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Occurrence of Larval and Juvenile Japanese Snook, *Lates japonicus*, in the Shimanto Estuary, Japan

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Abstract A total of 54 postlarval, 12 juvenile and six young *Lates japonicus* were collected in the Shimanto estuary from August 1985 to January 1987. The larvae (4.3–7.6 mm SL) and juveniles (8.1–28.0 mm SL) occurred only in areas with eelgrass beds from late July to middle August. Temperatures and salinities at waters where any number of them were collected ranged from 27.8 to 31.9°C and from 2.8 to 18.2‰, respectively. The larvae are very similar in general morphology to those of Mugilidae and some of Gobiidae, but are distinguished from others by the spines of preopercle, position of the anus and pigmentation patterns in the posterior part of body.

Japanese snook, *Lates japonicus* Katayama et Taki (Centropomidae), is indigenous to Japan contrasting with *L. calcarifer* which is widely distributed in tropical and subtropical areas of the Indo-west Pacific region (Greenwood, 1976; Katayama and Taki, 1984). *L. japonicus* is an euryhaline and catadromous fish, and commonly found in coastal areas and estuaries of Miyazaki and Kochi Prefectures. Sporadic occurrences of the fish have also been reported from Oita, Tokushima, Wakayama and Shizuoka Prefectures of southern Japan (Katayama, 1984; Ochiai et al., 1984; Takamatsu, 1985; Araga and Tanase, 1987).

Much work has been done on the ecology and early life history of *L. calcarifer* in India, Papua New Guinea, Thailand, Australia and the Philippines (Ghosh, 1973; Moore, 1982; Sirimontaporn et al., 1984; Russell and Garrett, 1985; Kohno et al., 1986). On the other hand, little is known about *L. japonicus*.

Recently we succeeded in collecting the larvae, juveniles and young of this fish in the Shimanto estuary, Kochi Prefecture. Their morphological characteristics and seasonal occurrence are presented in this paper.

Study site

The Shimanto River which is the longest in Shikoku (Katto, 1986) flows into the southwestern part of Tosa Bay, and the most famous for sport fishing of *L. japonicus* in southern Japan. Topography of its estuary includes three affluents (the Takeshima, Nakasuji and Ushiro Rivers) and one island (Ohshima). The shoal areas of the estuary are studded with eelgrass beds the year round (Fig. 1). According to Yamasaki (pers. comm.), the adults of *L. japonicus* inhabit the mouth to the junction with the Ushiro River.

Temperatures of waters fluctuated from 7.7 (late January) to 32.4°C (middle August) seasonally, and salinities from less than 1.8 to 29.2‰ according to tidal phases during the present study.

Materials and methods

Monthly collections of larval and juvenile fishes with a small seine were made at 11 stations in the Shimanto estuary from June 1985 to January 1987, with an extra-collection in August 1986. Of these stations, six (St. 3–7 and 10) were waters with eelgrass beds (Fig. 1). Our seine was fundamentally the same as Kinoshita's (1986), but with floats and weights along upper and lower margins, respectively. Two persons kept the net streched, and waded backward in the river, from ankle- to neck-depth along the coast for a distance of about 50 m. The collection for a month consisted of 26 to 43 hauls.

Specimens were preserved in 10% formalin until sorting and measurement in the laboratory and then transferred into 80% ethanol.

Of about 40,000 larval, juvenile and young fishes collected, *L. japonicus* accounted for 72, consisting of 54 postlarvae (4.3–7.6 mm SL), 12 juveniles (8.1–28.0 mm SL) and six young (42.9–

100.7 mm SL) (Table 1).

Results

1. Descriptions of larvae and juveniles. Morphology: Larvae are compressed and moderately slender, with large head and eyes. The gut is thick and its length is moderate throughout the larval period. Snout-anus distance is 59% of the body length at 4.7 mm SL, increases to 66% at 5.3 mm SL (Fig. 2A, B).

The pelvic buds are present at 4.7 mm SL (Fig. 2A). The rays of the second dorsal and the anal fins have been completed and fairly developed at 5.3 mm SL (Fig. 2B). And then the anal, first dorsal, pelvic and pectoral fins are completed at about 6.0, 6.5, 7.0 and 8.0 mm SL (Fig. 2C), respectively.

