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A Morphological and Meristic Comparison of Larval and Juvenile Temperate Bass, *Lateolabrax japonicus*, from Various Sites in Western and Central Japan

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Abstract Comparison of larval and juvenile specimens of the temperate bass, *Lateolabrax japonicus*, collected from 11 sites in western and central Japan, revealed that specimens from the Chikugo estuary located at the innermost Ariake Bay, differed markedly in morphology from other specimens. In the Chikugo specimens, melanophores were distributed more sparsely, the head was proportionately smaller and the numbers of dorsal pterygiophores and vertebrae were significantly lower. Larval and juvenile stages of the species were redescribed using specimens from the Shimanto estuary.

The temperate bass, *Lateolabrax japonicus* (Cuvier) (Percichthyidae), is a widely distributed and commercially important fish in coastal waters of Japan, Korea and China (Yamada, 1986). The eggs, larvae and juveniles were first illustrated by Mito (1957), followed by many works on the early life stages (Hatanaka and Sekino, 1962; Watanabe, 1965; Matsumiya et al., 1985; Fujita et al., 1988). Kinoshita and Fujita (1988) determined that most of the specimens illustrated by Mito (1957) were indeed *L. latus*, and newly described the larvae and juveniles from specimens collected in the Chikugo estuary located at the inner part of Ariake Bay.

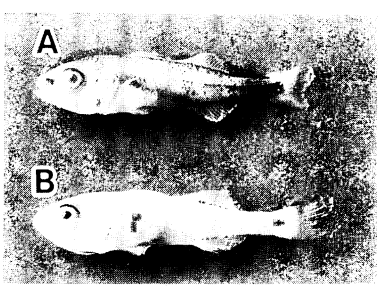

Fig. 1. Photograph demonstrating different in melanophore patterns in the juvenile *Lateolabrax japonicus* from the Shimanto (A) and Chikugo (B) estuaries. A) 17.4 mm SL, collected on April 15, 1986; B) 18.4 mm SL, collected on March 25, 1984.

Recently after noticing that early pigmentation development in fish in the Shimanto estuary differed from those in the Chikugo estuary (Fig. 1), further collections of the larvae and juveniles were made from various sites in western and central Japan. Morphological comparisons of these specimens substantiated the uniqueness of the fish in the Chikugo estuary.

In this paper, the above findings are reported and the larvae and juveniles redescribed, based on specimens from the Shimanto estuary.

Materials and Methods

Samples of larval and juvenile *Lateolabrax japonicus* were taken from 11 sites in western and central Japan (Fig. 2, Table 1). Specimens were preserved in 10% formalin, a portion of them being subsequently transferred to 80% ethanol. Fish were measured under a stereomicroscope using an ocular micrometer. Some of the specimens were cleared and stained, using the method of Dingerkus and Uhler (1977), to count dorsal and anal pterygiophores, and

