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Early Ontogeny of Two Bothid Species, *Psettina iijimae* and *Laeops kitaharae*

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Abstract From specimens collected in the western North Pacific, the early ontogeny of *Psettina iijimae* and *Laeops kitaharae* is described. Diagnostic characters of the genera throughout larval stages are also provided. It is suggested that these species are distributed on continental shelf or at the edge, and that they spawn between July and September.

Fishes of the family Bothidae, suborder Pleuronectoidei, are very diversified being widely distributed on the shallow sand-muddy bottoms of tropical and temperate waters and deeper waters as well. Their larvae also occur widely from over the continental shelves into the open oceans, and grow to be among the largest of pleuronectoid fishes. Recently, Ozawa and Fukui (1986) reported the early ontogeny and spatial distribution of 25 species belonging to 10 genera in the western North Pacific. The early development of some genera and species, however, was undescribed or incompletely known mainly due to lack of material.

In a total of 1,935 bothid larvae collected from the western North Pacific during two cruises (KH-84-2 and KH-86-4) by R. V. Hakuho maru of Ocean Research Institute, University of Tokyo, undescribed developmental stages of *Psettina iijimae* (Jordan et Starks) and *Laeops kitaharae* (Smith et Pope) were found. This paper describes the early ontogeny of these species, and provides estimates of their distribution and spawning seasons.

Materials and methods

The cruise of KH-84-2 was conducted to survey the distribution of ichthyoplankton in and around the East China Sea during June and July 1984, in which a total of 112 samplings were made with a 10 feet Isaacs Kidd Midwater Trawl net (IKMT, 8.7 m^2 mouth opening, 0.5 mm mesh) and Ocean Research Institute ring net (ORI 100 net, 2.0 m^2 mouth opening, 0.66 mm mesh). These nets were towed obliquely from depth of about 200 m to surface for 16–33 min with a ship speed of 2 knots. The present study materials were collected from the continental edge of East China Sea on July 2. KH-86-4 was conducted to survey the biology of leptocephali of Japanese eel *Anguilla japonica* Temminck et Schlegel in the western North Pacific (south of Okinawa and east of Taiwan and Luzon) between August and October 1986, in which a total of 230 net samplings were made (for details, see Ocean Res. Inst., 1988). The present study materials were collected from north of Ishigaki I. and Bashi Channel on September 10–13 with IKMT which was towed obliquely with W shaped vertical track from depth of 110–500 m to surface for 40–140 min with a ship speed of 1.5–3 knots. All of the materials were preserved in 70% ethanol after initial preservation in 10% formalin aboard vessel.

Counting and measurement methods, definition of developmental stages, and generic identification characters followed Ozawa and Fukui (1986). Developmental stages are defined as follows: stage I, before flexion of notochord; stage II, during notochord flexion; stage IIIa, until disappearance of air bladder; stage IIIb, until completion of metamorphosis, i.e. right eye's migration to left side; stage IV, pelagic larvae after metamorphosis. Larvae of the last two stages were not included in this study.

Following abbreviations are used in the description below: SL, standard length; HL, head length; BD, body depth; ED, eye diameter; VN, number of vertebrae.

Psettina iijimae (Jordan et Starks, 1904) (Fig. 1)

The larvae of stage IIIb (16.2–28.2 mm SL) were described previously (Ozawa and Fukui, 1986). In this study, 11 specimens of stages I–IIIa (3.8–11.9

