Anguillid Leptocephalus Found in the Japan Current and its Adjacent Waters*

By

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Introduction

The record on the larva of *Anguilla japonica* was made by UCHIDA (1935) and MATSUI (1957). But BRUUN (1937) objected to the UCHIDA's specimen, described that the larva must be referred to Muraena or its allied genus, and pointed out such characters, as the pigmentation above the brain, rounded tail and others. JESPERSEN (1942) agreed to his opinion, too. On the other hand, numerals of myomere in ano-dorsal space, pectoral fin rays and renal portal vein at level of myomere in MATSUI's specimen were found to be a subject of controversy.

At the beginning of Nov. 1967, Training ship M. S. Tenyō Maru, the Shimonoseki University of Fisheries made a research in the Japan Current waters, and on the 8th of Nov. 1967, we collected more than ten species of apodal leptocephali and one specimen probably referable to genus *Anguilla* on the spot of N. 21°40.5′, E.121° 08.5′ with the 10 ft ISAACS mid-water trawl. On the latter, accordingly, the authors described some knowledge through a morphological observation on the basis of the previous studies.

Before discussing this subject, we must express here our thanks to Prof. Dr. N. SASAKI of the Shimonoseki University of Fisheries, lst mate S. TAWARA, 2nd mate K. UCHIDA and all crews of the Tenyō Maru, for their kind co-operation given to us through the collection of larvae. And thanks are also due to Mr. T. KURITA, Mr. M. NAKAMURA and Mr. T. YOSHIOKA, for their helpful assistance in carrying out the morphological experiments.

Material and Methods

The specimen used in the present study was caught in the station shown by the double circle in Fig. 1. This station is among the course of the fisheries oceanographic survey in the Japan Current and its adjacent waters which was made by the training ship, Tenyō Maru. The counts and measurements of various parts of body were indicated by the same methods as those used in *Anguilla* leptocephali in the

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Indo-Pacific waters by JESPERSEN (1942) and CASTLE (1963); moreover, on the identification of species, we used the above-noted reports, while on the meristic characteristics, the present specimen was compared with our identified "*Anguilla japonica*".

