

# Maternal Egg Care in the Bridled Triggerfish, *Sufflamen fraenatus* (Balistidae) at Hachijojima Island, Japan

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**Abstract** Maternal egg care in the triggerfish *Sufflamen fraenatus* (Balistidae) based on underwater observations are described for the first time. Females cared for the eggs on sandy bottoms and rocky reefs. The eggs were adhesive and attached to sand particles. They were nearly spherical in shape, measuring 0.54 mm in diameter. Egg masses measured an average length of 94 mm × 74 mm, and one of which contained 91,500 eggs. The parental female positioned herself near the egg mass, often blowing water on it and driving away intruding fish. She blew water on the eggs vigorously in the evening of the spawning day to promote hatching, which behavior was similar to that found in the congeneric *S. chrysopterus*. Not only parental egg care in *S. fraenatus*, but also that in *S. chrysopterus*, *Melichthys vidua* and *Xanthichthys mento* was recorded at Hachijojima Island.

**Key words:** parental care, spawning site, territoriality, demersal eggs, Tetraodontiformes.

Triggerfish (family Balistidae), which include an estimated 40 species (Nelson, 1994), are widely distributed throughout the seas in tropical regions. The reproductive ecology such as spawning behavior, parental egg care and mating systems of several species have been reported based on underwater studies (e.g. Fricke, 1980; Gladstone, 1994; Kawase and Nakazono, 1994; Ishihara and Kuwamura, 1996; Kuwamura, 1997). One characteristic behavior of this family is that the parental females care for eggs by blowing water on them and driving away intruders (Kawase, 1998, 2002).

The bridled triggerfish *Sufflamen fraenatus* is found in the Indo-Western Pacific (Matsura, 1980), and is commonly seen in shallow waters in tropical and subtropical areas. Kawabe (1984) conducted aquarium observations and reported that *S. fraenatus* spawn in the morning and that females care for the eggs until hatching in the evening. In this article, I describe the maternal egg care, spawning site, size of egg mass, clutch size and eggs of *S. fraenatus* based on underwater observations conducted at Hachijojima Island, Japan. I also report on parental

egg care in other balistids *Melichthys vidua* and *S. chrysopterus* observed at the same site.

## Materials and Methods

Underwater observations of *Sufflamen fraenatus* were carried out on rocky reefs and sandy bottoms (10–20 m water depth) about 200 m offshore of Sokodo (33° 08' N, 139° 48' E), on the eastern coast of Hachijojima Island, Izu Islands, Japan. This study site is an oceanic island located in a temperate region, with annual water temperatures ranging from 15–29°C.

Observations of *S. fraenatus* were made in my spare time while I was studying another balistid species, *Xanthichthys mento*; these studies were carried out on 64 occasions between June and October from 1995 to 1998 (see Kawase, in press). When I found *S. fraenatus* females caring for eggs, I recorded the frequency of egg tending and guarding on a field map. Their behavior was also photographed and recorded on video. I then collected a part of each clutch from 6 nests, collecting two or three times on the same day in three cases (Table 1). The diameters of the eggs and total length of hatched larvae were

**Table 1.** Spawning site, size of egg mass and embryonic development of *Sufflamen fraenatus*.

Code of clutch	Date	Spawning site	Size of egg mass (mm)	Embryonic development	Time of embryos fixed	Water temperature (°C)	CMNH-ZF No.
A	11 Sep. 1995	cr	—	early blastula	7:00	29.0	0004722
B <sub>1</sub>	17 Aug. 1996	cr	90×80	6-myomere	12:40	28.4	0004723
B <sub>2</sub>				17-myomere	16:20	26.6	0004724
B <sub>3</sub>				hatched larvae*	19:25	26.5	0004725
C	19 Aug. 1996	sb	115×90	gastrula	10:20	26.5	0004726
D <sub>1</sub>	19 Aug. 1996	sb	105×90	gastrula	10:20	26.5	0004727
D <sub>2</sub>				14-myomere	14:24	27.7	0004728
E	19 Aug. 1996	cr	90×60	gastrula	10:20	26.5	0004729
F	29 Jun. 1997	cr	100×80	—	—	23.6	—
G	24 Aug. 1997	cr	70×50	—	—	28.2	—
H <sub>1</sub>	25 Aug. 1997	cr	100×60	5-myomere	12:30	26.9	0004730
H <sub>2</sub>				hatched larvae*	18:09	28.7	0004731

cr, small cavity of rocky reef; sb, sandy bottom; —, no data. \*The eggs of clutches B and H collected at 18:28 and 17:45 began to hatch, respectively.

measured under a binocular microscope. The developmental stage of embryos was confirmed under an optic microscope in order to detect the time and date of spawning. In one case (Table 1A), I removed all the eggs from a nest in order to determine the size of the clutch. After fixing the eggs in 10% formalin, sand particles attached to the eggs were removed and the total number of eggs was calculated following the method previously described (Kawase and Nakazono, 1996; Kawase, in press).

