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# Studies on the Larvae and Juveniles of the Sinistral Flounders—III. *Laeops kitaharae*

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**Abstract** The morphological features of four developmental stages from the early metamorphic stage to juvenile of *Laeops kitaharae* (Smith and Pope) are described and discussed here based on 15 examples collected from various areas of Japan. The postlarvae at the earlier stage are remarkable in having the following characteristic features: elongated shape and immense size (70–92 mm in standard length), produced second dorsal spine, dorsal and anal fin rays well elongated as a whole, and intestinal coil and liver greatly produced beyond body. Metamorphosis of this species is estimated to occur at about 80–90 mm in standard length. *L. variegata* Franz and *L. lanceolata* Franz are concluded to be synonyms of *L. kitaharae*.

## Introduction

A postlarva of the genus *Laeops* of the family Bothidae from off the Sipadan Island, Borneo was first described and figured by Hubbs and Chu (1934) and was identified as *Laeops parviceps* (Günther). The postlarva of the earlier stage of this group is remarkable among flounders in having great size of body, the intestinal coil and the liver greatly produced beyond the body, the second dorsal spine greatly produced, and the vertical fin rays much elongated.

The giant larvae and juvenile fish of 15 specimens, measuring 70–92 mm in standard length, referred to the genus *Laeops* was assembled from various areas in Japan.

Comparing the present larvae with adults of species of *Laeops* distributed in the relevant areas, the author identified these postlarvae and juveniles as *Laeops kitaharae* (Smith and Pope), 1906. This species, widely distributed in the waters of middle and southern Japan and caught at about 20–50 m in depth by trawl fishery, is characterized by having first two dorsal rays detached from other rays and teeth on both jaws entirely confined to the right side (Norman, 1934; Matsubara, 1955; Amaoka, 1969).

In the present paper, the author gives a detailed descriptions and figures of the specimens at each stage, discusses the identification of specimens in relation to *L. variegata* Franz and *L. lanceolata* Franz and the metamorphic size, and also discusses regarding the intestinal coil and the liver greatly produced beyond body.

## Material and methods

The material examined in the present study consist of 15 specimens measuring 85–108 mm in total length (70–92 mm in standard length), collected from several localities in Japanese waters over a period of years. They are divided into four different developmental stages from the early metamorphic to the juvenile stages in accordance with the division of Amaoka (1970).

The detail of the sampling data is shown in Table 1.

The specimens were examined by means of a binocular microscope and X-ray. The vertebrae in some specimens were counted after the body had been made transparent by the method of Hollister (1934).

The counts and the measurements of body parts follow the definitions of Norman (1934).

## Description

**1. Early metamorphic stage** (Figs. 1, 5):

Table 1. Sampling data of postlarvae and juveniles divided into four different stages in *Laeops kitaharae* (Smith and Pope).

| Stages | Number of specimens | Catalogue number* | Date | Locality | Remarks |
|---|---|---|---|---|---|
| Early metamorphic stage | 2 | ABE '60–371 | April 5, 1960 | Manazuru, Kanagawa Pref. | Near surface |
| | | SUF '67–A–1 | End of March, 1967 | Tsushima Island, Nagasaki Pref. | Surface, inlet of bay |
| Middle metamorphic stage | 5 | FAKU 42574–42575 | October 5, 1954 | Owase, Mie Pref. | 20–30 m in depth, bottom trawl net |
| | | FAKU 42578–42580 | April 10, 1961 | Miya, Aichi Pref. | |
| Late metamorphic stage | 6 | FAKU 42581–42586 | April 10, 1961 | Miya, Aichi Pref. | 20–30 m in depth, bottom trawl net |
| Juvenile stage | 2 | FAKU 42576 | March 15, 1959 | Mimase, Kochi Pref. | 20–30 m in depth, bottom trawl net |
| | | FAKU 42577 | April 10, 1960 | Miya, Aichi Pref. | |

* ABE—collections of Dr. T. Abe; SUF—collections of Shimonoseki University of Fisheries; FAKU—collections of Faculty of Agriculture, Kyoto University.

2 specimens, see Table 1.

Counts and proportional measurements of 2 postlarvae are shown in Table 2.

Body elongate, elliptical, its depth much more than 1/3 its length, and very thin. Dorsal contour with a deep notch above nostrils, somewhat steeply rising to anterior 1/4 of body and then slowly descending to caudal base; ventral contour, apart from extension of abdominal region and rather large notch below lower jaw, similar to dorsal in shape. Caudal peduncle a little narrower than 1/5 depth of body.

Head very small, about 1/6 length of body. Snout blunt, about as long as eye diameter; notched portion above nostrils loosely attached to ethmoid region of cranium. Eyes situated on each side of body, right eye a little popped, migrating near ethmoid region, locating slightly above left eye. A round small depression located above left eye. Openings of nostril very small and closely set each other, anterior one with a rudimentary tube; posterior one not tubular.

Mouth small, oblique and subequal on both sides, lower jaw slightly projecting beyond tip of upper jaw when mouth is closed. Maxillary elongate triangular in shape, extending anteriorly below nostril, and posteriorly below anterior margin of left eye; pedicel of premaxillary large, its tip rising to nearly below notched region. Small conical teeth arranged in a row on both jaws of each side.

Scales very small, slightly developed in places on both sides of body. Lateral line faintly visible on left side of body, but absent on right side.

