

Short Paper

Occurrence of Larval Red-Spotted Grouper *Epinephelus akaara* in Hiuchi-nada of the Seto Inland Sea of JapanShinji Fujita,*¹ Masashi Miyagawa,*^{2,†} and Kosaku Yamaoka*³*¹Nishinon Institute of Technology, Wakamatsu, Kochi 780, Japan*²Kagawa Prefectural Fisheries Experimental Station, Yashimahigashi, Takamatsu, Kagawa 761-01, Japan*³Usa Marine Biological Institute, Usa, Tosa, Kochi 781-11, Japan

(Received June 13, 1996)

Key words: red-spotted grouper, occurrence, larvae, Seto Inland Sea

The red-spotted grouper, *Epinephelus akaara* (Serranidae), is distributed from southern Japan to southern China.¹⁾ It is highly valued as a cultured fish on account of its commercial importance in Japan, especially in the Seto Inland Sea. Recently, artificial seedling production for this fish has been intensively carried out.²⁾ Although an increase of the fishery resource could be expected from the stocking by releasing, the necessary information on the spawning and on the early life history of this fish in the sea is lacking. The purpose of this study is to obtain information on the occurrence of the red-spotted grouper in the sea, as a part of ecological studies on the life cycle of this fish.

Samplings of larval fish with a conical plankton net (1 m mouth-diameter; 0.33 mm mesh-aperture) were made four times at nine stations in Hiuchi-nada during the spawning season, from July to September 1995.³⁾ These stations were settled around Ibukijima Island (33°30'N, 133°20'E), ca. 10 km off Kan-onji city. The net was obliquely towed from near the bottom (about 18 m in depth) to the surface. Towing was performed for 10 min at a speed of about 2 kt. The filtered volume of water was calculated from the flow meter count. All of these samplings were carried out by a fisherman's boat in the daytime (ca. 0900-1400 h). The plankton samples including fish larvae were preserved in 10% sea-water formalin until sorting in the laboratory, and then the sorted larvae were transferred to 80% ethanol.

Water temperatures were measured at the depths of 0, 5, 10, 15, 20 m during the larval net sampling (Table 1). In July and August, the mean water temperatures at the surface were higher than those at 20 m in depth by 5.5-7.3°C; a remarkable thermocline was observed at 5 to 10 m below the surface. This is a common feature of the thermal structure in Hiuchi-nada in summer.⁴⁾ Since the sampling was made by oblique tow, it is uncertain whether the grouper larvae were distributed above or below the thermocline.

Of the 26,750 larval and juvenile fishes collected during the study period, 21 were attributed to the grouper because of their resemblance to *Epinephelus* larvae in general morphology (Table 1). In the smallest postlarva of 1.5 mm TL,

Table 1. Collection record of the red-spotted grouper

Date	No. of fish collected (n/1000 m ³)	Range of TL (mm)	Mean water temperature (°C)				
			Depth				
			0 m	5 m	10 m	15 m	20 m
July 8, 1995	4 (5.6)	1.9-2.2	25.0	20.2	21.0	20.1	19.3
July 29	1 (1.6)	2.1	28.4	26.6	23.5	22.4	21.1
Aug. 19	12 (5.9)	1.5-2.4	29.9	28.2	26.8	25.8	24.4
Sep. 9	4 (1.5)	1.5-1.6	27.2	26.9	26.8	26.5	26.4

mouth and anus were opened and membranous pectoral fins developed. Pigment patterns characterized as grouper larvae appeared as follows: large melanophores on the dorsal side of the abdominal cavity; small ones on the ventral margin of the tail. In a postlarva of 2.1 mm TL, rudiments of the dorsal fin appeared in the marginal finfold. A cluster of melanophores appeared around the midpoint of the ventral side of the tail. The surface of the marginal finfold was covered with colorless granules likely to be mucous cells (Fig. 1A).⁵⁾ In the largest postlarva of 2.4 mm TL, pelvic and dorsal fin spines which are the most distinctive feature of grouper larvae, emerged. However, spinlets on these spines had not yet appeared. Lengths of dorsal and pelvic fin spines were 16% and 18% of total length, respectively. The abdominal cavity was densely covered with melanophores (Fig. 1B).

These characteristics agree well with those of the red-spotted grouper reared in the laboratory.³⁾ As indicated by Mori,⁶⁾ the larvae of this species are similar in general morphology to those of other *Epinephelus* species. However, we can distinguish the red-spotted grouper from six species, *E. tauvina*,⁷⁾ *E. salmonoides*,⁸⁾ *E. microdon*,⁹⁾ *E. fuscoguttatus*,¹⁰⁾ *E. moara*¹¹⁾ and *E. septemfasciatus*,¹²⁾ on the basis of pigment patterns on the gut, trunk and tail as discussed by Kohno *et al.*¹⁰⁾

E. akaara, *E. fasciatus* and *E. fario* have been reported to occur in Hiuchi-nada.¹³⁾ Since the early larvae of *E. fario*¹⁴⁾ resemble those of *E. akaara* in morphological features, it is difficult to distinguish them. Larval morphology of *E. fasciatus* is unknown. Therefore, our specimens can-

† Present address: Kagawa Prefectural Office, Ban, Takamatsu, Kagawa, 760-70, Japan.