The spines on the preopercle form early. On the outer margin of the preopercle, spines are counted to five in 5.3 mm SL larva and increased to seven in 8.1 mm SL juvenile, futhermore to about 14 at 15.5 mm SL (Fig. 2B–D); on the inner margin, about nine spines are present at 8.1 mm SL, but they have disappeared at 15.5 mm SL. On the upper part of opercle, two spines are found in juvenile period (Fig. 2C, D). The cleithrum exposed under the opercle has a spine at 12.4 mm SL and two spines at 15.5 mm SL.

Pigmentation: The melanophore pattern in larval stages is relatively heavy. Melanophores are distributed on the snout, on the cheek, on the lateral abdomen, on the ventral tail, along the lateral midline, on the dorsal trunk, and on the second dorsal and caudal fin bases. Melanophores of the first four parts are arranged level with each other. A single row of melanophores occurs ventrally from the chin to the hindgut (Fig. 2A, B).

In juvenile stages, melanophores are more numerous in the trunk and are present on the top of head, first dorsal, anterior anal and pelvic fin membranes (Fig. 2 C). Live juveniles over 8.0 mm

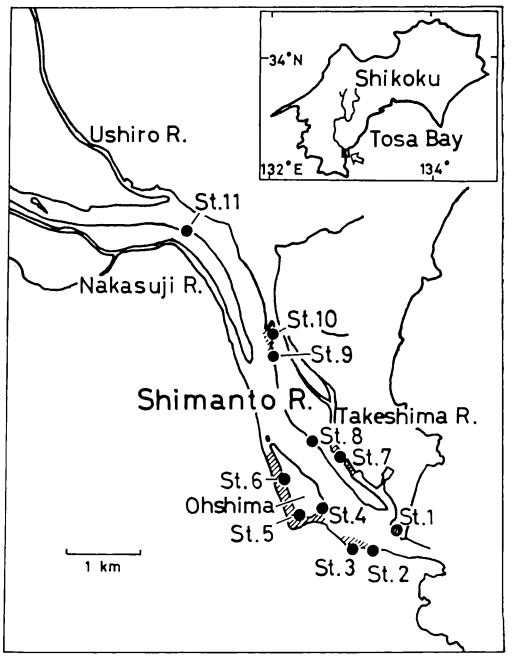

Fig. 1. A map showing the 11 stations in the Shimanto estuary where monthly collections with a small seine were made. Shaded areas represent waters with eelgrass beds.

Table 1. Collection record of *Lates japonicus* with a 1×4 m seine, in the Shimanto estuary. L, postlarva; J, juvenile; Y, young; w.t., water temperature; nr, not recorded.

Date			No. of fish collected			Range of SL (mm)			Range of w.t. (°C) and salinity (‰)	
d	m	y	L	J	Y	L	J	Y	w.t.	S
3	8	85	3	2		4.6–5.2	8.1–8.2		29.6	nr
27	4	86			1			100.7	18.9	7.6
25	5	86			1			88.3	22.8	14.6
27	7	86	2			4.9–5.0			30.2	3.8
2	8	86	16	2		4.3–7.6	8.1–9.0		30.7–31.9	2.8–3.3
3	8	86	21	2		4.8–6.6	8.1–9.3		27.8–28.9	4.8–8.1
18	8	86	12	6		5.1–7.0	12.4–28.0		28.9–30.6	11.1–18.2
27	10	86			1			55.2	18.5	15.3
15	1	87			1			42.9	9.5	11.0
16	1	87			2			78.6–92.6	10.4–10.5	14.0–15.8