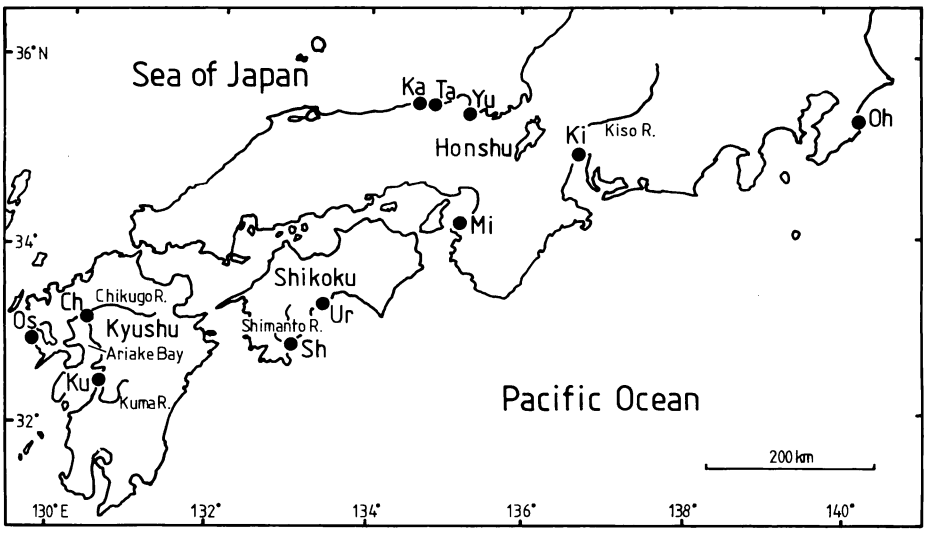

Fig. 2. Map showing sampling sites (solid dots) of larval and juvenile *Lateolabrax japonicus*. *Ch*—Chikugo estuary (Fukuoka Prefecture); *Ka*—Kasumi (Hyogo Prefecture); *Ki*—Kiso estuary (Aichi Prefecture); *Ku*—Kuma estuary (Kumamoto Prefecture); *Mi*—Misaki (Osaka Prefecture); *Oh*—Ohara (Chiba Prefecture); *Os*—Oseto (Nagasaki Prefecture); *Sh*—Shimanto estuary (Kochi Prefecture); *Ta*—Takeno (Hyogo Prefecture); *Ur*—Uranouchi (Kochi Prefecture); *Yu*—Yura estuary (Kyoto Prefecture).

vertebrae.

Results

Description of larvae and juveniles from the Shimanto estuary

Morphology.—Larvae and juveniles are laterally compressed. The head is moderate (21% SL in a preflexion larva; 28–36% SL in postflexion larvae and juveniles). Body depth is 13% SL in the smallest larva (Fig. 3A), increasing gradually to 24% in a 16.9 mm SL juvenile (Fig. 3). Total myomeres number 33 or 34. The gut is tightly coiled and relatively long in the smallest larva (Fig. 3A). Snout-anus distance is 57% SL in the smallest larva (Fig. 3A) and 63% throughout the postflexion and juvenile stages.

Caudal anlagen begin to develop at 6.4 mm SL, with notochord flexion being completed at about 12 mm SL (Fig. 3A–C). The second dorsal and anal anlagen first appear at 11.7 mm SL, their incipient fin rays beginning to differentiate. Full ray complements in both fins are present at 13.5 mm SL (Fig. 3B–D). The pelvic bud occurs at 11.7 mm SL, with rays starting to develop at 13.5 mm SL and being completed at 15–16 mm SL juveniles (Fig. 3E, F). A few incipient rays appear dorsally in the pectoral fin in about 12 mm SL larvae, the full complement of rays being present at 15.1 mm SL. Full caudal principal rays are completed at about 12 mm SL (Fig. 3C, D).

Four spines occur on both the inner and outer margins of the preopercle at 11.7 mm SL (Fig. 3B). Spines on both margins gradually increase in number, the outer margin spines finally numbering eight. The inner spines, however, disappear in the 16.9 mm SL juvenile (Fig. 3B–F). A single, small spine is present on the posterior margin of the interopercle near its junction with the subopercle at about 12 mm SL, increasing gradually to four at about 15 mm SL (Fig. 3C–E). The subopercle also bears three spines near its junction with the interopercle in the 16.9 mm SL juvenile (Fig. 3F). A single spine is present on the posterior margin of the opercle at 13.5 mm SL, but becomes obscure at 15.1 mm SL (Fig. 3D, E). Two spines each are visible on the supraorbital ridge and posttemporal in the 11.7 mm SL larva, increasing gradually to nine and six, respectively, and giving a serrated appearance to both elements in the 16.9 mm SL juvenile (Fig. 3B–E). The supracleithrum also bears a single spine in 12 mm SL larvae, increasing to three in

Table 1. Collection records and frequency distributions of the number of dorsal and anal pterygiophores, and vertebrae in larval and juvenile *Lateolabrax japonicus* from 11 sites in western and central Japan (site abbreviations are given in Fig. 2)

