Japanese Journal of Ichthyology
Vol. 34, No. 3 1987

魚類学雑誌
34巻3号 1987年

Occurrence of the Grunt Sculpin (*Rhamphocottus richardsoni*) Larvae from Northern Central Japan

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(Received December 15, 1986)

While checking shirasu-seine (anchovy larvae seine) samples taken on March 11, 1986, at the mouth of the Kuji River, Ibaraki Prefecture, northern central Japan (36°30′N, 14°38′E), the authors found 14 unusual fish larvae. After close examination, these specimens turned out to be the larvae of the grunt sculpin (*Rhamphocottus richardsoni* Günther), or kuchibashi-kajika in Japanese. Although *R. richardsoni* has been reported from the western North Pacific as south as Sagami Bay (Abe, 1963; Hayasi and Nishiyama, 1980; Fujita and Kamei, 1984), this is the first record of its early larvae from Japan. Some comparisons are made with the eastern Pacific specimens described by Richardson and Washington (1980).

Materials and methods

Samples were caught with commercial shirasu-seine fishing boats chartered by the Ibaraki Prefectural Fisheries Experimental Station and the Ibaraki Prefectural Mariculture Center to conduct chum salmon (*Oncorhynchus keta*) smolts survey at the mouth of the Kuji River (Fig. 1). Shirasu-seines were operated once at each station. Two stations, St. 1 and 2 are located at the mouth of the Kuji River at a depth of 6 m and 10.5 m. St. 3 is located north of the shipping port of Tokai Nuclear Power Plant at a depth of 7.5 m. Water temperature and salinity data at each station are given in Table 1. The bottom substrata at all three stations are sand. However, these stations are surrounded with rocky shores on both the south and the north.

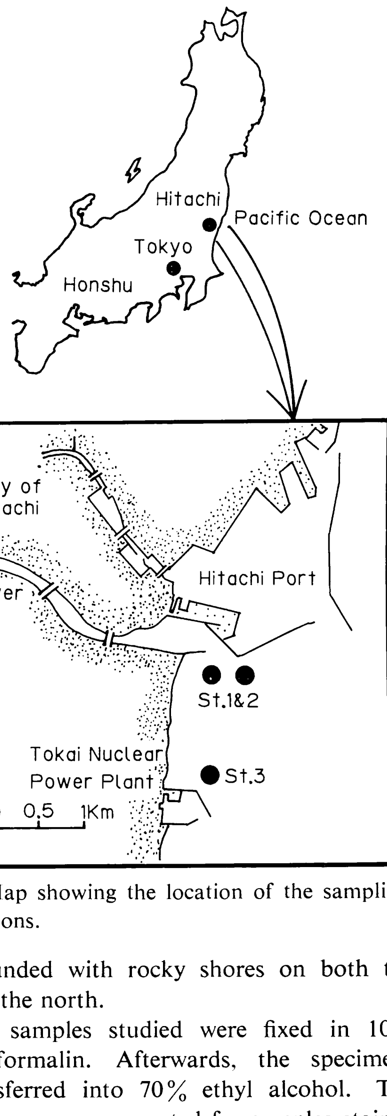

Fig. 1. Map showing the location of the sampling stations.

All the samples studied were fixed in 10% buffered formalin. Afterwards, the specimens were transferred into 70% ethyl alcohol. The spines and rays were counted for samples stained lightly with alizalin red-S. Sketches were made using a camera lucida attached to a binocular microscope. Abbreviations used in the present study are as follows: NL: notochord length, SL:

Table 1. Water temperature and salinity at each sampling station.

St. no.	Surface		Bottom	
	Temperature (°C)	Salinity (‰)	Temperature (°C)	Salinity (‰)
1	7.2	32.473	7.0	33.591
2	7.0	33.675	6.9	33.824
3	7.2	32.511	6.8	33.680