Dorsal fin originating from notched region above snout; 1st spine slender and very short, about half eye diameter; 2nd spine with a broad base and strong, greatly elongated, much longer than anterior rays of the fin, though mutilated on its extremity (about 4 times of head length in smaller specimen), the spine with broad membrane on its posterior margin connects to 1st fin ray basally. Remaining rays well produced as a whole, becoming higher towards near posterior 1/3 part of body, and gently decreasing in height posteriorly, the longest ray about twice of head length. Anal fin starting on a vertical through gill-opening, similar to dorsal in shape and structure. Pectoral fin symmetrical, fan-like in shape, with a heavy fleshy peduncle at base surrounded by a thin transparent membrane, but rays not yet discernible. Pelvic fins well

Table 2. Counts and measurements of the larvae and juveniles of *Laeops kitaharae* (Smith and Pope).

| | Early metamorphic stage | Middle metamorphic stage | Late metamorphic stage | Juvenile stage |
|---|---|---|---|---|
| Number of specimen | 2* | 5 | 6 | 2 |
| Total length (mm) | 85–95 | 82–104 | 100–108 | 102–105 |
| Standard length (mm) | 70–79 | 72–90 | 85–92 | 87–91 |
| Proportional measurements | | | | |
| In standard length: | | | | |
| Head length | 6.3 | 6.26–7.00 | 6.22–6.69 | 5.81–6.19 |
| Body depth | 2.54 | 2.69–3.06 | 2.65–2.9 | 2.95–3.05 |
| In head length: | | | | |
| Snout | 5.95 | 4.97–6.27 | 6.12–6.67 | 7.05–7.25 |
| Eye (left or lower) | 6.25 | 5.09–5.82 | 4.61–5.0 | 3.09–3.67 |
| Eye (right or upper) | 6.25 | 4.93–5.82 | 4.61–5.01 | 3.02–3.67 |
| Maxillary (left) | 4.17 | 4.07–5.55 | 4.3–4.66 | 3.61–3.67 |
| Maxillary (right) | 4.17 | 4.07–5.55 | 4.3–4.66 | 3.59–3.8 |
| Lower jaw | 3.05 | 2.61–3.19 | 2.69–3.0 | 2.47–2.49 |
| Depth of caudal peduncle | 2.55 | 2.43–2.89 | 2.29–2.45 | 2.67–2.96 |
| Longest dorsal ray | 0.5 | 0.61–0.77 | 0.75–1.01 | 1.41–1.47 |
| Longest anal ray | 0.52 | 0.65–0.82 | 0.7–1.04 | 1.33–1.41 |
| Caudal fin | 0.79 | 0.91–0.93 | 0.84–0.93 | 0.93–1.15 |
| Pectoral fin (left) | 1.78 | 1.98–3.4 | 2.75–3.41 | 2.01–2.46 |
| Pectoral fin (right) | 1.78 | 2.76–3.4 | 3.0–4.52 | 2.96–3.13 |
| Pelvic fin (left) | — | 1.54–1.7 | 1.7–1.97 | 1.9–2.1 |
| Pelvic fin (right) | — | 1.71–2.55 | 1.72–2.11 | 2.07–2.15 |
| Base of pelvic fin (left) | 2.12 | 1.72–2.34 | 2.07–2.25 | 2.13–2.27 |
| Base of pelvic fin (right) | 4.81 | 4.42–5.29 | 4.31–4.82 | 5.89–5.91 |
| Counts | | | | |
| Dorsal fin | II, 111 | II, 105–111 | II, 106–109 | 110–111 |
| Anal fin | 88–89 | 86–89 | 89–91 | 90 |
| Pectoral fin (left) | — | — | 13–14 | 14 |
| Pectoral fin (right) | — | — | 13 | 13 |
| Caudal fin | 17 | 17 | 17 | 17 |
| Vertebrae (including urostyle) | 12+41=53 | 12+41=53 | 12+41=53 | 12+41=53 |

* Smaller specimen is dried and unsuitable for proportional measurements.

developed, asymmetrical in position and shape, starting on a vertical through middle part of left eye, remotely separated from anal origin; 1st ray on right side opposite 4th ray on left side. Caudal fin slender, pointed posteriorly, much longer than head length.

Urohyal placed above anterior part of pelvic bone, shaped like fishhook.

Pelvic bones well developed, bifurcate anteriorly, with an up-bent process directed forwards, and a cartilaginous plate to support 6 pelvic rays; left process slightly in advance of the right; posterior process elongate and tapering, running along ventral margin of liver and of convoluted intestine, and extending backward near anus, ventral margin of process not serrate.

Posterior end of liver and three parts of intestinal coil extending far outward between pelvic and anal.

Color in formalin. Larger specimen (Abe '61–371, 79 mm in standard length): general ground color on left side yellowish white, with black eyes, and irregularly scattered dark spots and blotches; dorsal and anal fins with many dark spots; no pigmentation on right side.