On those occasions on which I found other balistid species caring for eggs, I observed the behavior of the fish and collected a part of the clutch to examine embryonic development.

The samples collected have been registered and are currently held by Coastal Branch of Natural History Museum and Institute, Chiba (CMNH-ZF-0004722–0004732).

## Results and Discussion

### 1. Clutch and eggs of *Sufflamen fraenatus*

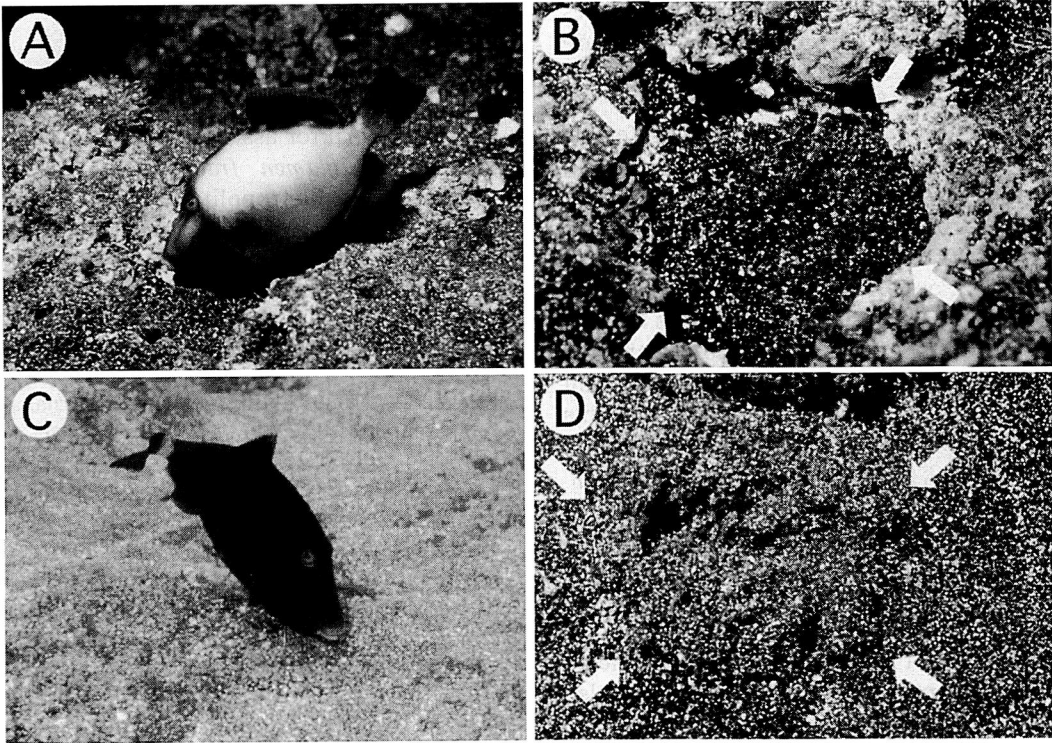
A total of 8 clutches of *S. fraenatus* were found on the bottom (Table 1). Eggs were deposited in a small cavity of the rocky reefs ( $n=6$ ) (Fig. 1A, B) or on the sandy bottom close to the reefs ( $n=2$ ) (Fig. 1C, D). The mean length and width of the egg masses was 94 mm×74 mm ( $n=7$ ), and clutch A contained approximately 91,500 eggs. The size of the egg mass and the number of eggs in a

clutch were similar to those of the congeneric *S. chrysopterus* (Kawase and Nakazono, 1994).

