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Studies on the Larvae and Juveniles of the Sinistral Flounders—II. *Chascanopsetta lugubris**

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Abstract Three postlarvae of the family Bothidae certainly identified as *Chascanopsetta lugubris* Alcock were obtained from the southwestern area of Japan. They have the following characteristic features: immense size (34 to 120 mm in standard length), elongate second dorsal spine, high dorsal and anal fins, greatly elongate and tapering posterior process of the pelvic bone, the expansion of the intestinal coil beyond the body, and a great number of dorsal and anal fin rays and vertebrae. The species metamorphoses at about 121 to 125 mm in standard length. The relative growth before and after the metamorphic stages, which was observed among several body parts, is divided into two types. The depth of body and the longest dorsal ray make a sudden degression, while the head length, the eye diameter, the pectoral fin length, and the maxillary length show remarkable growth. Probably, the largest of the present specimens, measuring 120 mm in standard length, 135 mm in total length, is the largest larval flounder ever recorded.

Introduction

In the course of studying the larvae and juveniles of the sinistral flounders, the author recently examined three large postlarvae of the family Bothidae obtained from the southwestern area of Japan. As the result of a detailed study, the author positively identified them as *Chascanopsetta lugubris* Alcock (1894), on the basis of the meristic characters. This species, which is widely distributed in the Indo-Pacific Ocean, as well as throughout the Atlantic, is a rather deep-sea inhabitant as indicated by its very large mouth and flexible body. It is a peculiar member of the genera of the family Bothidae (Amaoka, 1969).

A postlarva of this species measuring 46 mm in total length, taken from the Atlantic Ocean, was first reported by Kyle (1913) as an unidentified species. Afterwards, Bruun (1937) identified and described four postlarvae taken in Molucca Passage, at the north point of Sumatra and at the north and south ends of Madagascar, as *Chascanopsetta lugubris*, although the largest of these specimens was later (Nielsen, 1961a) referred to *C. galatheae*.

The author has here given a detailed description of the present postlarvae, and has discussed the metamorphic size and the relative growth during the period before and after the metamorphic stages, by examination of many juveniles, young, and adults of this species taken from Japanese coasts.

Materials and methods

The three postlarvae treated in the present study were taken from the southwestern area of Japan by the training ship "Tenyo-maru" of Shimonoseki University of Fisheries on July 14 and 15, 1966 (Fig. 1), and have been deposited in the Department of Biology and Aquiculture, Shimonoseki University of Fisheries. The midwater trawl for fish larvae, pentagonal and pyramidal in shape, 8 meters in length, and 9.1 square meters in its mouth, has been used in the sampling. The details of the sampling data are summarized in Table 1.

The juvenile and young specimens studied

* Contribution from the Shimonoseki University of Fisheries, No. 606.