Smaller specimen (SUF '67–A–1, 70 mm in standard length): general ground color on

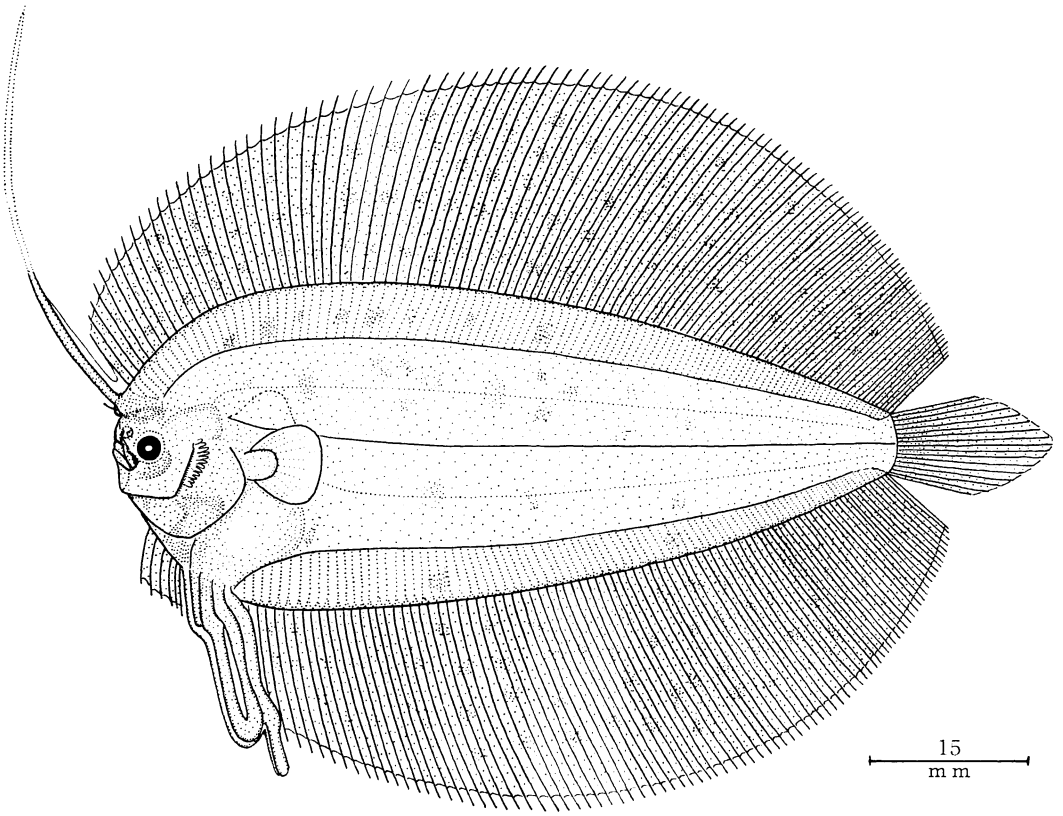


Fig. 1. Postlarva of *Laeops kitaharae* (Smith and Pope) in early metamorphic stage: Abe '61–371, 79 mm in standard length.

left side yellowish brown, with many dark blotches of various patterns on body, dorsal and anal fins (Fig. 5A).

**2. Middle metamorphic stage** (Figs. 2, 6A): 5 specimens, see Table 1.

Counts and proportional measurements of 5 postlarvae are shown in Table 2.

Body more elongate than former stage, its depth a little more than 1/3 its length; dorsal and ventral contours gently and evenly arched except for anterior profile of head. Caudal peduncle very narrow.

Head very small, shorter than 1/6 of body, anterior part of dorsal fin above upper eye swelling up basally, detached from ethmoid to form a slit. Right eye migrated through slit approaching above the left; both eyes separated by a narrow bony ridge. Openings of nostril in advance of upper margin of lower eye, anterior one somewhat tubular; posterior one opening closely behind the anterior, not tubular; Olfactory lamellae on both sides not yet fully developed.

Mouth subequal on both sides, oblique and small, a little longer than eye diameter; maxillary extending posteriorly to below anterior margin of left eye. Teeth small and in bands on right side, but entirely absent on left side.

Scales and lateral line developed on left side of body alone.

Dorsal and anal fins similar to those in former stage. Pectoral fins pedunculate, and almost symmetrical, fin ray-like line surrounded by a thin transparent membrane. Pelvic fin on left side starting below and at middle part or posterior margin of lower eye, 4th ray op-