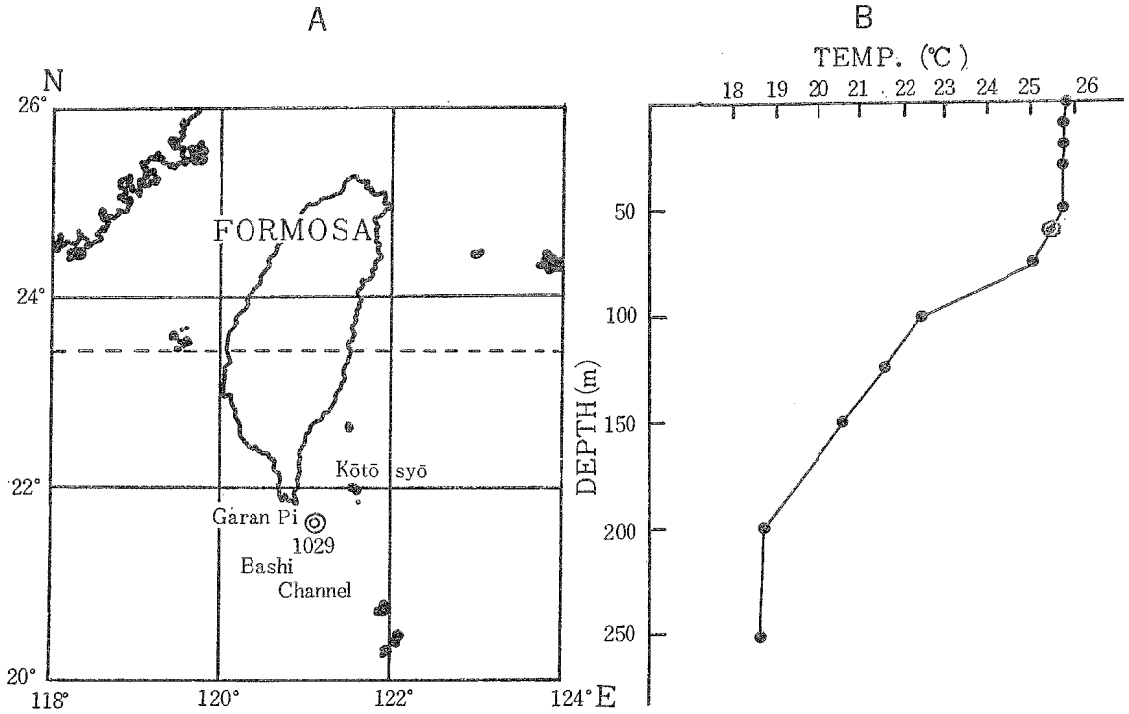

Fig. 1. A : The chart shows sampling station (◎) ; B : vertical distribution of temperature (0—250 m) at the sampling station. Numeral in chart, depth of sea (m).

Description

Measurements in mm: total length 53.5, standard length 52.6, head 4.2, snout 1.0, eye 1.1, upper jaw 1.9, postorbital 2.2, pectoral 1.4, preanal 39.1, predorsal 34.9, depth just before eye 1.8, depth at pectoral origin 3.2, depth at midpoint between pectoral and vent 8.4, depth at anal origin 8.4. Branchiostegal rays not obvious, pectoral rays 18, dorsal rays before level of vent 81, total rays 243, lst dorsal ray at level of myomeres 66, anal rays 207, caudal rays 2+2+2+2+1. Teeth $\frac{1+1+VI+12}{1+VII+7}$. Myomeres 75+40=115, a-d 8, lst vertical blood vessel at 18, 2nd at 28, 3rd at 40, 4th at 44 myomeres, anterior margin of gall-bladder at level at 31 myomeres.

Body moderately elongate, much compressed but relatively deep, with the maximum depth contained about 5.6 times in total length; tapering about equally in front of and behind the mid point of the body. Head short, about one-thirteenth of total length, head region differentiated from the trunk, snout short, not acute, about one-fourth of head length, its dorsal profile convex; anterior and posterior nostrils

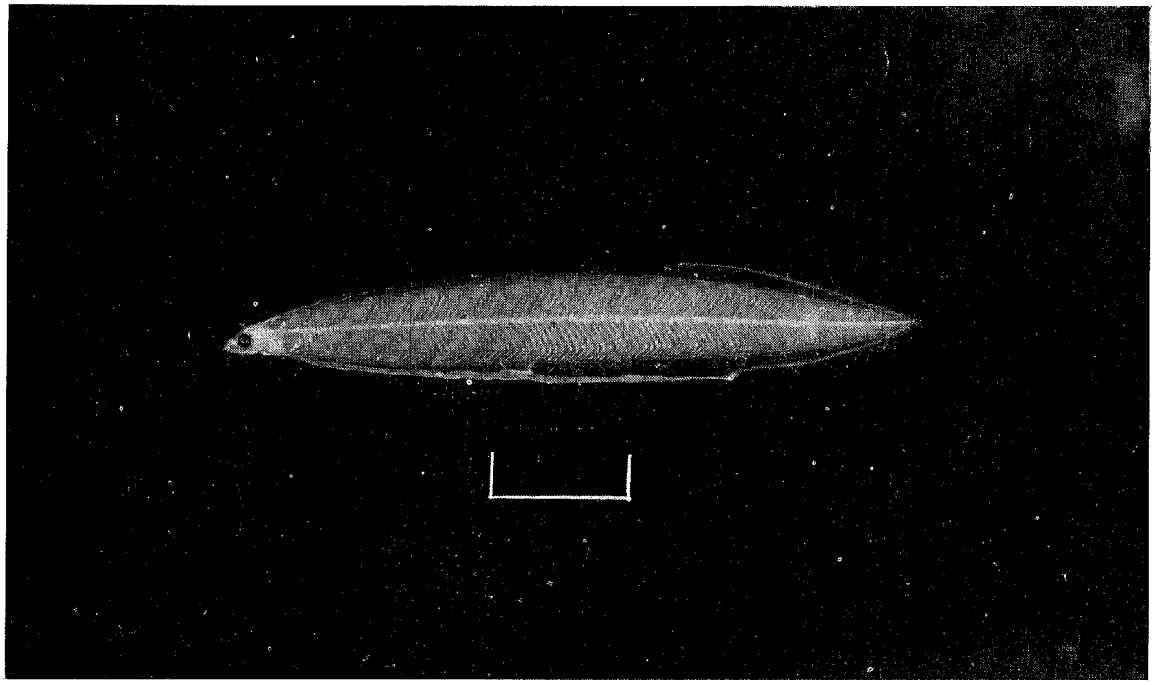

Fig. 2. Photograph of the specimen. 53.5 mm long. scale in 10 mm.