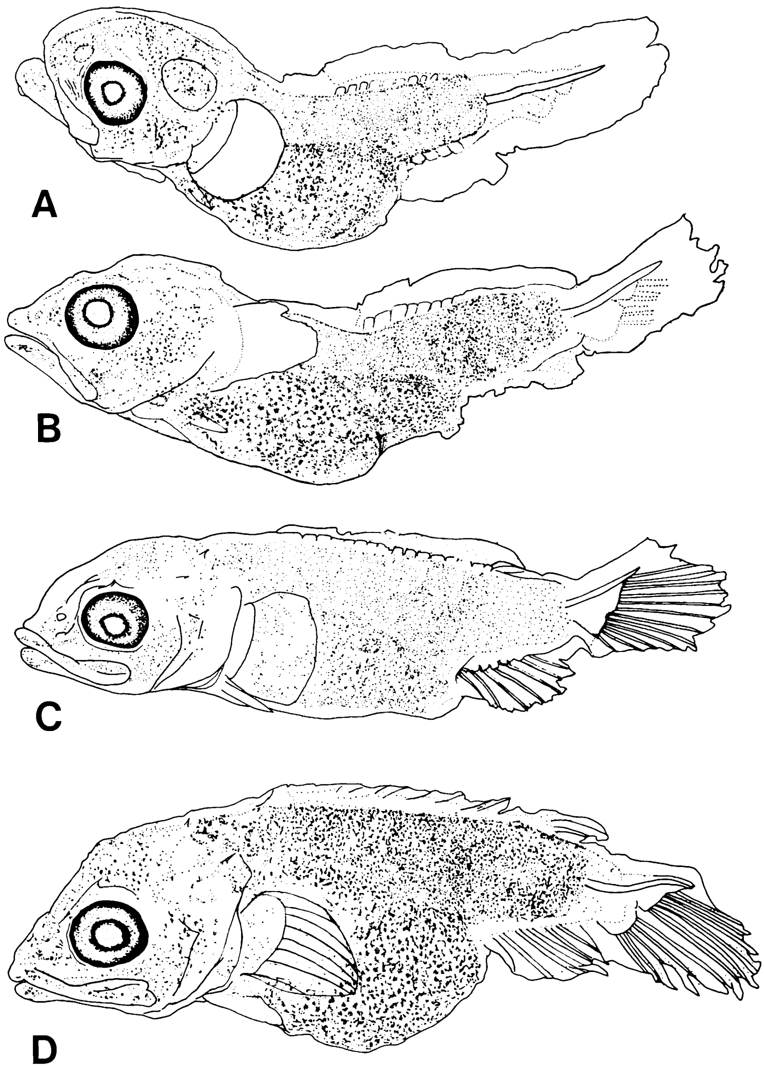

Fig. 2. *Rhamphocottus richardsoni* larvae. A, 6.9 mm NL (7.7 mm TL); B, 7.9 mm NL (8.5 mm TL); C, 8.3 mm NL (9.7 mm TL); D, 8.7 mm NL (9.6 mm TL).

standard length, TL: total length.

Results

The larvae of *R. richardsoni* were caught at the two stations shallower than 10 m (St. 1 and 3). Seven larvae were caught at each station. They ranged from 6.9 mm NL (7.7 mm TL) to 11.2 mm SL (14.2 mm TL), representing various developmental stages.

General description of larvae: Counts and measurements of the larvae of *R. richardsoni* are given in Table 2. Head large and pronounced, its length 1/3 of notochord length; eyes large, ca. 1/3 of head length; dorsal portion of the body and tail lightly compressed, abdominal portion round and potbellied; head, body, and tail darkly pigmented; caudal peduncle white.

Head and body of larvae covered with balloon-like skin. The head is round with prominent audio vescicles in larvae covered with balloon-like skin. As the balloon-like skin contracts at 8.0 mm NL, the snout begins to protrude and the head becomes lightly compressed. Squamation com-

Table 2. Counts and measurements of the larvae of *Rhamphocottus richardsoni*. NL, notochord length; SL, standard length; TL, total length; HL, head length; NS, nuchal spine; SOCS, supraoccipital spine; CLS, cleithral spine; POPS, preopercular spine; +, present; −, absent; M, membranous; B, bud. NL, SL, TL and HL are expressed in mm. One specimen omitted from table due to its poor condition.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
NL	6.9	7.9	8.0	8.3	8.7	8.7	8.7	9.0	9.1	10.3	—	—	—
SL	—	—	—	—	—	—	—	—	—	—	10.0	10.7	11.2
TL	7.7	8.5	9.6	9.7	9.6	9.7	9.9	10.6	12.1	11.8	12.3	13.3	14.2
HL	2.4	2.7	2.9	3.4	3.3	2.9	3.3	3.1	2.9	4.1	3.6	4.3	4.5
P	M	M	M	17	—	M	17	M	11	17	17	18	14
P2	B	B	B	B	B	B	B	B	B	B	I-3	I-3	I-3
D	B	B	B	III-8	VII-11	11	VII-11	V-12	VIII-12	VIII-12	VIII-11	VIII-12	VIII-11
A	7	7	6	7	7	7	6	8	8	6	6	9	8
C	9	10	11	12	12	11	11	12	13	12	12	13	13
NS	−	−	−	+	+	+	+	+	+	+	+	+	+
SOCS	−	−	+	+	+	+	+	+	+	+	+	+	+
CLS	−	−	−	+	+	−	+	+	+	+	+	+	+
POPS	−	−	−	−	+	−	−	+	+	+	+	+	+