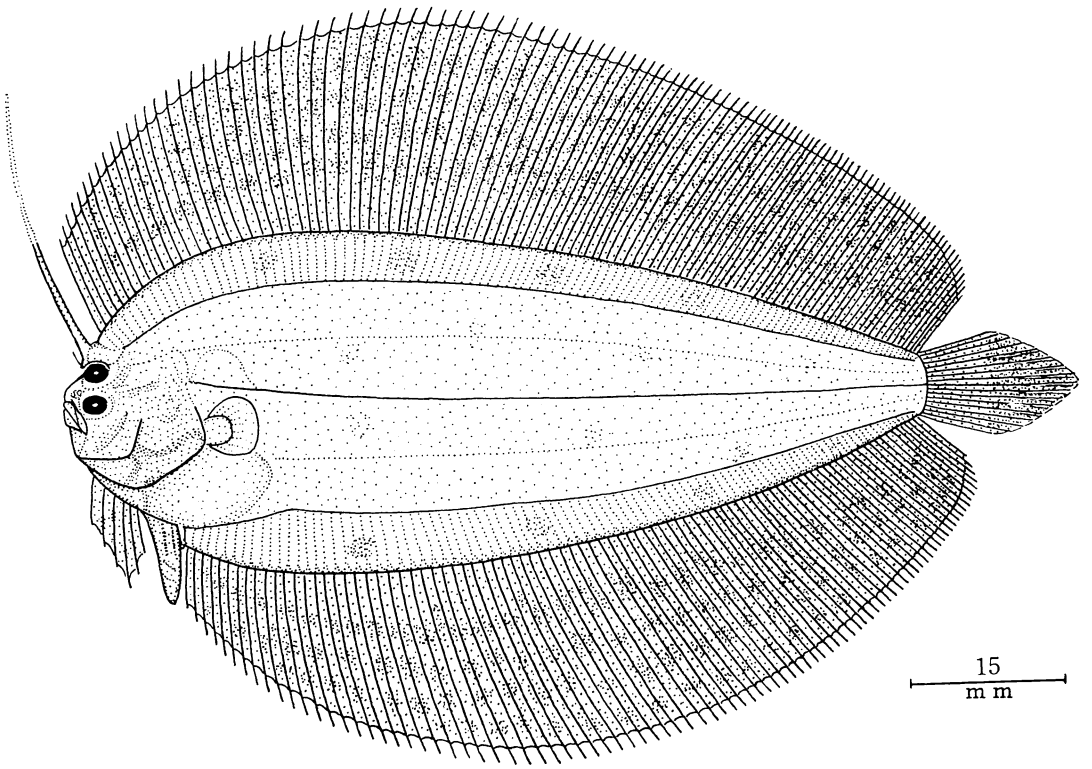


Fig. 2. Postlarva of *Laeops kitaharae* (Smith and Pope) in middle metamorphic stage: FAKU 42579, 84 mm in standard length.

posite 1st on right side. Caudal fin pointed posteriorly, uppermost and lowermost 4 or 5 rays simple, others branched.

Urohyal, being covered by branchiostegal- and gill-membranes, not visible externally.

Pelvic bone well developed; posterior process triangular in shape, very short, arms merely on end of liver entirely occupying abdominal cavity in this stage.

Intestinal coil extending far outward body, distance from abdominal edge to tip of intestinal coil about equal to half length of head; anterior two parts of intestinal coil twisted to the right, its last part with anus nearly putting into abdominal cavity in this stage.

Color in formalin: general ground color on left side yellowish white, except for black eye and pinkish heart; some faint dark blotches along dorsal and ventral edges of body, and paler same blotches on body; vertical fins with a number of serial dark spots except for basal parts; the right side milky white.

**3. Late metamorphic stage** (Figs. 3, 6B): 6 specimens, see Table 1.

Counts and proportional measurements of 6 postlarvae are shown in Table 2.

Body elongate, elliptical with slight projection of the intestinal coil, its depth a little more than 1/3 its length; dorsal and ventral contours gently and evenly arched except for anterior profile of head. Caudal peduncle very narrow, slightly more than 1/5 depth of body.

Head blunt, very small, shorter than 1/6 of body, with a slight notch in front of lower margin of upper eye; front part of dorsal fin touching ethmoid region, and a slit above upper eye in former stage entirely lacking. Snout blunt, very small, much smaller than eye diameter. Right eye having finished migration, located entirely above left eye, and sepa-

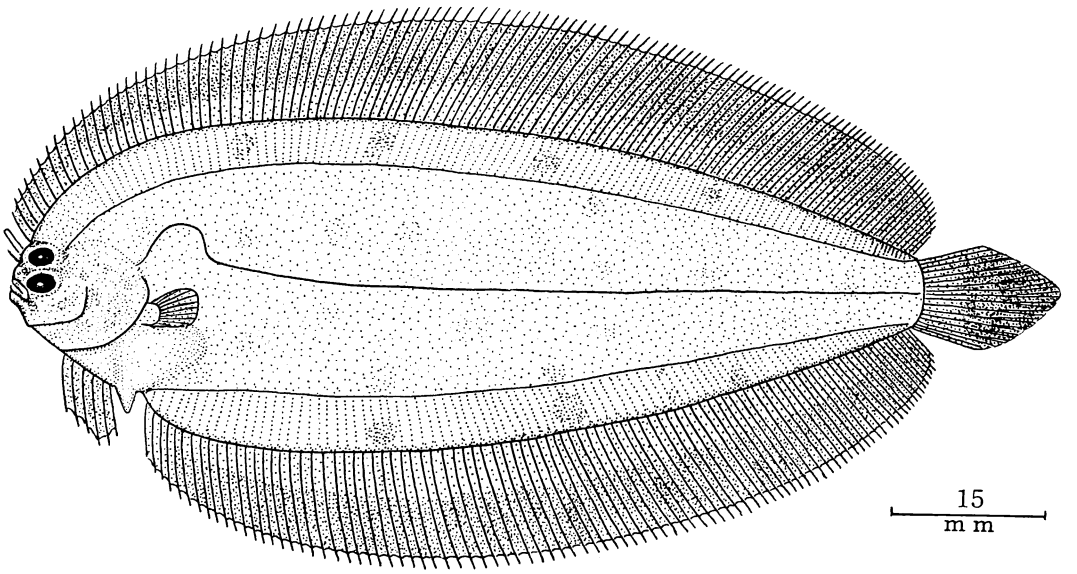


Fig. 3. Postlarva of *Laeops kitaharae* (Smith and Pope) in late metamorphic stage: FAKU 42581, 92 mm in standard length.

rated by narrow space; anterior margins of eyes on same vertical, or the lower slightly in advance of the upper. Openings of nostril on left side located in front of interorbital ridge, anterior one more or less tubular, posterior one not tubular; those on right side below detached anterior rays, similar to those on left side in shape and structure.