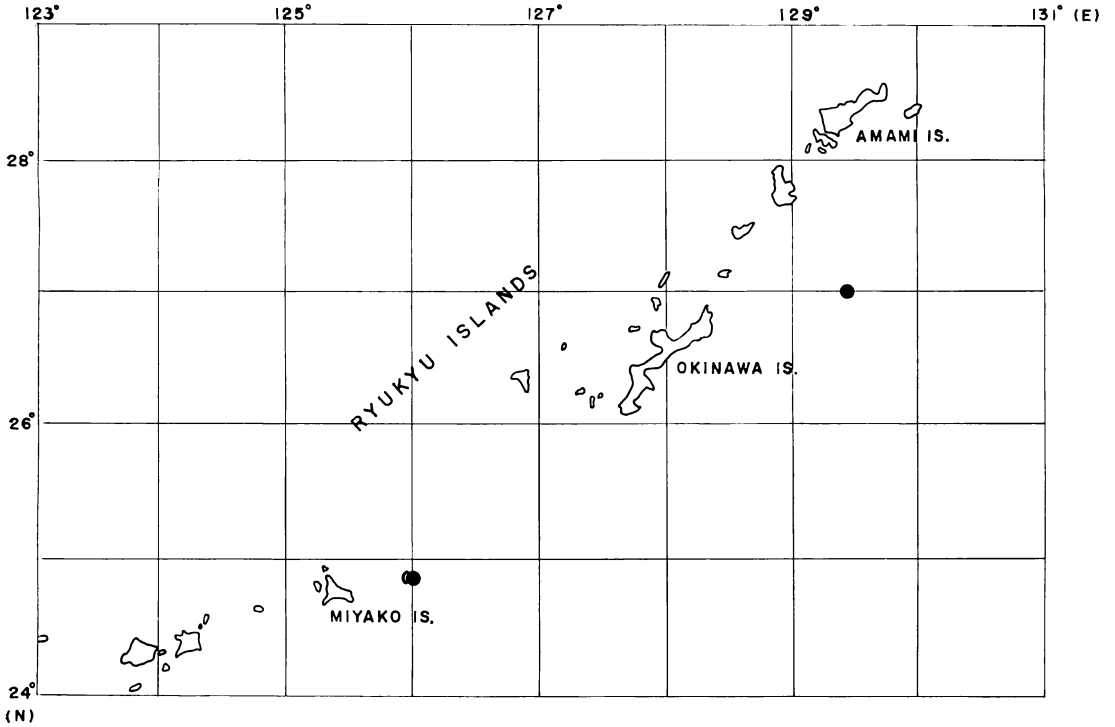

Fig. 1. Sampling stations where three postlarvae of *Chascanopsetta lugubris* were obtained.

Table 1. The sampling data at three stations where three postlarvae of *Chascanopsetta lugubris* were obtained.

Specimen No.	K-7-1	K-11-1	K-6-1
Date	July 14, 1966	July 14, 1966	July 15, 1966
Time	19.42-20.15	20.45-21.15	20.40-21.10
Latitude (N)	24°53.0′	24°52.5′	27°00′
Longitude (E)	125°59.0′	125°56.8′	129°26.5′
Wire length (m)	120	70	65
Towing depth (m)	67.5	40	31
Towing speed (knot)	2.0	1.5	1.65
Depth of bottom (echo) (m)	651	814	2910
Temperature (surface) (°C)	26.8	26.8	27.2

by the author for relative growth were mostly obtained at the following fish markets located near the fishing ground (about 100 to 300 m in depth) where the trawling is conducted, during the period from 1938 to 1959: Heta, Shizuoka Prefecture; Miya, Aichi Prefecture; Mimase and Urado, Kochi Prefecture; and Owase, Mie Prefecture. The data for juvenile and young specimens of *Chascanopsetta lugubris* have been shown by Amaoka (1969).

The counts and measurements of body parts have been made in accordance with the method used by Norman (1934).

Three specimens (SUF Nos. K-7-1, K-11-1, K-6-1), 34 to 120 mm in standard length (39 to 135 mm in total length), are described in detail below (Pl. 4, A-C), and the largest specimen is figured (Fig. 2).

Description of postlarvae

Counts and proportional measurements of body parts in three specimens are shown in Table 2.

Body much elongate with a remarkable expansion at the abdominal region, highest near the anterior 1/4 of body; depth about half length of body, and very thin. The dorsal contour with a deep notch in front of eye, steeply rising above the eye, and then gently arching or almost horizontally descending to caudal base; the ventral contour, apart from the expansion of the abdominal region, similar to dorsal contour in shape. Caudal peduncle very narrow, about 1/7 depth of body.

Head very small, about 1/4 depth of body. Snout rather long, about twice of eye diameter; the distance between the tip of snout and the origin of dorsal rather long, about 3 times as long as eye diameter. Eyes situated asymmetrically on each side of body; the right eye located slightly above the left, little popped-out and directed slightly outwards. Nostrils on the left side closely set each other, immediately before the eye, and very small; the anterior nostril with a rudimentary tube; the posterior one not tubular and close to the anterior rim of eye; those on the right side almost symmetrical in position, similar in shape and structure to those on the left.

Mouth oblique, almost symmetrical, the lower jaw slightly projecting beyond tip of the upper jaw when the mouth is closed. Maxillary directed downwards, and not extending to vertical of the anterior margin of eye. Teeth not yet discernible.

Scales and lateral line not visible.