Sites	Date of collection	No. of fish	Range of SL (mm)	No. of pterygiophores												No. of vertebrae				
				Dorsal						Anal										
				no	24	25	26	27	mean±SD	no	8	9	10	11	mean±SD	34	35	36	37	mean±SD
Ku	17 Apr. 92	29	15.4–26.5		1	14	14		25.45±0.57			17	12		9.41±0.50		8	20	1	35.76±0.51
Os	4 Mar. 92	9	9.7–12.0	9					——	9					——			8	1	36.11±0.33
Ch	27 Mar. 82	58	15.1–23.8		16	35	7		24.84±0.62	1	5	38	14		9.16±0.56	2	41	15		35.22±0.50
Sh	22, 23 Mar. 86	40	13.1–20.5		1	24	13	2	25.40±0.63		1	30	9		9.20±0.46		1	39		35.98±0.16
Ur	? Apr. 82	8	32.8–38.4			2	6		25.75±0.46			3	5		9.63±0.52		1	7		35.88±0.35
Mi	16 Feb.–18 May 87	21	16.4–22.9	11		3	7		25.70±0.48	11		3	7		9.70±0.48		2	18	1	35.95±0.38
Ka	14 May 91	31	21.9–32.0			14	17		25.55±0.51		2	19	10		9.26±0.58		2	27	2	36.00±0.37
Ta	14 May 91	22	21.4–30.0			11	11		25.50±0.51		2	12	8		9.27±0.63			22		36.00±0.00
Yu	2, 8 Apr. 92	40	10.8–15.5	17		10	13		25.57±0.51	15	2	15	8		9.24±0.60		3	37		35.93±0.27
Ki	? July 70	26	18.2–29.5		2	15	9		25.27±0.60			7	17	2	9.81±0.57		2	24		35.92±0.27
Oh	25 Apr. 86	47	17.7–21.4		2	28	17		25.32±0.56		1	27	19		9.38±0.53		3	43	1	35.96±0.29

no, not observed.