Mouth small, a little longer than eye diameter, and almost symmetrical on both sides, maxillary extending to below anterior margin of lower eye. Teeth small, pointed, narrowly arranged on both jaws of right side.

Scales cycloid, well developed on both sides of body, but snout and jaws naked. Lateral line with a small curve above pectoral fin developed on left side alone.

Dorsal fin originating on right side, on a level with lower margin of upper eye; 1st spine slender, very short, a little shorter than eye diameter; 2nd spine strong, much shorter than that in former stage, about equal to eye diameter; rays separated from spines, originating above eye, shorter than in former stage as a whole. Anal fin starting below vertical through origin of lateral line, similar to dorsal in shape and structure. Pectoral fins small, with fine visible rays; the left one longer than the right. Pelvic fin on left side with a broad base starting at a vertical through posterior margin of lower eye, 4th ray opposite 1st on right side. Caudal fin pointed posteriorly, as long as or a little longer than head length; inner 9–12 rays branched, others simple.

Posterior process of pelvic bone very short, and not visible externally. Intestinal coil nearly occupying whole abdominal cavity except at tip, projecting somewhat beyond the pelvic fin insertion.

Color in formalin: general ground color yellowish brown with dark snout and a series of dark blotches along dorsal and ventral margins; outer parts of vertical fins dark. No pigmentation is observed on right side.

**4. Juvenile stage** (Figs. 4, 6C): 2 specimens, see Table 1.

Counts and proportional measurements of 2 juvenile specimens are shown in Table 2.

Body elliptical, more elongate than in former stage, highest slightly in front of middle part of body, its depth about 1/3 length of body; dorsal and ventral contours gently and evenly

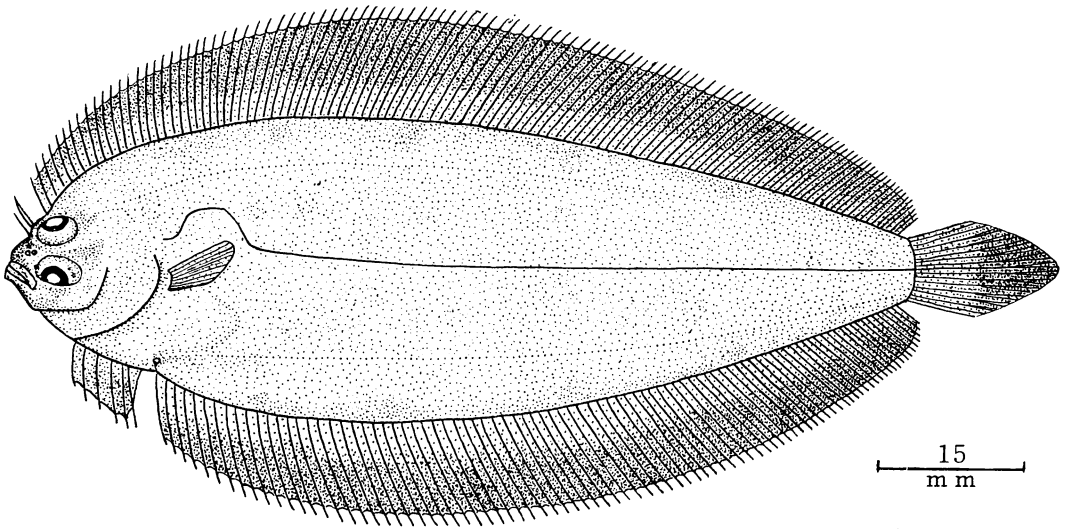


Fig. 4. Juvenile of *Laeops kitaharae* (Smith and Pope): FAKU 42576, 91 mm in standard length.

arched except for anterior profile of head. Caudal peduncle narrow, a little more than 1/3 length of caudal fin.

Head blunt, very small, subequal to 1/6 length of body, with slight notches in front of lower and upper margins of upper eye. Snout blunt, very small, about as long as half diameter of eye. Eyes very large, much longer than in former stage, and separated by narrow bony ridge, extended from anterior margin of lower eye to posterior margin of upper eye; eyes on a same vertical line, anterior margin of upper eye closely approaches to dorsal edge of head. Openings of nostril on left side closely set in front of lower part of upper eye, anterior one more or less tubular, posterior one not tubular; those on right side below origin of dorsal fin.

Mouth very small, about as long as or a little shorter than eye diameter, maxillary extending below anterior margin of lower eye. Teeth small, pointed, in bands, entirely confined to right side of jaws. Gillrakers 2～3+6～8, rather short and slender, those on upper limb much shorter and slenderer than those on lower limb.

Scales very small and deciduous, cycloid on both sides, snout and jaws naked. Lateral line developed on left side only, with a strong curve anteriorly, length of curve portion a little shorter than half length of head.