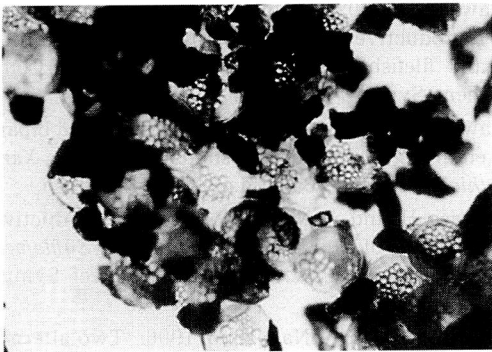
The eggs were nearly spherical in shape, measuring  $0.54 \pm 0.01$  mm (mean  $\pm$  SD,  $n=15$ ) in diameter. They were adhesive and attached to sand particles (Fig. 2), which is common among the other balistids (Kawase, 1998, 2002). The embryonic development of clutch D had attained gastrula stage by 10:20 and 14-myomere stage at 14:24. The clutch was not found the following morning. The eggs of clutches B and H had attained 5–6-myomere stage around noon. The eggs collected from the nests in the evening began to hatch, and the newly hatched larvae measured  $1.31 \pm 0.02$  mm (mean  $\pm$  SD,  $n=10$ ) and  $1.25 \pm 0.04$  mm (mean  $\pm$  SD,  $n=6$ ) in total length, respectively. These results suggest that the spawning of *S. fraenatus* took place early in the morning and that the embryos hatched in the evening of the same day, which is consistent with aquarium observations (Kawabe, 1984). Such a short period from fertilization to hatching has also been reported in the other balistids, and seems to be characteristic of this family (Kawase, 1998, 2002).

### 2. Maternal egg care in *Sufflamen fraenatus*

Parental females cared for the eggs deposited on the bottom. During this time, males occasionally approached the females, howev-



**Fig. 1.** Maternal care and egg mass of *Sufflamen fraenatus*. Egg-tending female with pale brown body color (A) and the egg mass deposited in a small cavity of the reef (B) (clutch B, Table 1). Egg-tending female with blackish body color with a vertical white band on the caudal peduncle (C) and the egg mass deposited on the sandy bottom (D) (clutch D, Table 1). White arrows indicate the margin of the egg mass.



**Fig. 2.** Photomicrograph of *Sufflamen fraenatus* eggs attached to sand particles.

er they soon departed without participating in parental care.

The females care for the eggs by blowing water over them (2.22 bouts per min, observation time: 29 min 47 sec) (Fig. 1A, C) and removing remnants of algae from them (0.17 bouts per min). The females also guarded the

eggs, driving away intruding fish such as *Gymnothorax* sp., *Calotomus japonicus* and *Canthigaster valentini* (0.20 bouts per min). Some females were aggressive and even attacked the observer, while others were nervous and retreated from the clutch site. The females did not devote time exclusively to egg care, but rather left the site in the daytime for 20–30 seconds at a time to feed within a few meters. Alternating egg care and feeding has also been reported in *S. chrysopterus* (Kawase and Nakazono, 1994; Ishihara and Kuwamura, 1996), although *Pseudobalistes fuscus* females do not feed at all during egg care (Fricke, 1980).

Kawabe (1984) reported that *S. fraenatus* females rapidly changed body color after spawning from pale brown with white blotches to uniformly blackish brown with a vertical white band on the caudal peduncle and maintained the darker color during egg care. The present study confirmed that body

color is changeable, but found that females show both color patterns during egg care (Fig. 1A, C).

At nightfall (18:15–18:28, sunset: 18:25) on 17 August, 1996, the parental female tended eggs exclusively without feeding (Table 1B) while strongly blowing water on the eggs from different directions. She also held a portion of the eggs in her mouth and spat them out on the bottom during this time. Females of the other balistids *S. chrysopterus* and *P. fuscus* also blow water on their eggs and fan them with the caudal fin while lying laterally on the bottom. This behavior is thought to promote hatching (Fricke, 1980; Kawase and Nakazono, 1994).

### 3. Parental egg care in other balistid fishes

While observing parental egg care among balistids at Sokodo, Hachijojima Island, I examined not only *Xanthichthys mento* (Kawase, in press) and *S. fraenatus*, but also *Melichthys vidua* and *S. chrysopterus*.