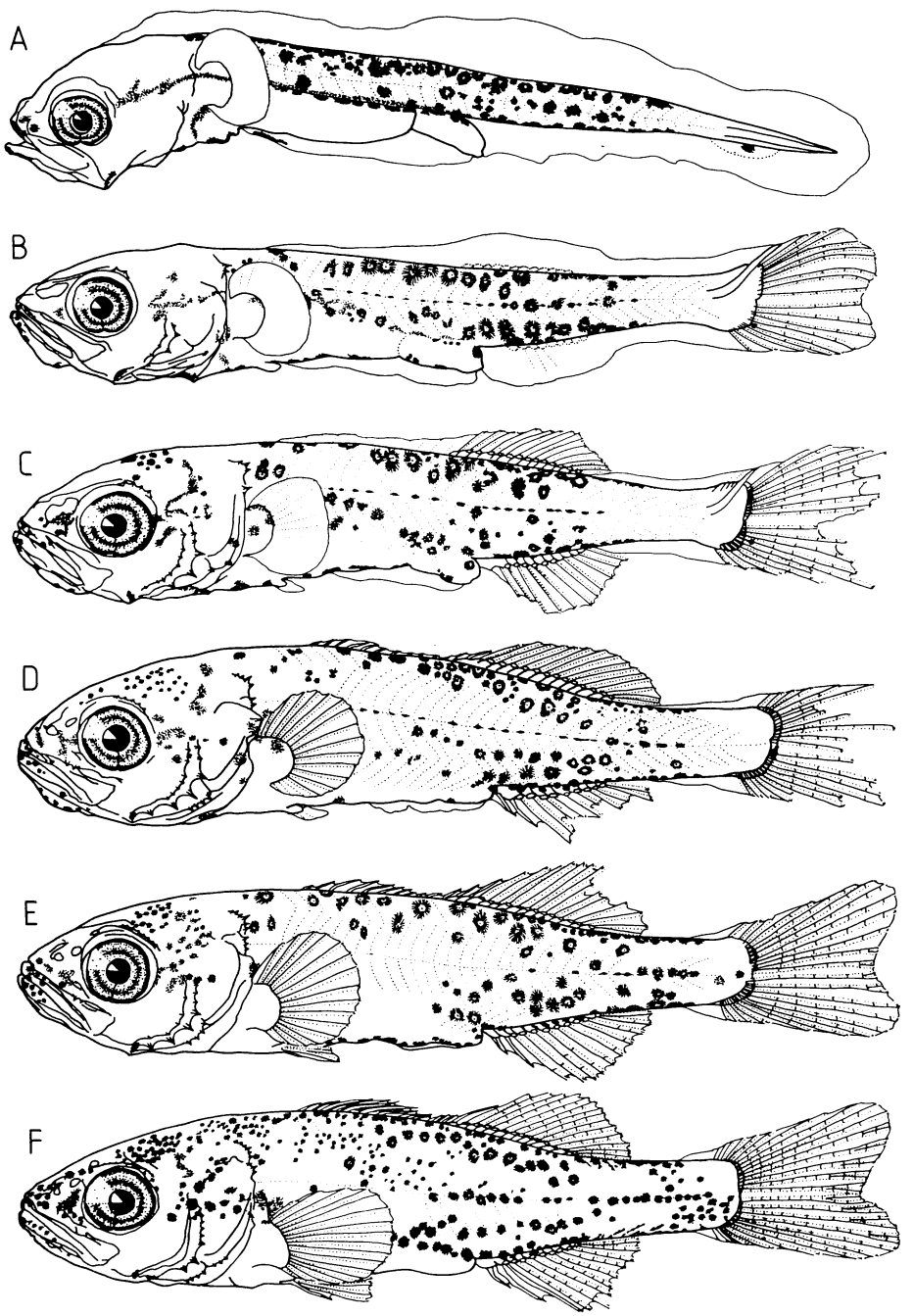

Fig. 3. Developmental stages of *Lateolabrax japonicus* from the Shimanto estuary. A) 6.4 mm SL preflexion larva; B) 11.7 mm SL flexion larva; C) 12.2 mm SL postflexion larva; D) 13.5 mm SL postflexion larva; E) 15.1 mm SL juvenile; F) 16.9 mm SL juvenile.

15 mm SL juveniles (Fig. 3C–E). The lower ridge of the lachrymal has two spines in 13.5 mm SL larvae, but becomes smooth in 17 mm SL juveniles (Fig. 3D–F).

The ventral finfold is still evident in 15 mm SL juveniles, but disappears at about 17 mm SL.

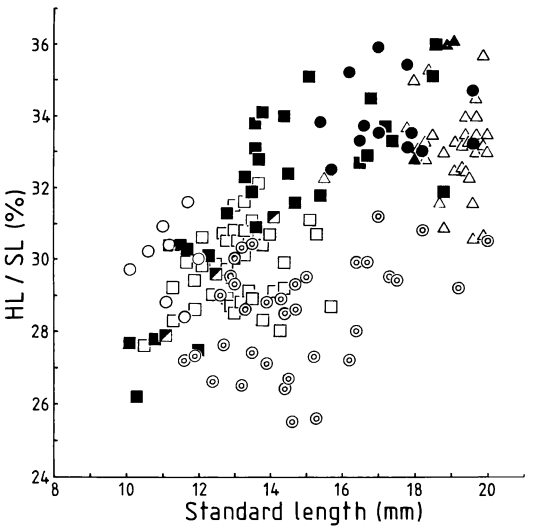

Fig. 4. Comparison of head length (HL) proportions, shown as percentages of standard length (SL), between larval and juvenile *Lateolabrax japonicus* from seven sampling sites. Since the Uranouchi, Misaki, Kasumi and Takeno specimens were outside the size range of the Chikugo sample, and those from Misaki were all cleared and stained, these samples were omitted. Solid, open and double circles indicate Ku ($n=13$), Os ($n=9$) and Ch ($n=36$); solid and open squares, Sh ($n=33$) and Yu ($n=43$); solid and open triangles, Ki ($n=3$) and Oh ($n=35$), respectively. Site abbreviations are given in Figure 2.