Dorsal fin originating on right side in front of middle part of upper eye; 1st two spinous rays detached from remainder of fin, 1st very short, about as long as half length of eye diameter, 2nd with broad and heavy base longer than 1st, equal to about 2/3 eye diameter; remaining rays much shorter than in former stage. Anal fin starting below vertical through base of pectoral fin. Pectoral fin rather short, unequal in size, a little longer on left side than on right side, with unbranched rays. Pelvic fin on left side originating at vertical through posterior margin of lower eye, rays as well as base longer than those on right side; 4th ray opposite 1st on right side; last ray approaching origin of anal fin. Caudal fin slender and elongate, subequal to head length, uppermost and lowermost 2 or 3 rays simple, others branched.

Anus opens on mid-ventral line of body and in front of origin of anal fin. Genital papilla displaced on left side, and above anus.

Color in formalin: general ground color yellowish white with a series of traces of dark blotches running along dorsal and ventral

margins of body, snout and jaws dark; vertical and pelvic fins on left side blackish distally; no pigmentation is observed on right side.

## Discussion

Postlarvae of sinistral flounders are remarkably diverse and unlike their adult so that it is often not an easy task to identify them. However, a reasonably complete picture to the development and a combination of the meristic characters are recognized to be of great value in correlating of larvae with their adults.

The present postlarvae and juveniles are clearly referable to the family Bothidae, for they are sinistral and have the anterior rays of pelvic fin on the left side located well in advance of the first ray of that on the right side. The family Bothidae, one of the larger families of flounders, contains many genera. These present postlarvae and juveniles have meristic characters having high value: dorsal fin 0– II, 111, anal fin 86–90, and vertebrae including urostyle counted as one 12+41=53. On the combination of the characters with special emphasis of 12 abdominal vertebrae, the present larval and juvenile specimens fit only one genus *Laeops* among many genera that occur in Japanese water (Amaoka, 1969 : 294).

A larva of the genus *Laeops* has already been described and figured by Hubbs and Chu (1934) with identification as *Laeops parviceps* Günther, measuring 71 mm in standard length, collected at the surface of the sea off Sipadan Island, near Tawao, Borneo, on December 17, 1931, with which the present larvae at the early metamorphic stage agree well in the number of dorsal and anal fin rays, general morphology and coloration. Since *Laeops parviceps* has been reported from Arafura Sea, East Indies, the author needs to search species of this genus that would possibly occur around Japan.

According to Norman (1934) and Matsubara (1955), there are four species of this genus around Japan: *Laeops nigromaculatus* Von Bonde, *L. kitaharae* (Smith and Pope), *L. lanceolata* Franz, and *L. variegata* Franz. However, as suggested by Hubbs (1915) and Norman (1931, 1934: 260) and shown by Amaoka (1969 : 208), the latter two species reported from Japan are considered to be conspecific. In the attempt of the specific identification, the meristic characters of the present postlarvae and juveniles described above, do not agree with those of *L. nigromaculatus* (dorsal fin rays 100–103; anal fin rays 82–83; vertebrae including urostyle 12+37=49), but agree well with those of *L. kitaharae* (dorsal fin rays 105–114; anal fin rays 85–93; vertebrae including urostyle 12+39−41=51−53). Also, the former species occurs rarely in Japanese waters whereas the latter is abundant. The author therefore reached the conclusion that the present larval and juvenile specimens should be identified as *Laeops kitaharae*.

The present larvae at the late metamorphic stage, measuring 100–108 mm in total length (85–92 mm in standard length),—they are characterized in having the right eye finished its migration, the slit above upper eye entirely touching the ethmoid region, the first ray greatly produced, median fins elongated as a whole, and slight extension of intestinal coil beyond body—correspond to an illustrated specimen of 4 syntypes firstly described and figured by Franz as *L. variegata*, and to 2 syntypes (77 and 92 mm in total length) re-examined by Norman (1931, 1934). On the other hand, the present specimens at the juvenile stage, measuring 102–105 mm in total length (87–91 mm in standard length)—they are characterized in having small body size, small eye, 4.61–5.0 in head (although becoming larger than that in the earlier stage), the first two rays being very short and separated from other rays, median fin rays not elongated as a whole, and the intestinal coil not produced—correspond also to specimens (80–90 mm in total length) described and figured by Franz as *L. lanceolata*, and to 5 syntype specimens (77–87 mm in total length) by Norman (1931, 1934). It, therefore, is highly probable that *L. variegata*

and *L. lanceolata* represent the postlarval and juvenile stages of *L. kitaharae*, respectively.

The postlarvae of the present species grow to a great size, the migration of the eye taking place at about 80–90 mm in standard length.

It is interesting to note here that most specimens of series of developmental stages were collected from several localities during the period from end of March to early of April, but that two specimens at the middle metamorphic stage, measuring 72–74 mm in standard length, collected from Owase, Mie Prefecture, were caught in early October, and were much smaller in body size than other specimens at the same stage which measuring 84–90 mm in standard length.