Table 1. proportional measuremnts of body in three long-finned species in *Anguilla* (CASTLE, 1963) and present specimen.

Species / Items	L. *Anguilla megastoma*	L. *Anguilla marmorata* or L. *Anguilla reinhardti*	Specimen
Total length (TL)	26.4(23.7)	39.2(27.3-43.6)	53.5
Head length (HL)	2.7(2.7)	3.8(3.1- 4.0)	4.2
Snout length (SL)	0.9(0.9)	1.2(1.1- 1.7)	1.0
Eye diameter (ED)	0.5(0.6)	0.8(0.9- 1.0)	1.1
Depth at midpoint between pectoral and vent (DL)	4.6(4.2)	8.6(5.0- 8.8)	8.4
Length of upper jaw	1.0(1.0)	1.9(1.4- 2.1)	1.9
Length of postorbital	1.3(1.2)	1.9(1.3- 2.0)	2.2
Length of pectoral fin	0.9(0.8)	0.9(0.6- 1.2)	1.4
Length of preanal	18.8(17.4)	30.9(21.3-33.6)	39.1
Length of predorsal	16.8(16.2)	25.8(19.6-31.1)	34.9
Depth just before eye	1.2(1.0)	1.7(1.5- 2.1)	1.8
Depth at pectoral fin origin	2.2(3.1)	3.4(2.4- 4.0)	3.2
Depth at anal fin origin	4.4(3.2)	6.8(4.1- 8.4)	8.4
TL/HL	9.8(8.8)	10.3	12.7
HL/SL	3.0(3.0)	3.2	4.2
TL/DL	5.7(5.6)	4.6	6.4
SL/ED	1.8(1.8)	1.5	0.9

Table 2. Meristic characteristics of various parts of body in present specimen and three long-finned species (data were cited from CASTLE, 1963).

Items \ Species	L. *Anguilla meggastoma*	L. *Anguilla marmorata* or L. *Anguilla reinhardti*	Specimen
Number of myomeres	111(114)	107(106,110)	115
Number of preanal myomeres	72	73	75
Number of myomeres in ano-dorsal distance	7(7)	9(8—9)	8
Vertical blood-vessels at level of myomeres	17,42,48	11(15-17),37 (37-39),43(43-44)	18(28),40,44
Gall bladder at level of myomeres	29	25(31)	31
First dorsal ray at level of myomeres	62	58	66
Dentition	$\frac{1+1+III+3}{1+III+2}$	$\frac{1+1+VI+10}{1+VII+3}$	$\frac{1+1+VI+12}{1+VII+6}$
Number of pectoral fin rays	—	—	18
Number of caudal fin rays	9 (2+2+2+2+1)	9 (3+2+2+2) 8 (2+2+2+2)	9 (2+2+2+2+1)
Number of dorsal fin rays	—	256(256—253)	247
Number of anal fin rays	—	200(183—225)	207

well separated, eye about equal to length of snout, oval shape; cleft of mouth oblique, extending to level middle of eye; teeth conspicuous, very acute, 18 in upper jaw projecting outside those of lower jaw which number 15 distributed as follows: first tooth of upper jaw small, needle-like, directed anteriorly and placed immediately above the second, much larger, anteriorly-directed grasping tooth; those two are followed by a series of six large teeth and a final series of 12 noticeably smaller teeth; lower teeth similar to those of upper jaw with the absence of the needle-like anterior tooth. Pectoral fin well developed, about 1.2 times diameter of eye, oval, base of fin fleshy.

Dorsal fin low, originating a few long distance in advance of the anal, with fin rays and radicals clearly visible. Anal fin similar. Caudal fin not greatly differentiated from the dorsal and anal and with well developed hypurals and fin rays. Colour in presentative translucent with black pigment restricted to the choroid of the eye.