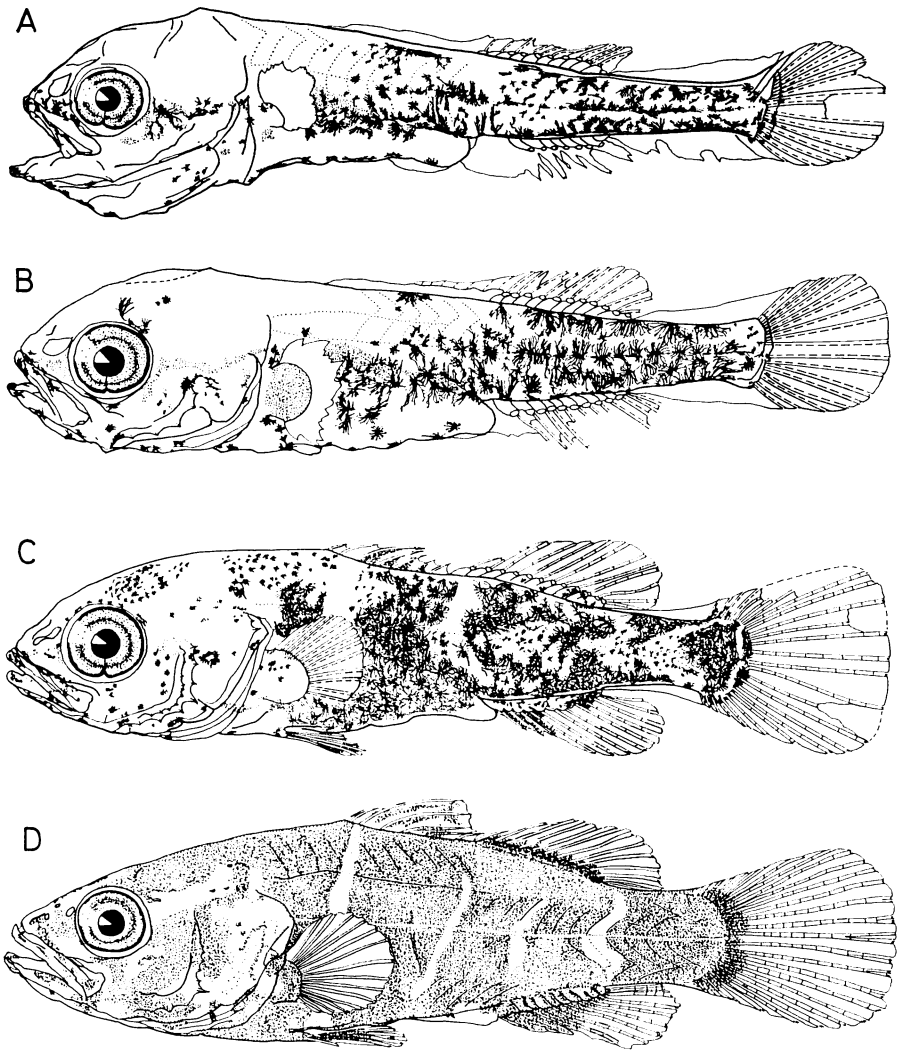

Fig. 2. Developmental stages of *Lates japonicus*. Upper three specimens were collected from the Shimanto estuary on August 3, 1985; lower one from the Hitotsuse estuary, Miyazaki Prefecture on August 24, 1981. A, 4.7 mm SL postlarva; B, 5.3 mm SL postlarva; C, 8.1 mm SL juvenile; D, 15.5 mm SL juvenile, URM (Dept. of Mar. Sci., Univ. of Ryukyus)-P 6697.

SL already have red eyes. At 15.5 mm SL, melanophores form five vertical bands on the body (Fig. 2D).

2. Seasonal occurrence and sizes. The larval and juvenile *L. japonicus* occurred from late July to middle August; young in April, May, October and January (Table 1). The larvae and juveniles were most abundant in August 1986. All of them were collected at staitions with eelgrass beds (St. 4–7 and 10), with no record of occurrence at stations lacking eelgrass beds (Table 2). They were especially concentrated in a channel behind Ohshima (St. 4–6). St. 3 was the only station with eelgrass beds where they were not found at all.

Temperatures and salinities at waters where any number of larvae and juveniles were collected ranged from 27.8 (August 3, 1986) to 31.9°C (August 2, 1986) and from 2.8 to 18.2‰, respectively (Table 1).

Sizes of larvae and juveniles ranged from 4.3–28.0 mm SL (Table 1, Fig. 3). The length frequency of the collected specimens suggested that

there were two groups among the specimens smaller than 10 mm SL, a smaller group with a mode at 5.6–6.0 mm SL and a larger one at 8.1–8.5 mm SL (Fig. 3).