Dorsal fin originating in the notched region above snout; the rays well produced, becoming higher towards near middle part of body, and evenly decreasing in height posteriorly, the longest ray much longer than head length; the first spine very short, the second with broad base and strong, more elongate, much longer than anterior rays of the dorsal fin, though slightly mutilated on its extremity in the largest specimen. Anal fin starts on the anterior 1/3 of body, similar to dorsal in shape and structure. Pectoral fin symmetrical, fan-like in shape, with a heavy peduncle at base and 17 obscure rays surrounded by thin transparent membrane. Pelvic fins well developed on both sides of body, asymmetrical

Table 2. Counts and proportional measurements of body parts in three postlarvae of *Chascanopsetta lugubris*.

Specimen No.	K-7-1	K-11-1	K-6-1
Total length (mm)	135	87	39
Standard length (mm)	120	78	34
In standard length			
Depth of body	2.44	2.13	1.87
Head length	8.06	7.02	5.85
In head length			
Snout	3.10	2.52	3.75
Eye diameter	7.85	5.25	6.52
Maxillary	3.31	2.90	3.87
Lower jaw	2.52	2.14	2.66
Depth of caudal peduncle	1.88	1.90	2.41
Longest dorsal ray	0.61	0.65	0.78
Longest anal ray	0.61	0.66	0.74
Second dorsal spine	——	0.52	0.82
Pectoral fin	1.86	3.90	4.50
Dorsal fin rays	118	120	111
Anal fin rays	82	82	79
Vertebrae including urostyle	16+39=55	16+38=54	16+38=54

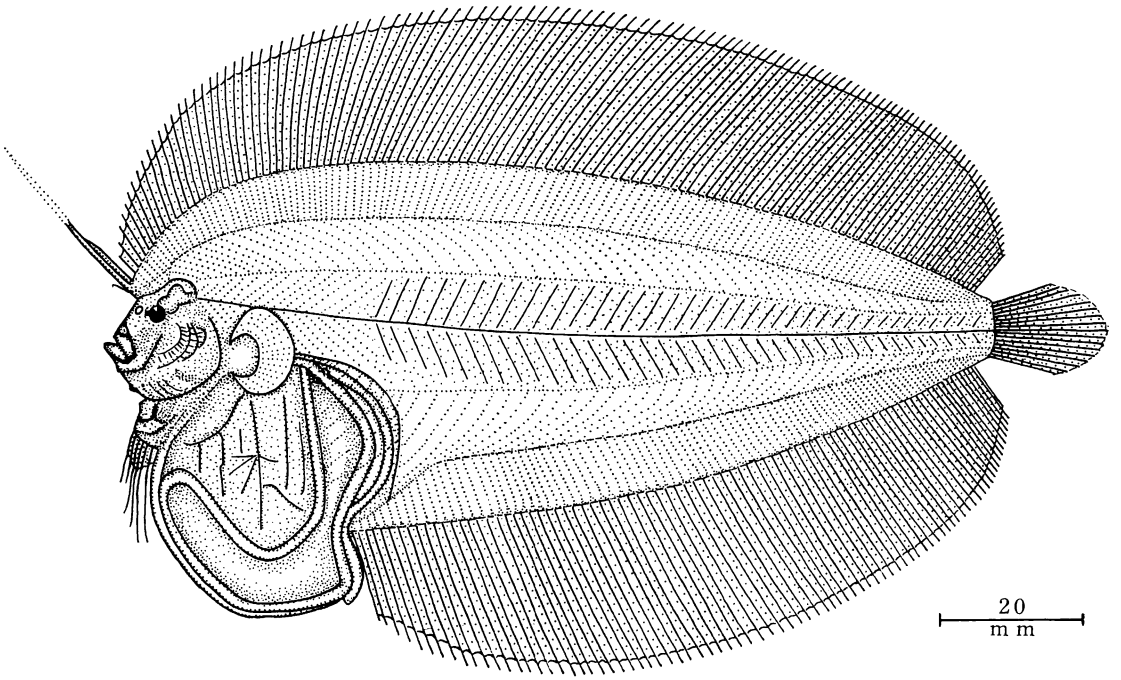

Fig. 2. Postlarva of *Chascanopsetta lugubris* in early metamorphic stage, 120 mm in standard length.

in position and in shape, immediately below eye, remarkably separated from the anal origin; the first ray on the right side opposite the second ray on the left side. Caudal fin rounded posteriorly.