Pigmentation.—In an 8.4 mm SL preflexion larva, melanophores are found on the snout, lower end of the preopercle ridge and ventral finfold, under the chin, throat and notochord tip, and along the lateral midline of the tail (Fig. 3A). Internally, melanophores form a line from the snout through ventral side of the skull to the dorsal end of the gut (Fig. 3A). After notochord flexion, melanophores appear on the ventral margin of the intestine and dorsal surface of the rectum (Fig. 3B). Melanophores extend posteriorly on the lateral midline, forming a broken line, to the middle of the caudal peduncle and also on the dorsal and ventral margins of the tail, throughout the larval period (Fig. 3A–D). Thus the posterior half of the caudal peduncle appears unpigmented. Thereafter, melanophores further extend toward the caudal base in juveniles (Fig. 3E, F). Dorsally the head melanophores appear at about 12 mm SL, subsequently becoming denser there and on the snout and cheek in juveniles (Fig. 3C–E). In juveniles of about 17 mm SL, small melanophores are scattered dorsolaterally on the trunk and on the first dorsal fin membrane .

Xanthophores are lightly distributed on the head and along body myosepta throughout the larval and juvenile periods.

Morphological comparisons of specimens from different sites

Pigmentation.—As shown in Figure 1, melanophores were more dense in juveniles from the Shimanto estuary than in those from the Chikugo estuary. In particular, melanophores on the dorsal and ventral margins, and the lateral midline of the tail, extended to the midle of the caudal peduncle in the former (Fig. 3), but barely exceeded the posterior end of the dorsal and anal fin bases in the latter (see Kinoshita and Fujita, 1988). Melanophores on the top of the head were already present at 12.2 mm SL in Shimanto specimens (Fig. 3C), but appeared only in juveniles over 20 mm SL in the Chikugo estuary (see Kinoshita and Fujita, 1988). Xanthophores were visible from the head to the tail in the Shimanto specimens, but were scarce in Chikugo specimens. Larvae and juveniles from other sites had the same pigmentation pattern as those from the Shimanto estuary.

Proportion of head length (HL) to standard length.—Ratios of HL/SL changed gradually as specimens increased from 10 to 20 mm SL. However, the head tended to be smaller in larvae from the Chikugo estuary compared with in those from the other sites (Fig. 4).

Meristic characters.—The mean number of dorsal pterygiophores of the Chikugo estuary specimens ($\bar{x}=24.84\pm0.16$ [95% confidence limit], $n=58$) was significantly smaller ($p<0.001$) than those from the other sites, for which mean numbers ranged from 25.27 ± 0.24 to 25.75 ± 0.41 (Table 2). The mean number of vertebrae in the Chikugo estuary specimens ($\bar{x}=35.22\pm0.13$) was also significantly smaller ($p<0.001$) than in the other specimens ($\bar{x}=35.76\pm0.19$ to 36.11 ± 0.25) (Table 2). There was little difference in the number of anal pterygiophores of specimens from the 11 sites sampled (Table 1).

Discussion

Differences in morphometric and meristic characters were apparent between *Lateolabrax japonicus*

from the Chikugo estuary and from the other sites. Adults of this fish from Ariake Bay into which the Chikugo River flows, resemble specimens from the Yellow and Pohai Seas rather than those found at other sites in Japan (Katayama, 1960, 1984; Yamada, 1986). Ariake Bay has many such fish species, which are commonly distributed in the Yellow and East China Seas, where the tidal range is large and vast tidal flats develop as in Ariake Bay (Uchida and Tsukahara, 1955; Kamata, 1985). Tanaka (1933) speculated that as the Japan Archipelago separated from the Asian continent, only Ariake Bay retained such an enviroment, consequently supporting these fishes as continental relicts.

A comparison of early life histories of *L. japonicus* from different sites in Japan revealed a difference between those from the Chikugo estuary and the other sites (i.e. the Shimanto estuary, the Inland Sea of Japan, and Wakasa, Mikawa and Sendai Bays). *L. japonicus* juveniles utilize eelgrass beds growing in inlets or estuaries as their nursery at most sites (Okayamasuishi, 1922; Oshima, 1954; Fuse, 1962; Hatanaka and Sekino, 1962; Nakatsugawa, 1980; Fujita et al., 1988), but live a pelagic life in the Chikugo estuary, migrating up muddy streams on rising tides (Matsumiya et al., 1985). It is significant that larvae from the Kuma estuary, which is adjacent to Ariake Bay, but does not have as extensive tidal flats, do not share morphological characters with specimens from the Chikugo estuary, but rather with those from the other nine sites (Tables 1 and 2, Fig. 4).