With respect to the extension of the convoluted intestinal coil beyond body, Franz (1910) suggested baselessly that this condition might be an artifact or as a result of a crush. Hubbs and Chu (1934), on the other hand, calls it a normal postlarval hernia related to the tremendous reduction of the coelom, which is not large enough to contain the required length of intestine. Throughout the present examination of the different stages, it is clearly considered to be normal condition because of the produced intestine and liver gradually putting into the abdominal cavity as developmental stage advances. The normal larval hernia of fishes were also observed in *Stylophthalmus macrentelon* (=young specimens of genus *Idiacanthus*) of the family Stomiatidae, which has a greatly produced intestine (Regan, 1916), and in *Chascanopsetta lugubris* of the family Bothidae which has a widely expanded intestine and liver, (Amaoka, 1971), etc. Uchida's (1937) suggestion that the process on body of larval form including the enlarged fin rays might be used as floating organ, even if it does not develop originally to serve its purpose, is fully recognized on the basis of the judgement from the larval life. It is of interest to note here how the living larva is floating and swimming in the water. The present smaller postlarva at the early metamorphic stage was taken near the coast in the inlet bay of Tsushima Island by Mr. Norihiko Utaguchi. It was observed by him that the translucent larva with a long dorsal spine was floating at horizontal position in the surface of water, and swimming leisurely just like a jellyfish among floating seaweeds. It, therefore, may be considered that the special shape of the larva has played an important role in floating life.

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## ヒラメ類の稚仔魚の研究—III. ヤリガレイ

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日本近海の各地から採集された 15 個体のダルマガレイ科(Bothidae)の後期仔魚および稚魚を調査した結果，これらは背鰭条数 (II, 111–0, 111)，臀鰭条数 (86–91) および脊椎骨数 (12+41=53) などの形質からヤリガレイ *Laeops kitaharae* (Smith and Pope) に同定された．後期仔魚は変態初期，中期および後期の 3 段階に分けられた．なお，本種の変態中の仔魚は本科魚類の中では比較的に大きく，約 80–90 mm であると推定される．

日本近海から Franz (1910) によって報告された本属の *L. variegata* および *L. lanceolata* は本種の異名で，前者は変態後期，後者は稚魚期に相当する．

本種の後期仔魚は体が大型 (70–92 mm) で，背鰭第 2 棘が著しく伸長し，背鰭や臀鰭の各軟条が長く，腸と肝臓が腹方に突出することで，特長づけられる．体外に突出した腸および肝臓は発育が進むにつれて体内に引き入れられるとみなされるので，変態中のこの特異現象は病的でなく正常な状態で発現するものと思われる．

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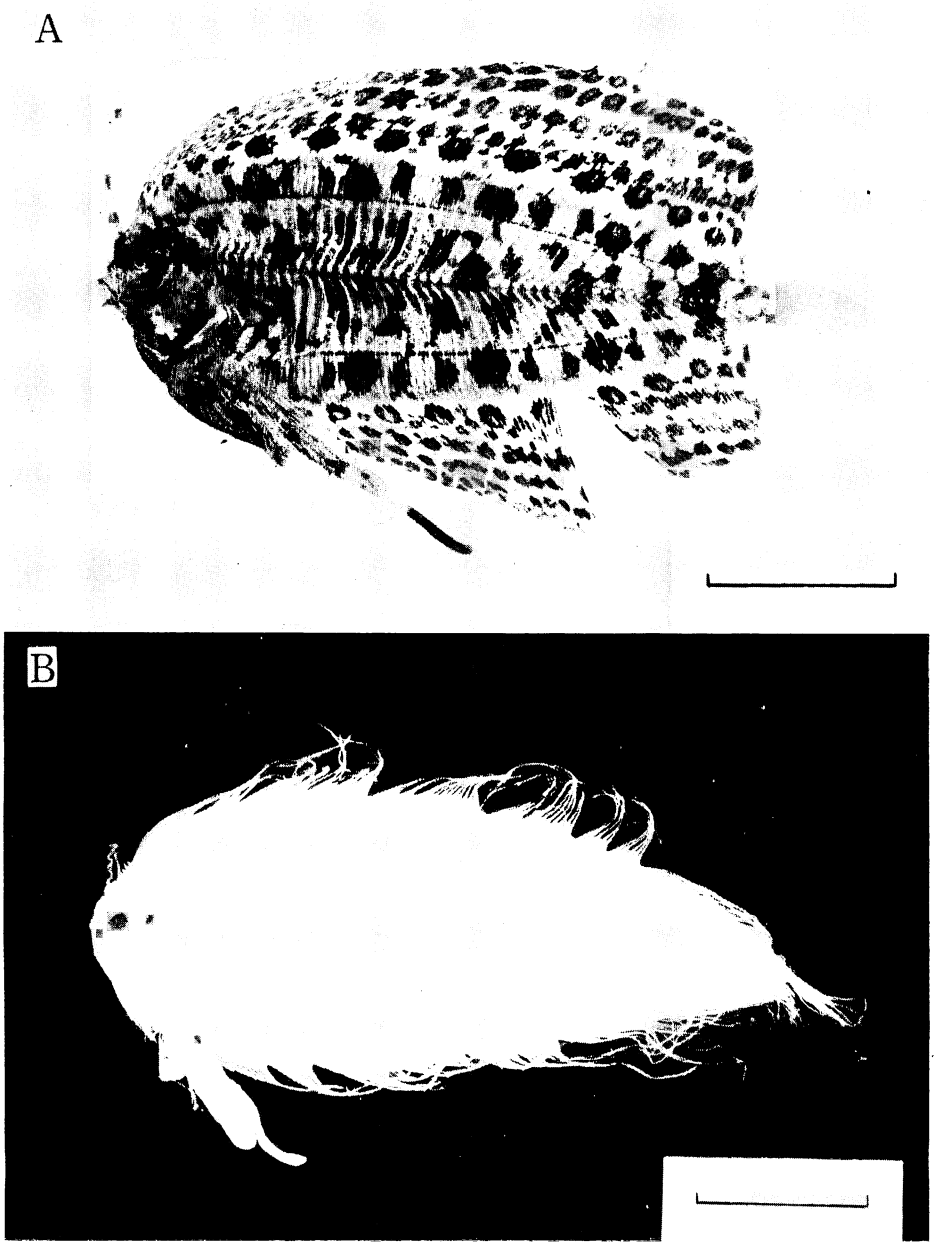