Urohyal fishhook-like in shape and entirely smooth, its main part covered by branchiostegal membrane, but most of the sciatic part exposed to view on the pelvic bone.

Pelvic bone well developed, and very asymmetrical in shape; each bone bifurcate in the lower region, the up-bent process of anterior part provided with six pelvic rays; the process of the posterior part elongate and tapering, extending near the anus, and running along the intestine at the ventral margin.

The liver and intestinal coil occupying a greater portion of the abdominal cavity and remarkably expanding outward between the pelvic fin and the origin of the anal fin. The esophagus, descending nearly straight along the dorsal wall of abdominal cavity, provided with small pyloric caeca above the origin of the anal fin, the stomach not prominent. The intestine, which descends subvertically along the posterior wall of abdominal cavity, turns to the front immediately before the anus, so that it rises near the pelvic fin, and thus turns back in a reverse direction to the front of the pyloric portion. It thus bends downward to the anus on the right side of pyloric portion. The anus greatly projecting below the origin of anal fin.

In formalin, general ground color yellowish white, with black eye and pinkish heart. There are a series of thin, continuous, black streaks along the bases of the interneural and interhaemal spines, and similar streaks along the dorsal and ventral margins of body between each ray of dorsal and anal fins on anterior 2/3 of body; no pigmentation anywhere else.

Remarks: The present three postlarvae are closely alike to each other in general physiognomy, counts, and pigmentation, but the difference of the relative growth occurs

in the following proportional measurements: depth of body and head length in standard length, and depth of caudal peduncle, length of dorsal fin, length of anal fin, and length of pectoral fin in head length (Table 2).

Relative growth during the metamorphic stage

Measurements of the three present post-larvae and the data of 21 specimens measuring 126 to 171 mm in standard length, hitherto examined by Amaoka (1969) are plotted on Fig. 3, which show the outline of external changes observed among several body parts, related to standard length, before and after metamorphosis. Abrupt shifting of two types occurs in the proportions of these body parts to standard length, before and after metamorphosis.

Some dimensions, the depth of body and the longest dorsal ray except for the second spine, makes a sudden degression during the stage, while other dimensions, the head length, eye diameter, length of the pectoral fin and length

