoda and Imai (1971), Shiogaki and Dotsu (1974) and Sunobe and Nakazono (1989).

Materials and Methods

The following specimens of each species were collected by hand net: *Trimma okinawae* (male; 29.9 mm SL, females; 22.0, 21.5 and 19.5 mm SL) at Cape Sata, Kagoshima Pref., Japan, on June 15, 1982, *Trimma grammistes* (male; 23.0 mm SL, females; 20.5 and 19.8 mm SL) at Azuma-cho, Kagoshima Pref., Japan, on May 26, 1982, and *Trimmatom* sp. (male; 21.2 mm SL, females; 19.8, 19.5 and 17.6 mm SL) at Kuchierabu I., Kagoshima Pref., Japan, on May 14, 1985. Methods of rearing and observation followed Sunobe and Nakazono (1987). Measurements of eggs and larvae were made using a binocular microscope with a micrometer. Figures were drawn with a camera lucida.

Specimens of *Trimmatom* sp. used in this study (deposited in Natural History Museum and Institute, Chiba [CBM-ZF 3153]) are conspecific with *Trimmatom* sp. in Akihito et al (1993).

Results

The sizes and number of the eggs of the three species are given in Table 1. The egg surface of

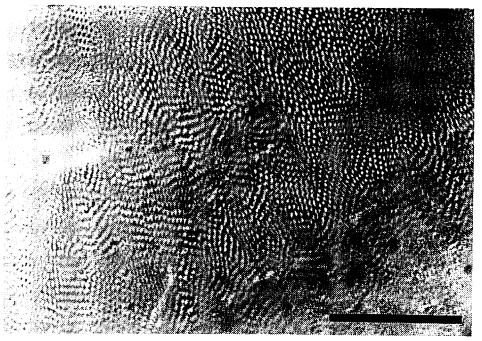

Fig. 1. Surface of the egg membrane of *Trimmatom* sp. Scale indicates 50 μm.

Trimma okinawae and *T. grammistes* was smooth, but in *Trimmatom* sp. was covered with numerous minute processes (Fig. 1). The eggs were elliptic, with a bundle of adherent threads at the base (Figs. 2A, 3A and 4A). Eggs were spawned by the females in a single layer on the ceiling of a shelter, the male staying in the shelter and guarding the egg mass until hatching.

The TLs of newly-hatched larvae of the three species are given in Table 1. In these larvae, the mouth had opened and peristalsis of the digestive tract could be seen. The larvae exhibited phototaxis. Seven pairs of cuplae and free neuromasts were recognized (Figs. 2E-2, 3E-2 and 4E-2), the former being easily lost following fixation with 5% formalin. The yolk was absorbed one day after hatching. All *Trimma okinawae* and *T. grammistes* larvae died of starvation by the 3rd day after hatching, but larvae of *Trimmatom* sp. survived until the 7th day.

Trimma okinawae

Spawning was observed from 5 : 30 to 8 : 00 on July 9, 12, 19 and 21, 1982. The egg blastopore closed and an embryo formed by 10 hrs after fertilization (Fig. 2A). After 14 hrs (Fig. 2B), a pair of ear vesicles and Kupffer's vesicle appeared, and a pair of optic vesicles and four myomeres could be recognized. Sixteen hrs after fertilization (Fig. 2C), brain differentiation became obvious and the heart had formed in front of the yolk. Granules were visible on the surface of the embryo. The numerous small oil globules in the yolk had fused and Kupffer's vesicle, disappeared. After 45 hrs (Fig. 2D), a pair of pectoral fin buds could be seen. Melanophores were present on the eyes, yolk and tail region.

Larvae hatched at 20 : 00, 107 hrs after fertilization, having 9+17 myomeres (adult: 10+16). Melanophores were observed on the optic cups, the dorsal parts of the gas bladder and rectum, and the ventral part of the tail (Fig. 2E-1).