The evidence supports the hypotheses that the Ariake Bay *L. japonicus* population is either a relict population from the Asian continent or has speciated independently, adapting to an environment similar to that of the coasts of China and Korea. In the future,

Table 2. Results of *t*-test for difference among the sites in means of number of dorsal (D), anal pterygiophores (A) and vertebrae (V) in larval and juvenile *Lateolabrax japonicus* (site abbreviations are given in Fig. 2)

Sites		Os	Ch	Sh	Ur	Mi	Ka	Ta	Yu	Ki	Oh
	D	——	5.109*	0.690	1.364	0.995	0.714	0.325	0.658	1.266	1.504
Ku	A	——	2.033	1.795	1.291	1.593	1.071	0.886	1.133	2.778	0.224
	V	1.923	4.737*	2.558	0.625	1.439	2.105	2.202	1.789	1.429	2.174
Os	V		5.145*	1.781	1.394	1.096	0.803	1.618	1.731	1.712	1.389
	D			4.668*	4.386*	4.369*	5.385*	4.730*	5.479*	3.448*	4.274*
Ch	A			0.374	2.238	2.857	0.794	0.753	0.584	4.887*	2.037
	V			9.268*	3.607*	6.204*	7.647*	7.290*	4.931*	6.667*	9.027*
	D				1.489	1.402	0.719	0.640	1.299	0.641	0.781
Sh	A				2.363	3.049	0.488	0.500	0.303	4.803*	1.682
	V				1.281	0.435	0.308	0.588	1.000	1.132	0.392
	D					0.448	1.508	1.456	0.980	2.078	2.048
Ur	A					0.297	1.637	1.446	1.573	0.796	1.238
	V					0.467	0.882	1.667	0.455	0.342	0.702
	D						0.852	1.047	0.874	2.028	1.990
Mi	A						2.167	1.911	2.063	0.539	1.758
	V						0.472	0.167	0.238	0.316	0.119
	D							0.352	0.143	1.905	1.840
Ka	A							0.060	0.127	3.595*	0.945
	V							0.000	0.921	0.920	0.533
	D								0.461	1.411	1.277
Ta	A								0.168	3.121	0.759
	V								1.207	1.379	0.645
	D									1.875	1.812
Yu	A									3.476	1.022
	V									0.147	0.500
	D										0.357
Ki	A										3.233
	V										0.580

* Significant at $p=0.001$. ——, not compared.

to examine further these alternative hypotheses, *L. japonicus* larvae from Ariake Bay should be compared with those from Chinese and Korean waters.

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西・中央日本の各地から得られたスズキ仔稚魚の形態的および計数形質的比較

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スズキ仔稚魚の形態を西・中央日本の11地域間で比較したところ，有明海奥部に位置する筑後川河口域のものは，他10地域のものよりも，黒色素胞の分布が淡い傾向にあった．さらに両者間には，背鰭担鰭骨数，脊椎骨数および頭長の体長比にも有意な差がみられた．これら発育初期の形態的情報から，有明海産スズキの特異性が示唆された．また，これまでの天然スズキ仔稚魚の形態発育は，筑後川河口域産のものだけをもとに記載されていたので，本報告ではスズキ仔稚魚の典型として高知県四万十川河口域産のものについて形態記載を行った．

（木下：〒625 舞鶴市長浜　京都大学農学部附属水産実験所；藤田・高橋：〒780 高知市若松町9–30　西日本科学技術研究所；東：〒787 中村市具同1167–2　西日本科学技術研究所中村分室；乃一：〒260 千葉市中央区青葉町955–2　千葉県立中央博物館；田中：〒606–01 京都大学農学部水産学科）