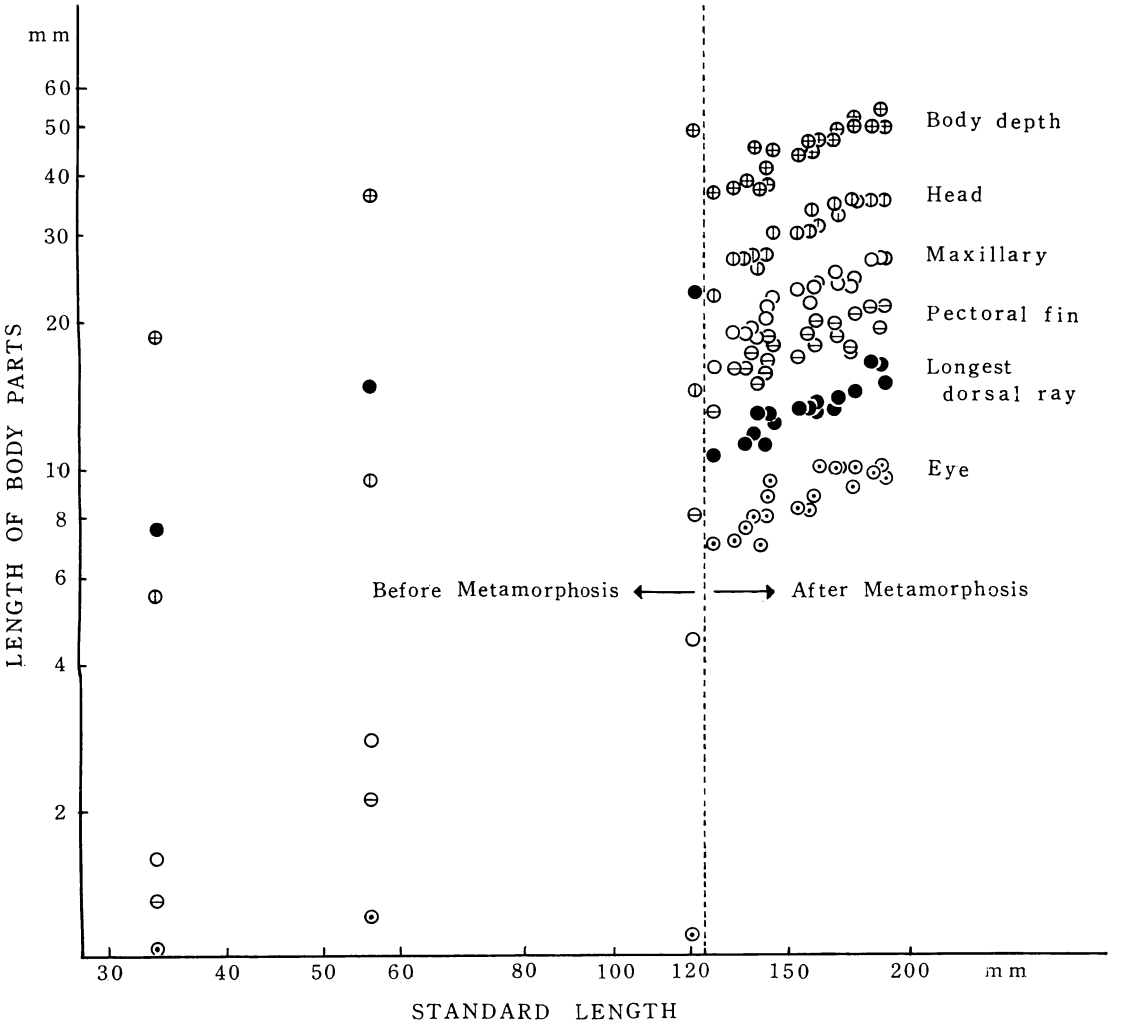

Fig. 3. Relation of body depth (⊕), head length (ⓘ), maxillary length (○), pectoral fin length (⊖), length of longest dorsal ray except for second elongate spine (●), and eye diameter (⊙), to standard length in *Chascanopsetta lugubris*.

of the maxillary, shows remarkable correlation to the standard length.

Discussion

The present postlarvae are remarkable for the large size, well-produced second dorsal spine, and the extension of the convoluted intestine beyond body. As the literature on postlarval Pleuronectiformes is very scarce and characters of the adult form develop in a very late stage, the identification of postlarvae in this group is in most cases extremely difficult. The present postlarvae are clearly referable to the family Bothidae, for they are sinistral—the right eye gradually migrating to the dorsal edge of the same side—and they have the base of the left pelvic fin elongate. They have the high number of dorsal and anal fin rays (111 to 120 and 79 to 82), and vertebrae (54 to 55), of which 16 is abdominal. The combination of meristic characters shown by the present postlarvae fits only one genus, *Chascanopsetta*.

In the literature, the author finds six species (as described in the Table by Nielsen, 1963) and two subspecies of this genus in all the waters of the world. They are *C. prorigera*, *C. prognathus*, *C. galatheae*, *C. microstoma*, *C. normani*, *C. lugubris lugubris*, and *C. lugubris danae*, though it seems very probable that many of these species will eventually be referred to one species upon the examination of many specimens. Among these species the first five, having fin-ray counts slightly higher than those of the present specimens, will probably be eliminated from the present discussion. The subspecies *C. lugubris danae*, proposed by Bruun (1937) as the name for the first form of *Chascanopsetta* known from the Atlantic Ocean, can hardly be distinguished from *C. lugubris lugubris* in many characters.

Finally, the author concluded that the specimens can be identified as *Chascanopsetta lugubris*.

The larval *Chascanopsetta* has already been described and figured by Kyle (1913) from the West Atlantic, but he naturally could not identify it with any known Atlantic flatfish. After adult specimens of *Chascanopsetta lugubris* were reported from the Atlantic Ocean by Bruun (1937), Cadenat (1937), Deubler and Rathjen (1958), Poll (1959), and Nielsen (1961b), the question was decisively solved. In 1937, Bruun also referred to four postlarvae of *C. lugubris*, collected from the Molucca Passage, at north points of Sumatra and at the north and south ends of Madagascar, the largest of them, from south end of Madagascar, was later (Nielsen, 1961a) referred to *C. galatheae* Nielsen.