Trimma grammistes

Spawning was observed from 7 : 00 to 11 : 30 on June 18, 22, July 4 and 6, 1982. The blastopore closed, and an embryo formed by 14 hrs after fertilization (Fig. 3A). After 19 hrs (Fig. 3B), a pair of optic vesicles and Kupffer's vesicle appeared. Granules were visible on the surface of the embryo which had four myomeres. Twenty-four hrs after fertilization (Fig. 3C), lenses formed in the optic cup and a pair of ear vesicles appeared. Kupffer's vesicle had disappeared. After 42 hrs (Fig. 3D), the numer-

Table 1. Size (mm) and number of eggs, and TL (mm) of newly-hatched larvae (NHL) of *Trimma okinawae*, *Trimma grammistes* and *Trimmatom* sp.

	T. okinawae		*T. grammistes*		*Trimmatom* sp.	
Size of eggs	Length	Width	Length	Width	Length	Width
Range	0.78 – 0.89	0.45 – 0.51	0.65 – 0.75	0.46 – 0.54	1.88 – 2.00	0.79 – 0.84
Mean±SD	0.85±0.04	0.48±0.02	0.70±0.03	0.49±0.03	1.93±0.06	0.78±0.04
n	9	9	9	9	5	5
Number of eggs						
Range	300–480		200–540		56–112	
Mean±SD	400±70		370±130		88±23	
n	5		5		6	
TL of NHL						
Range	1.98–2.08		1.66–1.72		3.01–3.12	
Mean±SD	2.01±0.06		1.70±0.02		3.07±0.05	
n	5		5		5	

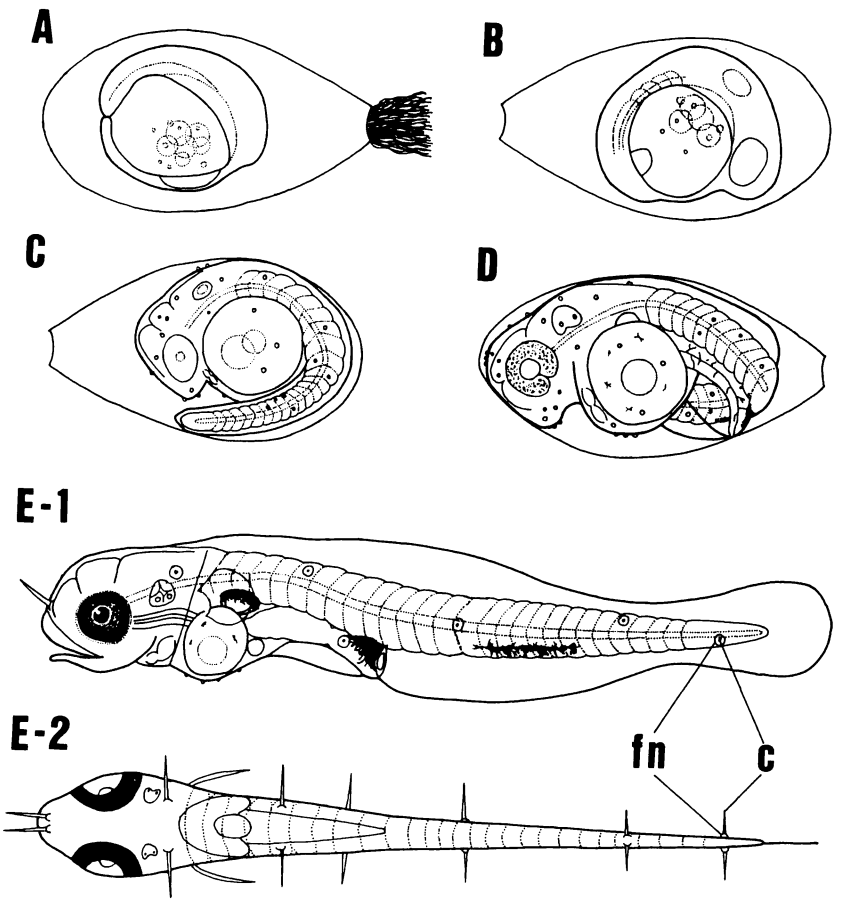

Fig. 2. Embryonic development and a newly-hatched larva of *Trimma okinawae*. A) 10 hrs after fertilization; B) 14 hrs; C) 16 hrs; D) 45 hrs; E-1) newly-hatched larva, 2.01 mm TL; E-2) dorsal view of the same specimen. *c*—cupla; *fn*—free neuromast.