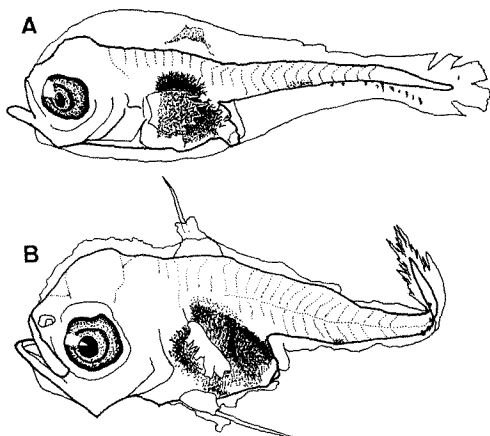


Fig. 1. Postlarvae of the red-spotted grouper collected from Hiuchi-nada.

A) 2.1 mm TL preflexion larva; B) 2.4 mm TL preflexion larva.

not be identified as the red-spotted grouper only by means of morphological features. On the other hand, there is a great difference in the biomass among these three species inhabiting Hiuchi-nada. A large amount of red-spotted grouper is usually caught by commercial fishing in Hiuchi-nada, while the other two species are seldom caught.¹⁵⁾ Inaba¹³⁾ also reported that *E. fasciatus* and *E. fario* were rare in Bingo-nada and Hiuchi-nada, inner regions of the Seto Inland Sea. Underwater observations conducted by us around Ibukijima Island since 1994 have revealed frequent occurrence of *E. akaara*, but none of *E. fasciatus* and *E. fario*. These evidences suggest that almost all of the grouper larvae collected around Ibukijima Island can be attributed to *E. akaara*.

According to Ukawa *et al.*,³⁾ the artificially reared red-spotted grouper reaches 2.20–2.25 mm TL within 4.5 days after hatching, when the yolk and oil globule have been completely consumed. The anterior part of the dorsal fin base appears just behind the head in a 7-day larva of 3.83 mm TL, and a 15-day larva of 4.05 mm TL has long dorsal and pelvic spines. Fukuhara and Fushimi¹⁶⁾ also reported that the elongated spines persist during most of the larval life, from 3 to 19 mm TL, (about 7 to 40 days after hatching). The red-spotted grouper larvae collected in the present study ranged from 1.5 to 2.4 mm TL. According to the morphological development, they were estimated to

be about 5 to 10 days after hatching.

The Hiuchi-nada basin is located in the central part of the Seto Inland Sea that is linked to an eastern channel of Kii by the Bisan Strait and to a western channel of Bungo by the Kurushima Strait. The residual tidal current is very weak in the eastern part of Hiuchi-nada,¹⁷⁾ and exchange of water in this area is low.¹⁸⁾ The oceanographic conditions and short time-span from spawning of collected larvae suggest that the red-spotted grouper may spawn in summer not far from Ibukijima Island, located in the eastern part of Hiuchi-nada.

We thank Dr. I. Kinoshita, Fisheries Research Station of Kyoto University, for his valuable advice. We are indebted to the staff of the Ibukijima Fisheries Cooperative Association and Nishinohon Institute of Technology, who helped us in many ways. We are also grateful to Mrs. Sophie Fukudome for her kind revision of our English text.

References

- 1) P. C. Heemstra and J. E. Randall: *FAO Fish. Synop.*, **16**, 1–382 (1993).
- 2) Y. Kayano: *SUISANZOSHOKU*, **43**, 269–272 (1995) (in Japanese).
- 3) M. Ukawa, M. Higuchi, and S. Mito: *Japan J. Ichthyol.*, **13**, 156–161 (1966) (in Japanese).
- 4) H. Takeoka, Y. Ohno, and N. Inahata: *J. Oceanogr. Soc. Japan*, **47**, 33–44 (1991).
- 5) T. Kaji, K. Yamaoka, T. Isshiki, and T. Yamada: *Bull. Mar. Sci. Fish. Kochi Univ.*, **15**, 117–120 (1995).
- 6) K. Mori: in "An atlas of the early stage fishes in Japan" (ed. by M. Okiyama), Tokai Univ. Press, Tokyo, 1988, pp. 413 (in Japanese).
- 7) N. A. Hussain and M. Higuchi: *Aquaculture*, **19**, 339–350 (1980).
- 8) S. Hamamoto, S. Manabe, A. Kasuga, and K. Nosaka: *Tech. Rep. Farm. Fish.*, **15**, 143–155 (1986) (in Japanese).
- 9) T. Tawada: *SUISANZOSHOKU*, **37**, 99–103 (1989) (in Japanese).
- 10) H. Kohno, S. Diani, and A. Supriatna: *Japan J. Ichthyol.*, **40**, 307–316 (1993).
- 11) S. Manabe and A. Kasuga: *J. Japan Assoc. Zool. Gardens Aquariums*, **30**, 16–24 (1988) (in Japanese).
- 12) C. Kitajima, M. Takaya, Y. Tsukashima, and T. Arakawa: *Japan J. Ichthyol.*, **38**, 47–55 (1991) (in Japanese).
- 13) A. Inaba: *Fauna and flora of the Seto Inland Sea*, second edition II, Mukaishima Mar. Biol. Stn., Hiroshima, 1988, pp. 475 (in Japanese).
- 14) A. Tsujigadou and B. Hayashi: *Bull. Mie Pref. Owase Fish. Exp. Stn.*, 29–34 (1982) (in Japanese).
- 15) S. Hamamoto: *Bull. Kagawa Pref. Fish. Exp. Stn.*, **2**, 39–45 (1986) (in Japanese).
- 16) O. Fukuhara and T. Fushimi: *Aquaculture*, **69**, 379–386 (1988).
- 17) T. Yanagi, H. Takeoka, and H. Tsukamoto: *J. Oceanogr. Soc. Japan*, **38**, 293–299 (1982).
- 18) T. Ochi and H. Takeoka: *J. Oceanogr. Soc. Japan*, **42**, 1–11 (1982).