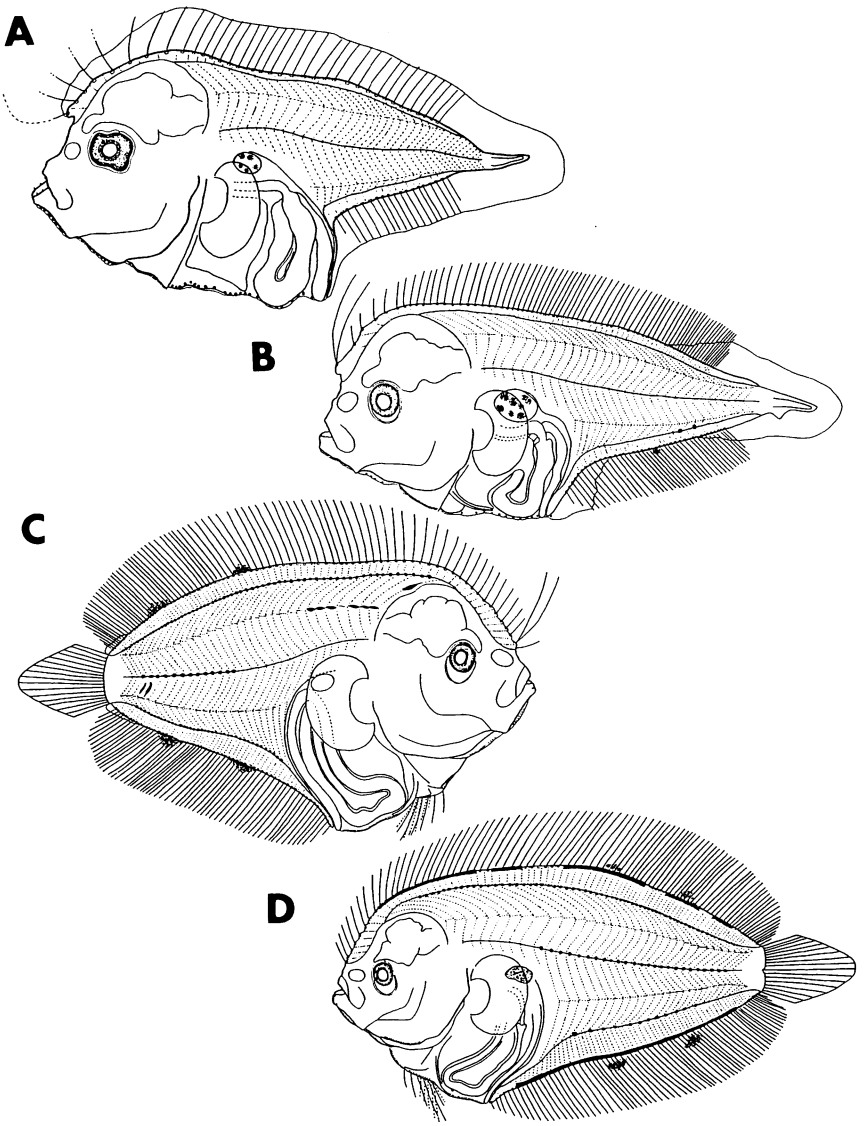

Fig. 1. Larvae of *Psettina iijimae*. A, 3.8 mm SL; B, 5.4 mm SL; C, 7.5 mm SL; D, 11.9 mm SL.

mm SL) are ascribed to this species. The larvae of stage IIIa have the following diagnostic characters recognized in the stage IIIb: as generic characters, oval body, melanophores on midlateral line and interspine base of dorsal and anal fins, and short posterior basipterygial process; and as species characters, lack of spines on urohyal bone and posterior basipterygial process, presence of melanophores along myosepta, VN 10+26–28=36–38 (Amaoka, 1969; Ozawa and Fukui, 1986), and melanophores on air bladder (at stages I–IIIa) which persist until 16.2 mm SL of stage IIIb (see Ozawa and Fukui, 1986).

Body size at developmental stages: stage I, 3.8–4.5 mm SL; II, 4.5–5.5 mm; IIIa, 7.5–11.9 mm.

Development of larvae. Body form is moderately slender in stages I and II and oval in stage IIIa: BD 43–46% of SL in stage I, 41–54% in stage II, and 56–70% in stage IIIa. Relative size of HL to SL is constant, 30–39%. Anus is located slightly behind 1/2 of SL in stage I and slightly before 1/2 to 1/3 of SL in stages II and IIIa. ED decreases from 23–28% of HL in stage I to 18% in stage IIIa. Prominent choroid tissue appears on right eye in 3.8 mm SL and

on left in 4.5 mm SL. Its depth is 40–50% of ED on both eyes. Second dorsal soft fin ray (bifurcated by damage) is elongate (11–19% of SL), and thread-like only in less than 7.5 mm SL. 86–87 dorsal and 69 anal fin rays are formed definitively beyond 8.5 mm SL. Complete six pelvic fin rays are formed in 7.5 mm SL, 3rd ray of left side being opposite to 1st of right side. Elliptical air bladder is present in less than 11.9 mm SL, but absent in more than 16.2 mm SL (Ozawa and Fukui, 1986). Origin of dorsal fin base is slightly convex in stages I and II and straight in stage IIIa.