3. Growth. The growth of *L. japonicus* is shown in Fig. 4. No larvae were found in June of both 1985 and 1986. The larvae which first occurred on July 27 were 4.95 mm SL on the average. They reached 8.23 mm SL on the average on August 2; transferred to the juvenile stage, further 8.70 mm SL on the average on August 3. On August 18, they reached 19.15 mm SL on the average. They exceeded 50 mm SL in October and 100 mm SL in next April at least in the estuary.

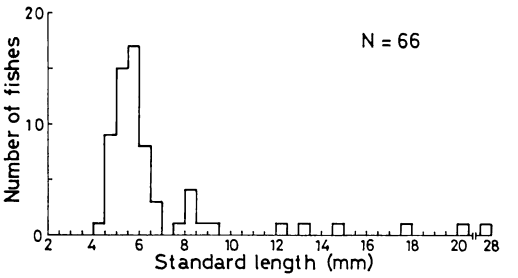

Fig. 3. Length frequencies of larval and juvenile *Lates japonicus* collected in this study period.

Discussion

Larvae of *Lates japonicus* are similar in general morphology to those of Mugilidae and some of Gobiidae, but are easily differentiated from the latter two. Spines are present on the preopercle in *L. japonicus*, against their absence in the Mugilidae and Gobiidae. Position of the anus is at 66% of body length in *L. japonicus*, against 70% in Mugilidae. The gas bladder is not as conspicuous in *L. japonicus* and Mugilidae as in Gobiidae. Melanophores on the body are smaller in Mugilidae and larger in Gobiidae than in *L. japonicus*.

Larvae and juveniles of *L. japonicus* are very similar to those of the closely related *L. calcarifer* and *Centropomus undecimalis* in general morphology (Lau and Shafland, 1982; Moore, 1982; Kosutarak and Watanabe, 1984). But *L. calcarifer* is deeper in body depth and *C. undecimalis* is lighter in body melanophores than

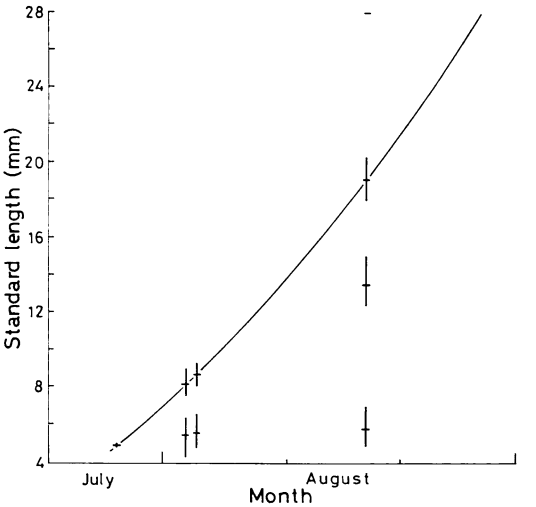

Fig. 4. Growth of larval and juvenile *Lates japonicus* in 1986. Horizontal and vertical bars indicate means and ranges, respectively.

Table 2. The number of larval, juvenile and young *Lates japonicus* collected at each station.

Date			Station										Total
d	m	y	1	2	3	4	5	6	7	8	9	10	11	
3	8	85				2	3							5
27	4	86						1						1
25	5	86					1							1
27	7	86						2						2
2	8	86				7	11							18
3	8	86					1	19	3					23
18	8	86				1	3	8				6		18
27	10	86						1						1
15	1	87						1						1
16	1	87						2						2
Total						10	19	34	3			6		72

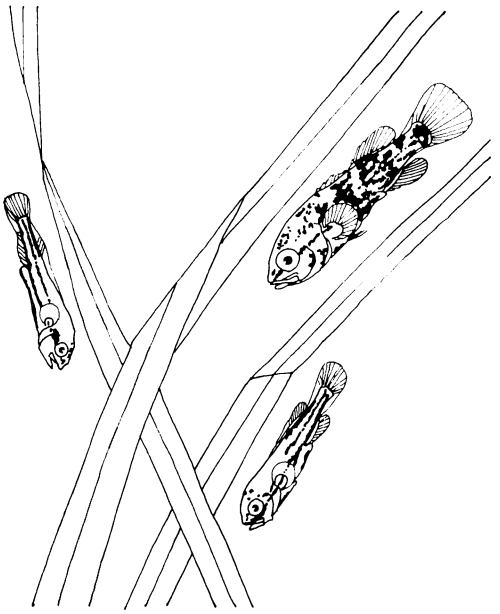

Fig. 5. A schematic illustration of the posture of the larval and juvenile *Lates japonicus* kept in a 500-m*l* specimen bottle together with eelgrass leaves (just after catching and before adding formalin). They were static, keeping a head-down position parallel to a leaf of eelgrass.