Fig. 5. Postlarvae of *Laeops kitaharae* (Smith and Pope) in early metamorphic stage. Each scale indicates 20 mm. A. 70 mm in standard length, collected from Tsushima Island. (SUF '67-A-1). B. 79 mm in standard length, collected from Manazuru, Kanagawa Prefecture. (ABE '60-371).

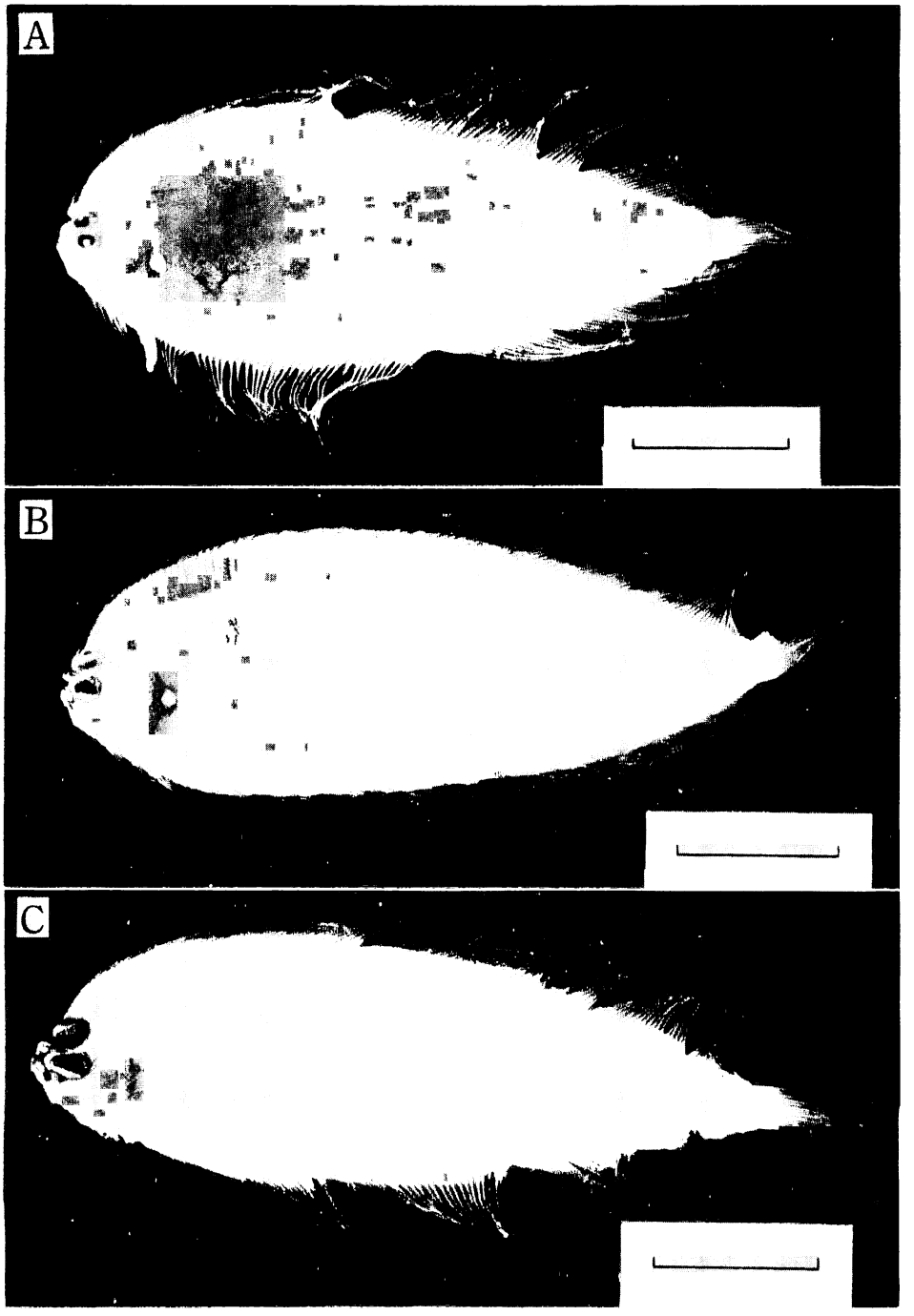


Fig. 6. Two postlarvae and a juvenile of *Laeops kitaharae* (Smith and Pope). Each scale indicates 20 mm. A. Postlarva in middle metamorphic stage, 84 mm in standard length, collected from Miya, Aichi Prefecture (FAKU 42579). B. Postlarva in late metamorphic stage, 92 mm in standard length, collected from Miya, Aichi Prefecture (FAKU 42581). C. Juvenile 91 mm in standard length, collected from Mimase, Kochi Prefecture (FAKU 42576).