Discussion

One of the above mentioned specimens has morphological characters shown by JESPERSEN (1942), CASTLE (1963) about leptocephalus of genus *Anguilla*, for instance, the number of myomeres in ano-dorsal space, the number of postanal myomeres, the existence of pectoral fin, the complete lack of pigments except choroid membrane of eyes, and the position of vertical blood vessels in myomere, above all, the first and last position, and forth.

On the number of myomeres in ano-dorsal space, JESPERSEN (1942) classified leptocephalus of genus *Anguilla* into two types according to the number of myomeres in ano-dorsal space; short-finned type under five, and long-finned type of six to ten. Measured by JESPERSEN's (1942) method, this specimen has eight myomeres, therefore, it belongs to the latter.

On the relative structure between myomeres and vertebrae, JESPERSEN (1942) reported that the number of vertebrae estimated by myomeres is the one which is deducated 1 from total myomeres. Therefore, the number of estimated vertebrae is 114, because there are 115 myomeres in this specimen.

According to JESPERSEN (1942), in the above-mentioned long-finned species in the eastern Indian and the Pacific Oceans, the number of vertebrae is as follow: *A. ancestralis* is 101-106, *A. interioris* is 104-107, *A. borneensis* is 103-108, *A. celebesensis* is 101-109, *A. marmorata* is 103-109, *A. reinhardti* is 104-110, *A. megastoma* is 108-110, *A. dieffenbachi* is 109-116, *A. japonica* is 112-119 and its average is 115.8.

Therefore, this specimen enters into the range of the latter three. *A. megastoma* and *A. dieffenbachi* are distributed around the southern hemisphere of the Pacific Ocean.

On the number of fin rays, pectoral and caudal fin rays are obvious; the former has 18 soft rays, and the latter 9. These fin rays are included into the variation of adult form of *A. japonica* counted by MATSUI and TAKAI (1959). As shown in Table 2, dorsal and anal fin rays number 248 and 207 respectively.

And the results obtained from 6 immature-grown *A. japonica* (total length in cm 32.1-58.5, the number of vertebrae 112-116) were as follows; the former 244-261, and the latter 219-237.

About this subject, FORD (1931), BERTIN (1956) and CASTLE (1962) state that those are less useful to identification because the fixed number doesn't appear in larvae of the early stages, although the number comes out immutably from fully-developed leptocephalus. The development of interspinous elements in anterior base of dorsal and anal fin rays of this specimen is still imperfect.

According to the growth stage given by SCHMIDT (1909) and STRUBBERG (1913), this specimen belongs to stage 1, judging from the shape of body, the position of anus, the proportion of depth to length, the developed condition of fins and the larval teeth.

Ege (1939) assumed that each size of fully-grown larvae of temperate species is 55-57 mm in *A. japonica* (Japan), and 62-64 mm in *A. dieffenbachi* (New Zealand). On the maximal length in developing stages, on the other hand, MATSUI (1952), judging from the monthly change of length of elver (glass eel), states that the growth curve in early stage of *A. japonica* relatively resembles that of *A. japonica* which is about 58 mm. From the above reports, this specimen will grow up about 5 mm or so until the full growth in developing stage and interspinous elements including dorsal and anal fins are completed during the time.

On the position of vertical intestinal blood-vessels at the myomere level, the

last one (renal portal vein) changes little in the developing and metamorphosing stages of leptocephalus. On the other hand, the posterior edge of kidney corresponds to the end of abdominal vertebrae in adult form, and renal portal vein also enters posterior part of kidney. From the above reason, meristic characteristics were illustrated on both the present specimen and the long-finned species (data cited from JESPERSEN and CASTLE) in Indo-Pacific waters as shown in Fig. 3. As the result, this specimen was closely set in the variational sphere of meristic constitution of