L. japonicus. The sequence of fin completion in *L. japonicus* is the same as in *L. calcarifer* and *C. undecimalis*: D_2-A-D_1-P_2-P_1, the most standard type in Percoidei (Johnson, 1984).

Lates japonicus of 4.3 to 100.7 mm SL occurred only in places with eelgrass beds (Tables 1, 2). This suggests that they seldom move out of these waters during larval and young period. We can conclude that *L. japonicus* is among "residents" (Modde, 1980) of the waters with eelgrass beds in the estuary, utilizing this habitat at least for the period of postlarva to young.

Based on the growth of reared *L. calcarifer* (Kosutarak and Watanabe, 1984; NICA, 1986), we consider that the larval and juvenile *L. japonicus* collected during the present study could be about 14–120 days old (mostly 14–30 days old). On the otholiths of a 4.9 mm SL postlarva caught on July 27, 1986, we counted 13 or 14 rings. We estimate that *L. japonicus* spawns from late June to early August.

According to Yamasaki (pers. comm.), *L. japonicus* with mature eggs have never been caught in the Shimanto River. Furthermore, three postlarvae (3.8–4.1 mm SL), smaller than the smallest specimen reported in the present paper, were collected from the surf zone of Tei beach facing Tosa Bay on July 10, 1982. Hence *L. japonicus* seems to spawn not in the estuary but in the sea like *L. calcarifer*. Both in the Gulf of Papua and the Gulf of Thailand, *L. calcarifer* spawns in nearshore coastal waters. Particularly, the spawning in the former is known to take place in a single major site (Moore, 1982; Sirimontaporn et al., 1984). We do not know where of the sea *L. japonicus* spawns, and do not identify its eggs. However, the restricted range of size of our specimens suggests that the spawning of *L. japonicus* near the Shimanto estuary also takes place in a relatively narrow area.

Larvae of *L. calcarifer* do not appear in the nursery grounds of estuary until the close of the wet season (Ghosh, 1973; Moore, 1982; Sirimontaporn et al., 1984). Those of *L. japonicus* which may have hatched in the sea began to occur in the estuary from late July, i.e., also after the passing of the wet season. Larvae seem to avoid the freshet period (from late June to middle July) being hard to enter the estuary from the sea. It may be said that this spawning season is advantageous for the larvae to enter estuaries. In view of the presumably not very functional fins of the small larvae found in the waters with eelgrass beds, they probably entered the estuary taking advantage of flood tide.

We had an opportunity of observing live larval and juvenile *L. japonicus* placed in a 500-m*l* transparent bottle just after collection on August 2, 1986. They were static, keeping a head-down position parallel to a leaf of eelgrass (Fig. 5). This posture was observed in juvenile *Sphyraena barracuda*, too. Larval and juvenile *L. japonicus* seem to mimic a leaf of eelgrass as some of Syngnathidae. According to an observation in aquarium (Sakurai, 1981), young *L. japonicus* (10 to 20 cm probably in total length) are usually static with their heads aslant downward. This seems to be traces of the larval habit.

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四万十川河口域におけるアカメ仔稚魚の出現

木下　泉・藤田真二・高橋勇夫・東　健作

四万十川河口域において，1985 年 8 月から 1987 年 1 月の間に，アカメの後期仔魚 54 尾，稚魚 12 尾および若魚 6 尾を採集した．仔魚 (4.3–7.6 mm SL) および稚魚 (8.1–28.0 mm SL) は，アマモ場を有する水域にのみ，7 月下旬から 8 月中旬にかけて出現した．このことは，本種は 6–8 月にかけて産卵することを示唆している．仔稚魚が採集されたのは，水温 27.8–31.9°C，塩分濃度 2.8–18.2‰ の範囲であった．アカメ仔魚は，ボラ科およびハゼ科のものらと形態的によく類似するが，前鰓蓋骨の棘，肛門の位置および尾部の黒色素胞の発達程度により，これらと識別できる．

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