The present postlarvae are closely allied to the specimens of Bruun in general body form and in meristic characters. As for the pigmentation, the larvae, having a series of black streaks running along both dorsal and ventral contours of body and along the bases of interneural and interhaemal spines, are similar to specimens described by Kyle (1913) and Bruun (1937). However, such beautiful pigmentation as silvery white, rose-colored sheen, and yellow, recorded in detail by Bruun, has not been observed in the larvae. It is probable that most of the pigmentation, especially yellow, disappeared after a short period of preservation.

It is said that the postlarvae of Pleuronectiformes become greater in size than those of other fishes; this is especially remarkable in the fishes of the family Bothidae.

Probably, the present specimen, measuring 120 mm in standard length (135 mm in total length), is the largest larval flounder of the family Bothidae ever recorded. Until now the records of large larval specimens of flounder were collected from the Philippine Sea, measuring 91 mm in standard length, described by Nielsen (1963) as *Kamoharaia megastoma* (Kamohara); from Madagascar, 78 mm, by Bruun (1937) as *Chascanopsetta lugubris* Alcock; and from off Sipadan Island (Borneo), 70.5 mm, by Hubbs and Chu (1934) as *Laeops parviceps* (Günther).

The smallest specimen completely metamorphosed, measuring 126 mm in standard length, has been examined by the author; the largest larval specimen, 120 mm in standard length, is still a little far from metamorphosis. Therefore, it appears that the migration of the eye takes place at about 121 to 125 mm in standard length—at the largest size of any known bothid flounder. However, it seems probable that the length at metamorphosis varies greatly and that the fish does not increase or decrease in size during metamorphosis.

There is a remarkable change in the proportions of body parts during metamorphosis, which is divided into two types as noted above. The first type is found in the depth of body and the longest anal ray as the longest dorsal ray shows a sudden degression. The other type is found in the head length, the eye diameter, the length of the pectoral fin, and the length of the maxillary, which show a sudden ascension. In the former case, the remarkable growth before metamorphosis may be closely related to larval adaptation to pelagic life, and is probably of very long duration. Possibly these characters are developed as floating organs to resist sinking, as already described by Uchida (1937). In the latter case, the abrupt shifting may be coincident with the transition period of food, and the benthonic life taking the place of the floating life of the larval stage. The fish, which has hitherto passively taken the plankton during the postlarval stage, actively takes such food as polychaets, fishes, and other animals after metamorphosis. It may be that this shifting of the growth of each organ is advantageous for benthonic and predatory life.

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(Department of Biology and Aquiculture, Shimonoseki University of Fisheries, Yoshimi, Shimonoseki, Japan).

ヒラメ類の稚仔魚の研究—II. ザラガレイ

尼岡邦夫

日本の南西海域から中層びきの仔魚網によって採集された大型のヒラメ類後期仔魚3尾を調査した．これらの仔魚は著しく大型（標準体長 34–120 mm）であること，伸長した第2背鰭棘，背鰭軟条および臀鰭軟条をそなえること，体外に突出した腸をもつこと，および著しく多くの背鰭軟条（111–120），臀鰭軟条（79–82），脊椎骨（16+38–39=54–55）をもつことなどの特徴で，ダルマガレイ科（Bothidae）の他の種類の仔魚から明らかに区別され，ザラガレイ（*Chascanopsetta lugubris*）に同定される．この種類の変態完了体長は121–125 mm であると推定され，120 mm の後期仔魚は今までに報告されたヒラメ類の中では最大のものである．

変態期前後の仔魚の体長に対する体各部の相対成長に2型が認められる．体高，背鰭軟条長および臀鰭軟条長はこの期を境にして急激に減少する．一方，頭長，眼径，胸鰭長および上顎長などは著しく増大する．前者は浮遊生活への適応に，後者は食性の転換および底生生活への適応に関係していると考えられる．