ous small oil globules in the yolk had fused and a pair of pectoral fin buds could be seen. Melanophores were present on the tail region, the heart had formed in front of the yolk, and 22 myomeres could be counted.

Larvae hatched at 20:00, 101 hrs after fertilization, having 9+17 myomeres (adult: 10+16). Melanophores were observed on the optic cups, the dorsal parts of the gas bladder and rectum, and the ventral and dorsal parts of the tail (Fig. 3E-1).

***Trimmatom* sp.**

Spawning was observed from 8:00 to 10:00 on June 6, 11, 13, 22, 30, July 8 and 13, 1985. The blastopore closed, and an embryo, in which Kupffer's vesicle was apparent by 23 hrs after fertilization (Fig. 4A). After 26 hrs (Fig. 4B), a pair of optic vesicles could be recognized, along with three myomeres. Twenty-nine hrs after fertilization (Fig. 4C), a pair of ear vesicles and eight myomeres could be recognized. Granules were visible on the surface of the embryo and Kupffer's vesicle had disappeared. After 48 hrs (Fig. 4D), the heart was present in front of the yolk and a digestive tract had formed. Brain differentiation could be seen in addition to 24 myomeres.

Larvae hatched at 17:00, 126 hrs after fertilization, having 8+17 myomeres (adult: 10+16). Melanophores were observed on the optic cups, and the dorsal parts of the gas bladder and rectum (Fig. 4E-1).

Seven days after hatching (Fig. 4F), two surviving individuals had attained 3.43 and 3.52 mm TL, re-