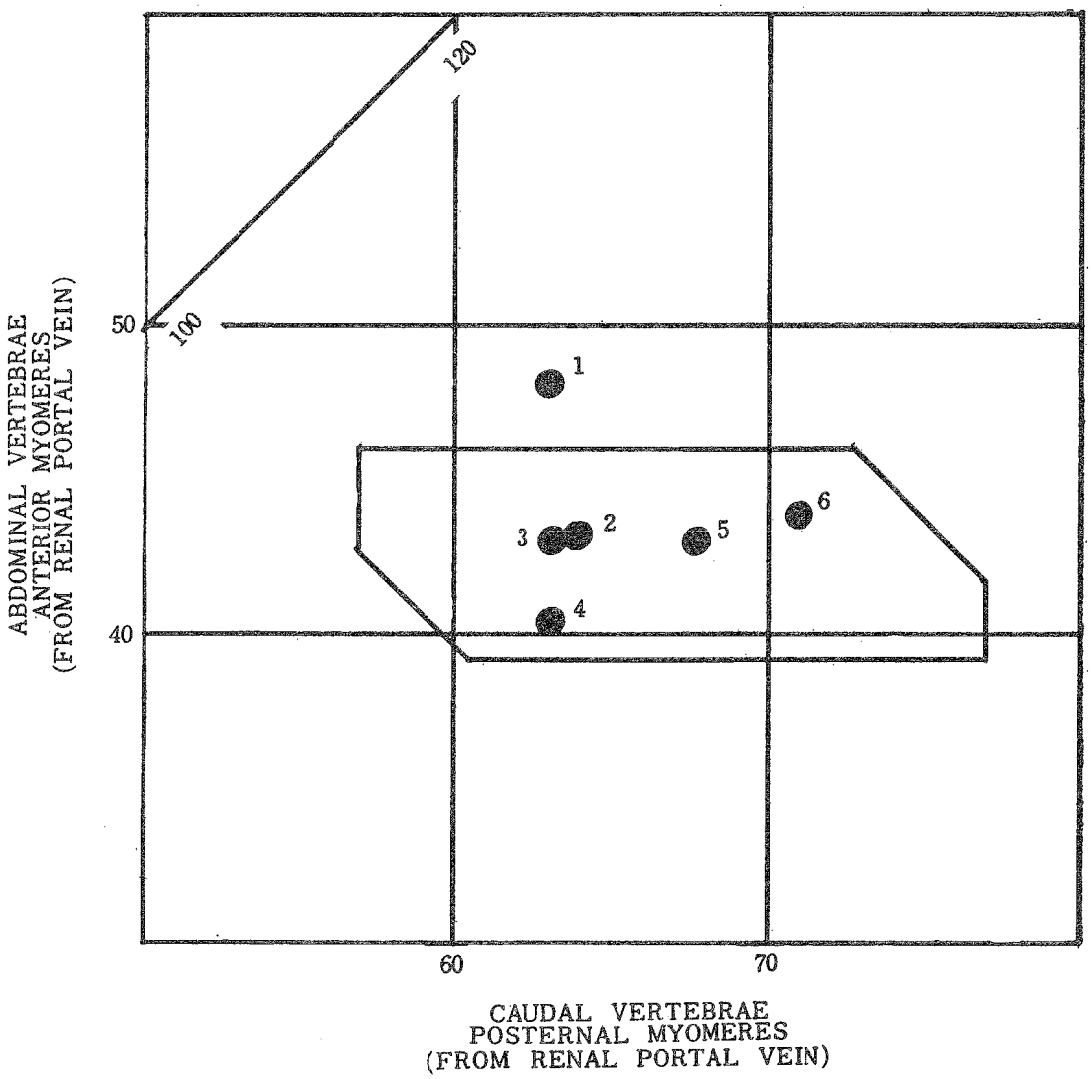

Fig. 3. Illustration of meristic characteristics of leptocephalus and adult form of Anguillid eels. The diagonal line indicates the total counts of meristic characteristics (leptocephalus, myomeres; adult form, vertebrae). The polygon shows the variation of abdominal and caudal vertebra counts of 16 species (the data were cited from JESPERSEN, 1942) and black solid circles indicate the meristic characteristics of leptocephali of the present specimen and 5 species of long-finned eels (the data from JESPERSEN, 1942 and CASTLE, 1963).
Note: 1, *Anguilla megastoma* (CASTLE, 1963); 2, *A. marmorata* or *A. reinhardti* (CASTLE, 1963); 3, *A. marmorata* or *reinhadti* (JESPERSEN, 1942); 4, *A. celebesensis* (JESPERSEN, 1942); 5, *A. nebulosa* (JESPERSEN, 1942); 6, present specimen.