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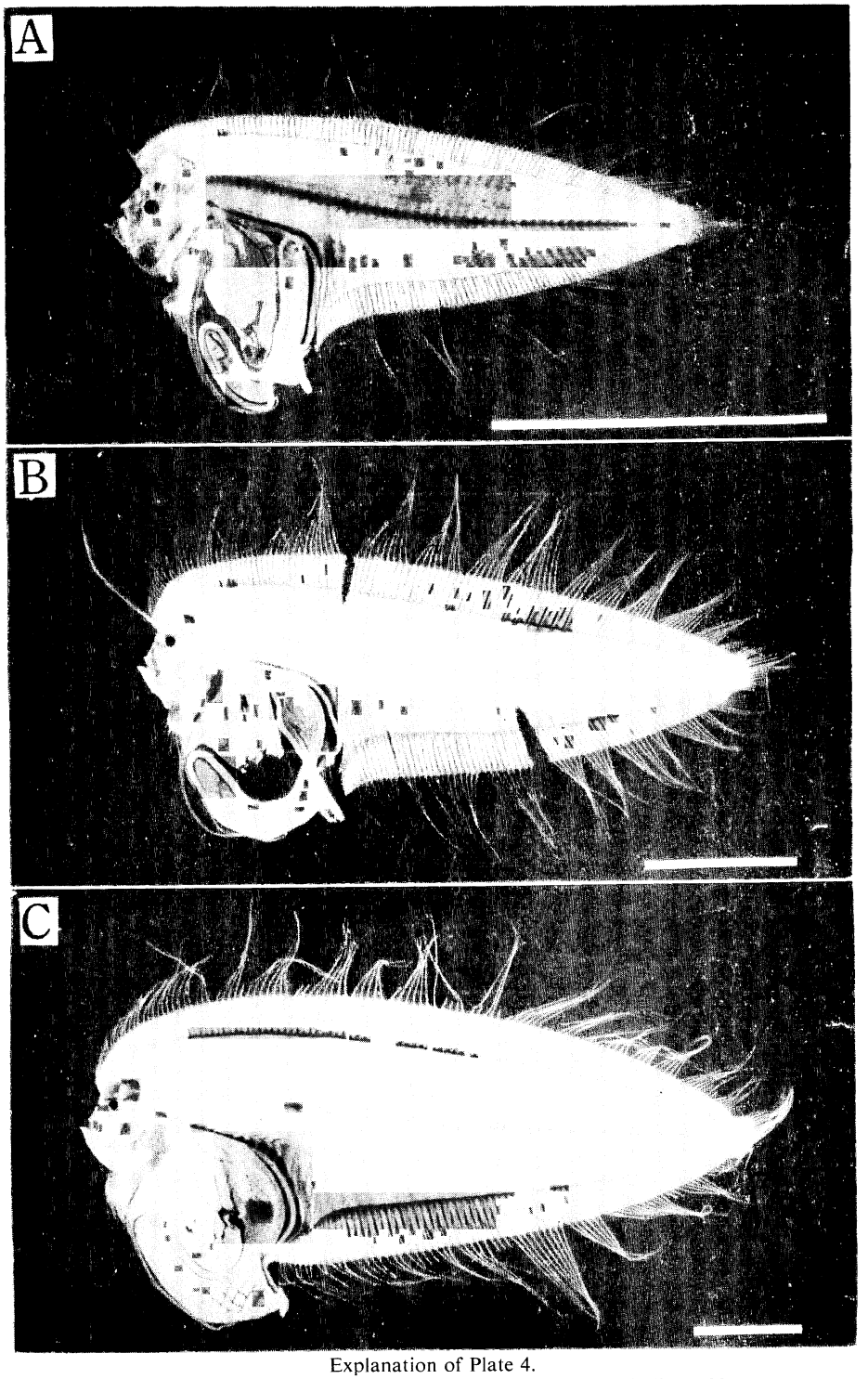

Explanation of Plate 4.

Photographs of three postlarvae of *Chascanopsetta lugubris*. Scales indicate 20 mm.

A. Specimen (K–6–1), 34 mm in standard length, collected at 27°00′N, 129°26.5′E.
B. Specimen (K–11–1), 78 mm in standard length, collected at 24°52.5′N, 125°56.8′E.
C. Specimen (K–7–1), 120 mm in standard length, collected at 24°53.0′N, 125°59.0′E.