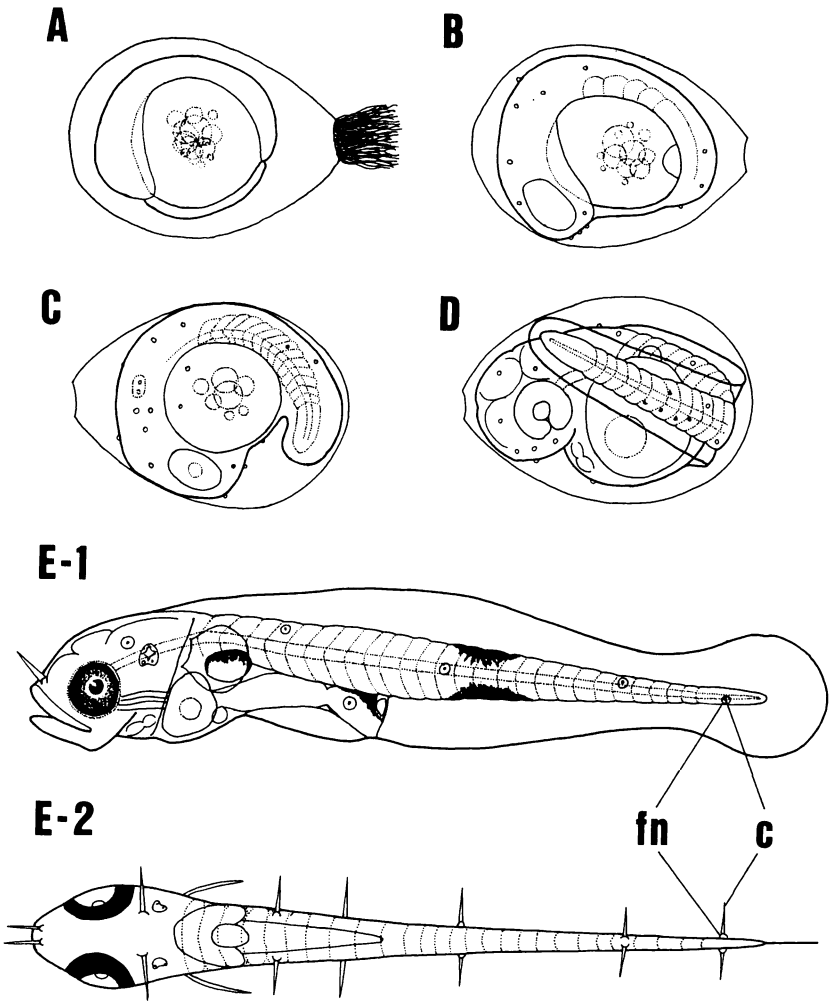

Fig. 3. Embryonic development and a newly-hatched larva of *Trimma grammistes*. A) 14 hrs after fertilization; B) 19 hrs; C) 24 hrs; D) 42 hrs; E-1) newly-hatched larva, 1.72 mm TL; E-2) dorsal view of the same specimen. *c*—cupla; *fn*—free neuromast.

spectively, having 8+17 myomeres. All of the cuplae and free neuromasts had disappeared. Red pigments had newly appeared on the dorsal part of the gas bladder, the anus, the ventral part of the abdomen and the ventral part of the tail, and primordal hypural and caudal fin ray elements were apparent.

Discussion

The development of eggs and newly-hatched larvae of *Trimma grammistes* from Kagoshima, was similar to that in material from Suruga Bay, reported by Shiobara and Tanaka (1994), although the latter did not describe granules on the embryo surface and gave the number of pairs of cuplae and free neuromasts as eight (seven in this study).

Newly-hatched larvae of *Trimma okinawae*, *T. grammistes* and *Trimmatom* sp. were easily distinguishable, both by the location of melanophores in the tail region and by body size. Melanophores were present on the dorsal and ventral parts of the tail in *T. grammistes*, but were observed only on the ventral part in *T. okinawae*. *Trimmatom* sp. larvae lacked melanophores on the tail. Newly-hatched larvae of *Trimmatom* sp. were the largest (over 3.0 mm TL), those of the other species being less than 2.1 mm TL.