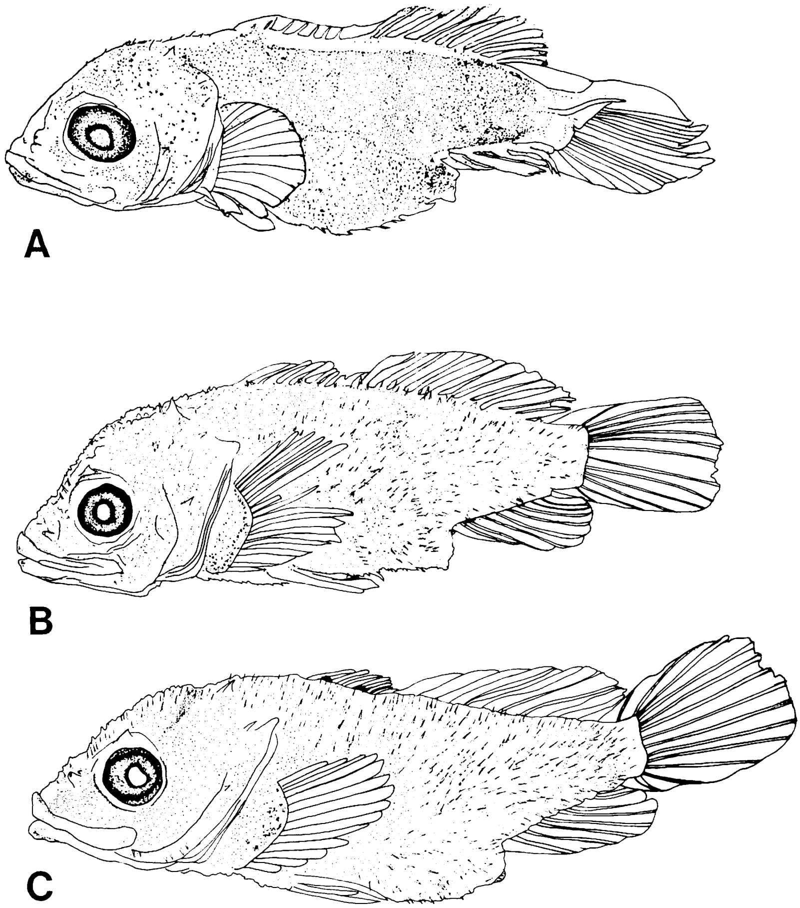

Fig. 3. *Rhamphocottus richardsoni* larvae. A, 9.1 mm NL (10.6 mm TL); B, 10.7 mm SL (13.3 mm TL); C, 11.2 mm SL (14.2 mm TL).

mences first around the head at 8.3 mm NL and gradually spreads to dorsal and ventral regions. Scales bear slender spines. The whole body becomes covered with scales at 10.0 mm SL. Fin membranes are absorbed by 9.0 mm NL. Small one located immediately in front of the anus remains distinct at 11.2 mm SL. Notochord flexion is already observed in the smallest specimen (6.9 mm NL) in our collection, and is complete at 10.0 mm SL. At 11.2 mm SL, a black band is formed from the periphery of the upper lateral orbit to the origin of the nuchal spine.

Fin formation: Pectoral fin is membranous until 8.7 mm NL. Smallest specimen with fin rays is 8.3 mm NL. Rays become complete at 10.7 mm SL. Base of pectoral fin becomes darkly pigmented at 10.7 mm SL.

Pelvic fin buds are present from 6.9 mm NL. Rays are formed at 9.0 mm NL and becomes complete at 10.0 mm NL.

Dorsal fin buds are present from 6.9 mm NL. Rays begin to form from 8.0 mm NL. Dorsal spines are first observed at 8.3 mm NL. Dorsal fin differentiates into the first and second dorsal fins from 9.0 mm NL. Dorsal fins become complete at 10.0 mm SL. Two black spots are formed at the base of the first dorsal fin when the juvenile reaches 11.2 mm SL.

Anal fin rays are present from 6.9 mm NL, and becomes complete at 9.0 mm NL.

Caudal fin rays are present at 9.1 mm NL. The number of rays increases with the progress of notochord flexion and becomes complete at 10.0 mm NL.

Cephalic spine formation: Supraocular spine is formed at 8.0 mm NL. Nuchal and cleithral spines are first observed at 8.3 mm NL. Nuchal spine becomes very slender at 10.3 mm NL and gradually becomes stout and short with growth (from 10.0 mm SL). Preopercular spine is formed at 8.7 mm NL.

Discussion

The larvae of *R. richardsoni* were first described by Richardson and Washington (1980). Their specimen larger than 10.6 mm SL bears segmented caudal fin rays. Our samples are more underdeveloped because even the largest specimen (11.2 mm SL) does not have segmented caudal fin rays. Also, nasal spines and the fusion of nuchal and parietal spines mentioned in Richardson and Washington (1980) in specimen of 11.7 mm SL were not observed. As can be seen in Table 2, the timing of fin formation as well as cephalic spine formation is not uniform, suggesting both geographic and ontogenic variations in early development of the species.