Fairly abundant punctate melanophores are developed in larval stage. At 3.8 mm SL, five large ones are present on the left side of air bladder, and many minute ones from symphysis of lower jaw through ventral margin of urohyal bone to anus. At 5.4 mm SL, one small melanophore is added at 1/2 of anal fin base and two at 2/3 of interspine base of anal fin of left side. At 7.5 mm SL, melanophores are further developed as follows: a row along 1st epaxial myoseptum, 2nd/4th and 6th/8th central epimers, and 31st and 32nd hypaxial myosepta of right side; an internal row on midlateral line between 11th and 24th caudal vertebrae; a row along dorsal and anal interspine bases of right side; two masses on basal parts of dorsal and anal fins. At 8.5 mm SL, melanophores are increased on left side: a row along dorsal and anal fin bases and many punctate ones at interspine base of dorsal and anal fins. In the subsequent development, melanophores develop on nearly whole myosepta, interspinous regions of dorsal and anal fins, but disappear on ventral margin of intestine (Ozawa and Fukui, 1986).

Remarks. Larvae of stages I–IIIb of other two Japanese *Psettina* species, *P. gigantea* Amaoka and *P. tosana* Amaoka, have already been described by Pertseva-Ostroumova (1965), Amaoka (1976), and Ozawa and Fukui (1986) (for identification of Pertseva-Ostroumova (1965) and Amaoka (1976), see Ozawa and Fukui (1986)). For specimens of stages I–IIIa of *P. iijimae* in this study the early ontogeny (except stage IV) is now known for this genus. Larvae of this genus have the following distinct melanophore pattern: in stages I–II, minute melanophores either on ventral margin from urohyal bone to anus (*P. iijimae* and *P. gigantea*), or on posterior wall of abdominal cavity (*P. tosana*); in stage IIIa, punctate ones on interspine bases of dorsal and anal fins and midlateral line of body. Ozawa and Fukui (1986) did not characterize the

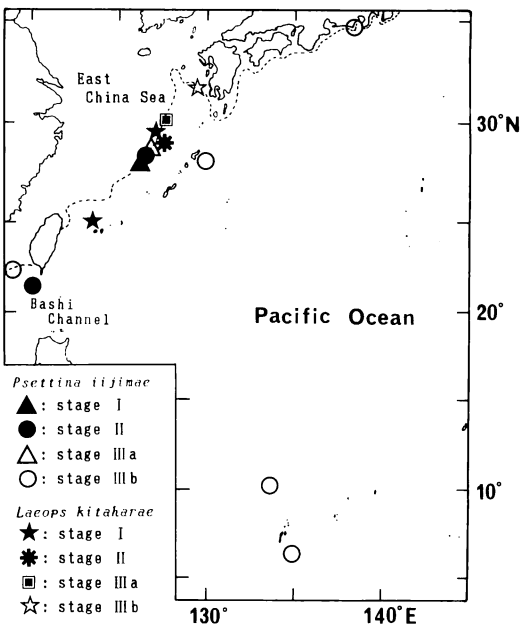

Fig. 2. Collection localities of the larvae of *Psettina iijimae* and *Laeops kitaharae* (including larvae at the stage IIIb of both species studied by Ozawa and Fukui, 1986).

melanophore pattern of stages I–IIIa for *Psettina* due to lack of information. Therefore, the above melanophore pattern can be added to their study.