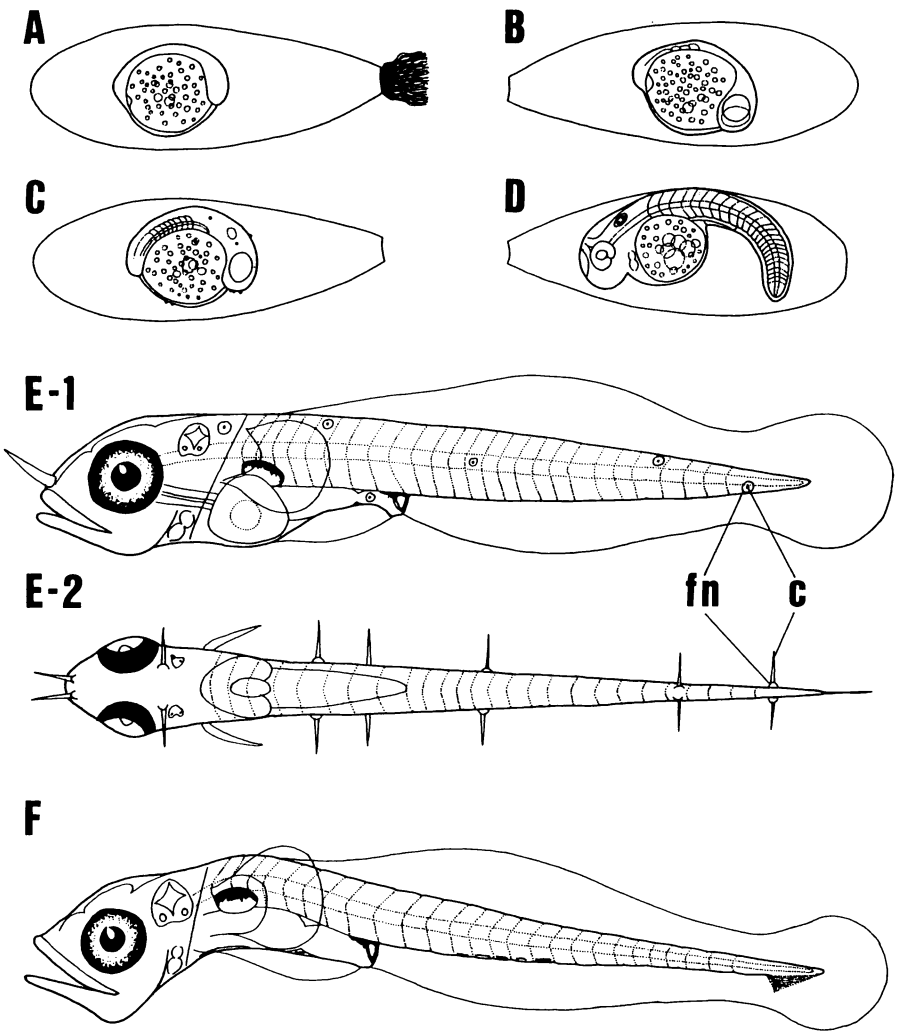

Fig. 4. Embryonic development and a newly-hatched and seven day-old larva of *Trimmatom* sp. A) 23 hrs after fertilization; B) 26 hrs; C) 29 hrs; D) 48 hrs; E-1) newly-hatched larva, 3.03 mm TL; E-2) dorsal view of the same specimen; F) seven day-old larva, 3.52 mm TL. *c*—cupla; *fn*—free neuromast.

Trimma and *Trimmatom* are closely related to *Priolepis* (Winterbottom and Burridge, 1992). Newly-hatched larvae of *P. semidoliatus*, *P. boreus* and *P. naraharae* were described by Sonoda and Imai (1971), Shiogaki and Dotsu (1974) and Sunobe and Nakazono (1989), respectively. The larvae of these *Priolepis* species are distinguished from *T. okinawae*, *T. grammistes* and *Trimmatom* sp. by having melanophores absent on the dorsal part of the rectum, but continuously present on the ventral part of the body. In addition, xanthophores occur in *Priolepis*.

Seven day-old larvae of *Trimmatom* sp. had red pigments, as observed in *Eviota abax*, *E. prasina* and *E. prasites* (Sunobe and Nakazono, 1987, 1995), but differed from the latter in lacking melanophores on the ventral part of the tail. Also unlike the latter, the red pigment in *Trimmatom* sp. also occured around the anus.

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オキナワベニハゼ，イチモンジハゼ及びシマイソハゼの卵発生と仔魚

須之部友基

ハゼ科オキナワベニハゼ *Trimma okinawae*，イチモンジハゼ *Trimma grammistes* 及びシマイソハゼ *Trimmaton* sp. の卵発生と仔魚を記載した．卵型は楕円形で大きさはそれぞれ 0.78–0.89×0.45–0.51 mm, 0.65–0.75×0.46–0.54 mm, 1.88–2.0×0.79–0.84 mm であった．卵の表面はオキナワベニハゼとイチモンジハゼはなめらかであったが，シマイソハゼでは多数の突起物が見られた．オキナワベニハゼ，イチモンジハゼ及びシマイソハゼの孵化仔魚は全長がそれぞれ 1.98–2.08 mm, 1.66–1.72 mm, 3.01–3.12 mm であった．この 3 種は尾部の黒色素胞の位置によって容易に判別できた．オキナワベニハゼとイチモンジハゼの仔魚は孵化後 3 日で死亡した．シマイソハゼの仔魚は 7 日後まで生き残り，全長 3.45–3.52 mm に達し，赤色胞が新たに出現した．

(〒812 福岡市東区箱崎 6 丁目 10 番 1 号　九州大学農学部水産学第二教室．現住所：〒260 千葉市中央区青葉町 955–2　千葉県立中央博物館)