Anguillid species, and separated from *A. marmorata* by the meristic counts (Fig. 3).

In consequence of this morphological study, the leptocephalus of genus *Anguilla* which we collected is identified as the leptocephalus of *Anguilla japonica*.

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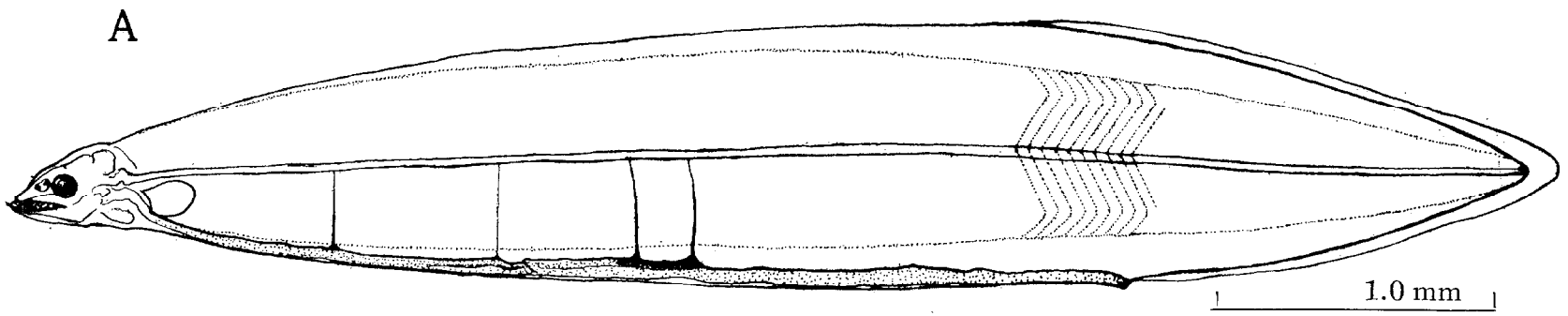
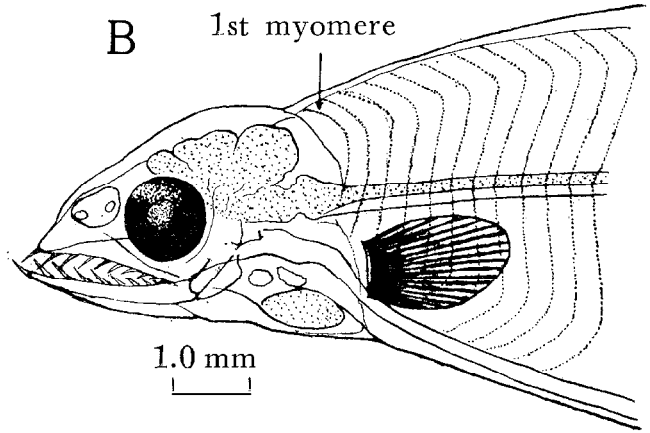
PLATE

PLATE I

L *Anguilla japonica*, 53.5 mm in total length. A : Lateral view, to show distribution of major vertical blood-vessels, intestine and myomeres at level of vent; B : Lateral view of head and pectoral fin rays; C : Lateral view of caudal region.





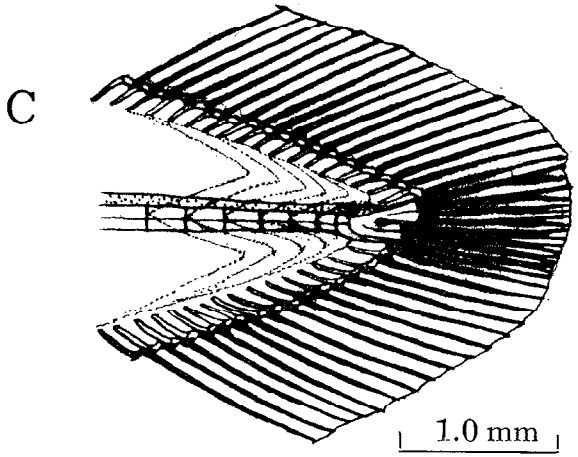


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PLATE I