Although it is a common aquarium species in the eastern North Pacific, *R. richardsoni* is rare in Japan with only three records of its occurrence, one from Kadonohama, Iwate Pref. (Abe, 1963), one from Sagami Bay (Hayasi and Nishiyama, 1980) and another from Tokyo Bay (Fujita and Kamei, 1984). The Kuji River is located between these three known Japanese localities. It is likely that *R. richardsoni* inhabits the waters throughout the Pacific coast of northern Japan.

In the eastern North Pacific, *R. richardsoni* inhabits shallow rocky shores and kelp forests as well as on sandy beaches with a record of capture from 165 m depth (Hart, 1973). It spawns from August to October with the eggs hatching 16–20 weeks after fertilization (Fitch and Lavenberg, 1975; Eschmeyer et al., 1983) and larvae are known to occur from March to June (Hart, 1973; Richardson and Washington, 1980). The place and the timing of the appearance of *R. richardsoni* larvae in the present study agree well with the information cited above. These evidences show that *R. richardsoni* can reproduce around Japan.

Richardson and Washington (1980) states that the larvae of *R. richardsoni* is rare in their collections, occurring in waters 2–9 km offshore during the months of March and April. This may be due to the lack of specimens taken from shallow waters in their collections, because there are other records indicating its occurrence from low salinity waters such as at the mouth of the Fraser River (Hart, 1973).

The surf zones of sandy beaches has attracted much attention during the past decade as a nursery ground of fish larvae (e.g. Kinoshita, 1984; Senta and Kinoshita, 1985). Marliave (1986) has documented the lack of planktonic dispersal of fish larvae in shallow rocky shores by studying the distribution patterns of both adult and juvenile fish. In the same paper, he has also noted on the probable affinity of fish larvae to the bottom substratum at very early stage of development. The occurrence of *R. richardsoni* larvae in various developmental stages may reflect this affinity. However, it is impossible to determine the size at settlement from the specimens examined because the depth of the seine used in the sampling was about the same as the depth of the stations sampled. There was a single specimen of 9.8 mm SL caught on March 1986 off the coast of Ibaraki with bottom beam trawl net (Ishikawa, pers. comm.). Therefore, after hatching in the rocky shores, the larvae of *R. richardsoni* may be transported to the shallow waters of both the sandy beaches and the rocky shores where they settle down at 9–10 mm SL, thus avoiding planktonic dispersal offshore. It is interesting to note that the waters where the larvae of *R. richardsoni* were caught is one of the major fishing grounds of the Ishikawa icefish (*Salangichthys ishikawae*) which is caught with shirasu seine fishing boats mostly at depths shallower than 10 m. The larvae and the juveniles of this fish are also known to occur in the surf zones of sandy beaches as well as in shallow rocky shores (Senta et al., 1986; Saruwatari and Okiyama, unpublished data). Both *R. richardsoni* and *S. ishikawae* larvae must be utilizing a very effective retention mechanism to stay in the surf zone in order to avoid loss of larvae due to planktonic dispersal, and thus effectively utilize the high productivity of the surf zone to ensure stable recruitment. A likely candidate of this mechanism is the wave-induced circulation cell which was reported by Itosu and Miki (1983), to explain the cause of the formation of ormer (*Sulculus diversicolor diversicolor*) fishing grounds.

Acknowledgments

The authors are greatly indebted to Mr. Nobuhiro Shimizu of the Ibaraki Prefectural Fisheries Experimental Station for his assistance while sampling and for providing us with environmental data. We owe our gratitudes to Mr. Koki Ishikawa of the Ibaraki Prefectural Fisheries Experimental Station for providing us with information on the larval specimen. We would also like to express our gratitudes to the staff of the Ibaraki Prefectural Fisheries Experimental Station and the Ibaraki Prefectural Mariculture Center for their help.

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日本近海におけるクチバシカジカ仔稚魚の出現

猿渡敏郎・別井一栄・沖山宗雄

14 尾のクチバシカジカ仔稚魚 (7.8 mm NL–11.5 mm SL) が 1986 年 3 月 11 日，茨城県久慈川河口にて行われたサケ稚魚調査の採集物中から発見された．今回の出現時期が，東部太平洋岸に於て報告されている本種に関する知見と良く一致する事と，出現水域が現在知られている本種の日本沿岸に於ける分布域の中央に位置することから，クチバシカジカは我が国沿岸においても繁殖していることが判明した．茨城県下では，幼期に砕波帯に出現するイシカワシラウオが本種と共通する分布様式を示すことが推定された．

(猿渡・沖山：164 東京都中野区南台 1-15-1　東京大学海洋研究所資源環境部門；別井：310 水戸市三の丸 1-5-38　茨城県庁農林水産部農政企画課)