Distribution and occurrence. The adults of this species live on the bottom at a depth of around 100 m in the western Pacific Ocean (Amaoka, 1984) inclusive of the continental shelf of the East China Sea (Yamada, 1986). In this study, three larvae of stage I, four of stage II and three of stage IIIa were obtained from the continental edge of the East China Sea, and one larva of stage II from Bashi Channel (Fig. 2). Twelve larvae of Ozawa and Fukui (1986) were recorded from off Shimizu of the Pacific coast of Central Japan, around Ryukyu Is., at the edge of the continental shelf in the South China Sea, and around Palau Is.

Ozawa and Fukui (1986) recognized the following three distributional patterns in bothid species from the distribution of larvae: continental shelf species, continental and equatorial islands species, and continental, equatorial and oceanic islands species. Due to lack of adequate number of specimens, they could not define the distribution of *P. iijimae*. This species seems to be a continental shelf inhabitant, as the adults occur on the continental shelf of the East

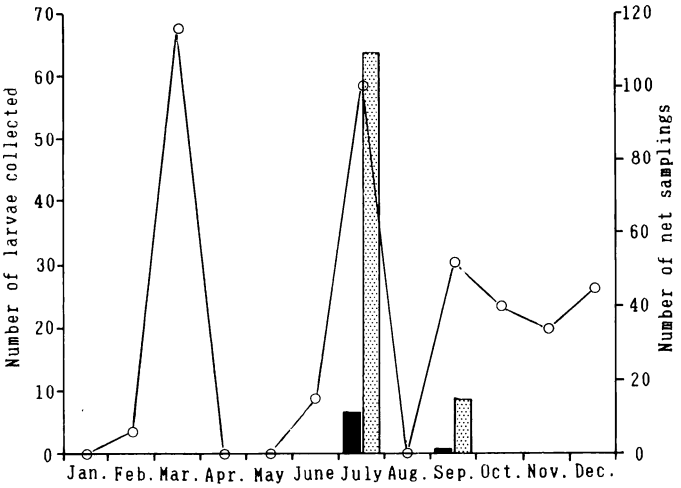

Fig. 3. The number of monthly net samplings (circles) and the number of stages I and II larvae of *Psettina iijimae* (black bars) and *Laeops kitaharae* (dotted bars) in the East and South China Seas and their adjacent regions (data of number of net samplings during Oct.–Mar. from Ozawa and Fukui, 1986).

China Sea (Yamada, 1986) and the larvae of early developmental stages (I and II) were caught in the continental edge of the East China Sea inclusive of Bashi Channel. The origin of larvae of stage IIIb collected around Palau Is. (Ozawa and Fukui, 1986: 411–413) should be reconsidered, because there is a possibility of dispersal from the continental shelf of New Guinea.

Temporal occurrence of bothid larvae has never been analyzed in any study including the recent work of Ozawa and Fukui (1986). In the 16 cruises of Ozawa and Fukui (1986) and in those of the present two, the following collections were made in and around the continental shelf where the early larvae of *P. iijimae* occurred: KH-73-2, March 5–23, 1973, number of net samplings 116; KH-73-5, December 12–15, 1973, 45; KH-75-1, February 3–4, 1975, 6; KG-79, October 2–26, 1979, 14; KG-80, November 9–19, 1980, 34; KG-84, October 2–26, 1984, 26; KH-84-2, June 28–30, 1984, 12 and July 1–25, 100; KH-86-4, September 9–13, 1986, 52. The number of net collections is arranged monthly in Fig. 3 together with the number of larvae collected. Because of significant differences in sampling methods between the cruises, the number of larvae could not be standardized. However, it is clear that the early stage larvae are not obtained in any months except July and September, which means that the spawning season can be inferred to be between July and September for *P. iijimae*.

Laeops kitaharae (Smith et Pope, 1906) (Fig. 4)

Large larvae of stages IIIb and IV (28.2–92 mm SL) were described previously (Amaoka, 1972; Ozawa and Fukui, 1986). The present 74 specimens of stages I–IIIa (2.8–13.9 mm SL) are ascribed to this species. The larvae of stage IIIa show the following diagnostic characters recognized in stage IIIb: as generic characters, slender body, protruded gut, lack of spines on head and abdomen, and as species characters, VN 12+40=52 (Amaoka, 1969; Ozawa and Fukui, 1986). The larvae of stages I–IIIa are characterized with slender body (BD/SL 8–24%) and the following melanophore pattern: a small mass above intestinal coiling in less than 5 mm SL, two small masses on ventral contour of caudal region in 5–9 mm SL, and small masses on air bladder and midlateral line (two or three parts) in 9–14 mm SL.