A *M. vidua* parent (probably female) was observed caring for eggs on the reef at a depth of 13.8 m on 17 August, 1996 (water temperature: 26.6°C), in the first recorded observations of egg care in this species. The eggs were deposited in a small cavity of the reef and the egg mass measured 90 mm × 80 mm. The eggs were adhesive and attached to sand particles. They were almost spherical in shape, measuring  $0.48 \pm 0.01$  (mean  $\pm$  SD,  $n = 15$ ). The eggs (CMNH-ZF-0004732) had reached 14-myomere stage at 16:20, and they had hatched at 19:25. The parent fish cared for the eggs by blowing water on them and driving away nearby intruders such as *Thalassoma lutescens*.

*S. chrysopterus* females were observed caring for eggs on sandy reefs on 25 August, 1997 (14.2 m depth, 26.7°C) and 3 October, 1998 (16.0 m depth, 27.1°C). Parental egg care of *S. chrysopterus* has also been reported from other regions, specifically at Kashiwajima Island (32°46' N, 132°37' E), southern Shikoku and Sesoko Island (26°38' N, 127°52' E), Okinawa, Japan (Kawase and Nakazono, 1994; Ishihara and Kuwamura, 1996).

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### References

- Fricke, H. W. 1980. Mating systems, maternal and biparental care in triggerfish (Balistidae). *Z. Tierpsychol.* 53: 105–122.
- Gladstone, W. 1994. Lek-like spawning, parental care and mating periodicity of the triggerfish *Pseudobalistes flavimarginatus* (Balistidae). *Env. Biol. Fish.*, 39: 249–257.
- Ishihara, M. and T. Kuwamura. 1996. Bigamy or monogamy with maternal egg care in the triggerfish, *Sufflamen chrysopterus*. *Ichthyol. Res.* 43: 307–313.
- Kawabe, R. 1984. Spawning behavior of the bridled triggerfish, *Sufflamen fraenatus*, in the aquarium. *Jpn. J. Ichthyol.* 31: 193–197.
- Kawase, H. 1998. Reproductive behavior and evolution of triggerfish (Balistidae) and filefish (Monacanthidae). *Jpn. J. Ichthyol.* 45: 1–19. (in Japanese).
- Kawase, H. 2002. Simplicity and diversity in the reproductive ecology of triggerfish (Balistidae) and filefish (Monacanthidae). *Proc. Int. Commem. Symp., 70th Anniv. JSFS*: 119–122.
- Kawase, H. in press. Spawning behavior and biparental egg care of the crosshatch triggerfish, *Xanthichthys mento* (Balistidae). *Env. Biol. Fish.*
- Kawase, H. and A. Nakazono. 1994. Reproductive behavior of the flagtail triggerfish, *Sufflamen chrysopterus*. *Proc. 7th Int. Coral Reef Symp., Guam.* 905–907.
- Kawase, H. and A. Nakazono. 1996. Two alternative female tactics in the polygynous mating system of the threadsail filefish, *Stephanolepis cirrhifer* (Monacanthidae). *Ichthyol. Res.* 43: 315–323.
- Kuwamura, T. 1997. Evolution of female egg care in harem triggerfish, *Rhinecanthus aculeatus*. *Ethology.* 103: 1015–1023.
- Matsuura, K. 1980. A revision of Japanese Balistoid Fishes. *Bull. Natn. Sci. Mus., Ser. A (Zool).* 6: 27–69.
- Nelson, J. S. 1994. *Fishes of the world*. 3rd ed. 600

pp. John Wiley & Sons, Inc, New York.

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八丈島におけるメガネハギ  
(モンガラカワハギ科) の  
雌による卵保護行動

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野外におけるメガネハギ *Sufflamen fraenatus* の卵  
保護行動が初めて確認されたので報告する。東京都八

丈島での潜水観察によると、メガネハギの雌は砂底や岩礁で卵保護を行った。卵は直径 0.54 mm の沈性粘着卵で、卵の表面には砂粒が付着していた。卵塊の直径は 94 mm×74 mm で、1 つの卵塊には約 91,500 個の卵が含まれていた。雌は卵塊の近くにおいて、時々その卵塊に水を吹きかけて世話をし、卵塊に近づく魚を発見すると追い払って防衛した。産卵当日の夕方になると、雌は卵塊に水を強く吹きかけるなどして孵化を促したが、これは同属のツマジロモンガラ *S. chrysopterus* の場合と類似していた。メガネハギのほか、八丈島ではツマジロモンガラ、クロモンガラ *Melichthys vidua*、ナメモンガラ *Xanthychys mento* の繁殖が確認された。