Body size at developmental stages: stage I, 2.9–7.1 mm SL; II, 9.6 mm; IIIa, 13.9 mm.

Development of larvae. Body is slender throughout larval stages: BD 8% of SL in 3.3 mm SL, 13% in 5.0 mm SL, and 22–24% in 6.2–13.9 mm SL. Relative size of HL to SL is constant, 15–24%. Anus is located slightly behind 1/2 of SL in 2.8–5.0 mm SL, and at about 1/2 in 6.2 mm SL. At more than 9.6 mm SL, gut is remarkably protruded beyond ventral profile, and length of posterior basipterygial process covering the gut ventrally is about 80% of HL. Eye shape changes from circular in less than 5 mm SL to

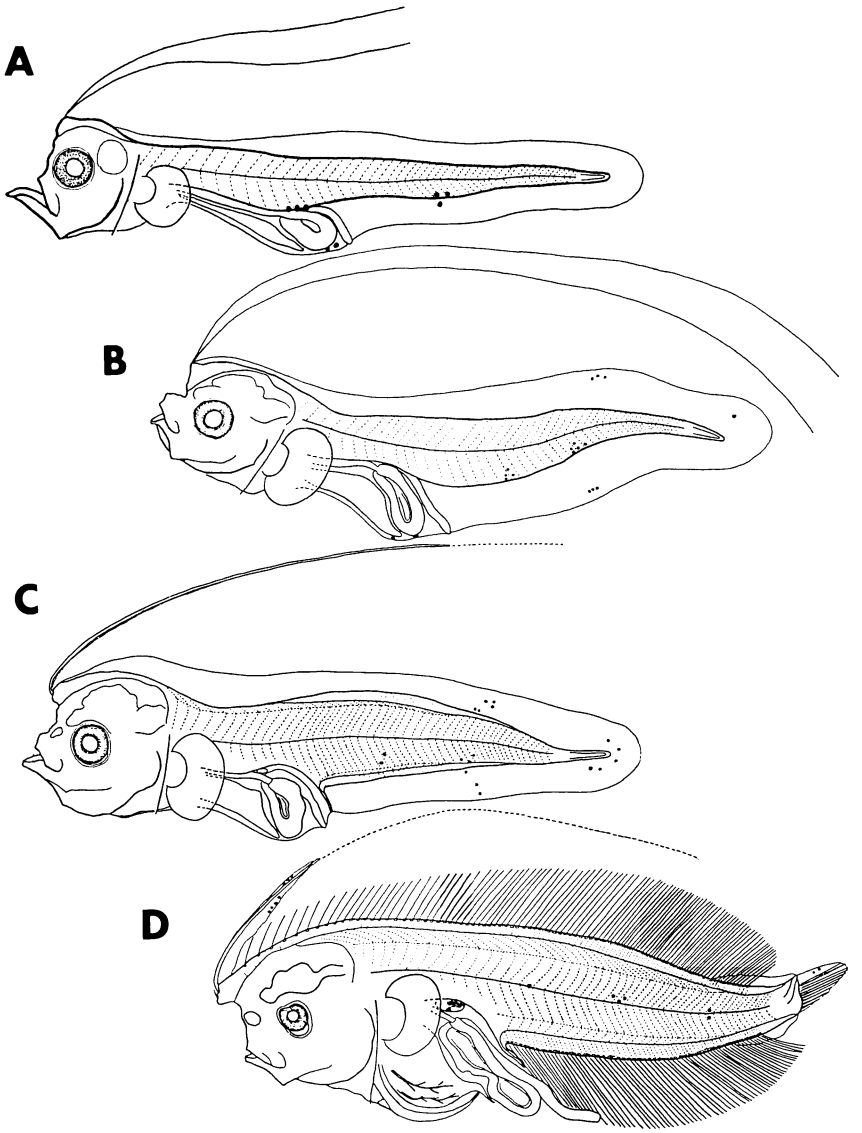

Fig. 4. Larvae of *Laeops kitaharae*. A, 3.3 mm SL; B, 5.0 mm SL; C, 6.2 mm SL; D, 9.6 mm SL.

elliptical in more than 6 mm SL: ED to HL decreases from 44% in 3.3 mm SL, through 30% in 6.2 mm SL, to about 20% in more than 9.6 mm SL. Choroid tissue appears on right eye in 5.0 mm SL and on left in 6.2 mm SL. Its depth is about 20–40% of ED on both eyes in 9.6–13.9 mm SL. Second dorsal soft fin ray (bifurcated by damage) is elongate, being 65–130% of SL, thread-like in specimens less than 5 mm SL and string-like in those more than 6 mm SL. At 13.9 mm SL, 108 dorsal and 82 anal fin rays are counted but not definitive on caudal part, and only three pelvic fin rays are developed. At 6.2 mm SL, air bladder is recognized. Origin of dorsal fin base is slightly convex in 6.2 mm SL and becomes remarkably projected in 9.6–13.9 mm SL, forming a rostrum above snout.

Melanophores are poorly developed at stages I–IIIa. At 3.3 mm SL, small and obscure mass of two to three small melanophores is present on dorsal and ventral contours of intestinal coiling, and at about 2/5 of ventral contour of caudal region. At 5.0 mm SL, similar mass is increased at ventral contour of caudal region, and added at three parts on fin fold of caudal region. Two masses on intestine are absent

in 6.2 mm SL. At 9.6 mm SL, following indistinct melanophores are developed: single or a mass of melanophores on midlateral line at 6th, 17th, and 28th/30th caudal vertebrae; a mass on air bladder of left side; three small melanophores on caudal fin; a mass on membrane of front (three melanophores) and hind margins (four) in elongated dorsal fin ray. At 13.9 mm SL, the single melanophore at 6th caudal vertebra on midlateral line is absent. In the subsequent development, melanophores develop gradually on body surface and become different between both sides, the left being more densely and amoebiform pigmented (Amaoka, 1972; Ozawa and Fukui, 1986).

Remarks. The larvae of stages I and II are described on the genus *Laeops* for the first time. They are closely similar to Indo-Pacific *Arnoglossus* and *Chascanopsetta* in elongated body, poor melanophore and rostrum above snout, but differ distinctly from the former genus in having a small mass of melanophores above intestinal coiling in less than 5 mm SL and two melanophores on ventral contour of caudal region in 5–9 mm SL, and from the latter in lacking melanophores on posterior wall of abdominal cavity and having remarkably elongated second dorsal ray.

Distribution and occurrence. The adults of this species live on bottom at a depth of 70–300 m extending from western Japan to West Pacific and Indian Oceans (Amaoka, 1984). In this study, 63 larvae of stage I, and each one of stage II and IIIa were collected from the continental edge of East China Sea, and nine of stage I from east of Taiwan (Fig. 2). Three larvae of stage IIIb were recorded from shallow water of Nagashima I., southern Japan (Ozawa and Fukui, 1986).

Ozawa and Fukui (1986) did not consider the distribution of deep living bothid genera inclusive of the present one due to lack of information. Judging from the collection of the larvae of early developmental stages near the edge of continental shelf of East China Sea, this species seems distributed on the continental shelf or the edge.

Similar analysis to *P. iijimae* about the temporal occurrence of the early larvae of *L. kitaharae* indicates that spawning season is between July and September (Fig. 3).

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イイジマダルマガレイとヤリガレイ（ダルマガレイ科）の幼期発育

福井　篤・小沢貴和

北西太平洋で採集された個体に基づいて，イイジマダルマガレイとヤリガレイの幼期発育を記載し，両種が含まれる属の全幼期に亘る特徴を示した．両種は陸棚域あるいはその縁辺域に分布し，7月から9月に産卵すると推察される．

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