

Morphology and Identification of the Young Ipnopid, “*Macristiella*” from the Tropical Western Pacific

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Abstract Four specimens of “*Macristiella*” ranging from 13.1 to 39.3 mm in standard length were collected from the tropical western Pacific for the first time. The internal as well as external morphology of these specimens was described in detail, especially for the largest individual. All the known specimens of “*Macristiella*,” one from the Atlantic and four from the Pacific, were considered to be the young stages of the genus *Bathytyphlops* of the family Ipnopidae, Myctophiformes, but their specific identification remained to be solved.

The family Macristiidae was erected by Regan (1911) to include a single species, *Macristium chavesi*, Regan, 1903, which was obtained from Azores. Later, smaller specimens of the same genus were reported from the Atlantic Ocean by Marshall (1961) and Rosen (1971), and from the Indian Ocean by Ida and Tominaga (1971). The second species of this family, *Macristiella per lucens*, was described by Berry and Robins (1967) from a larval specimen collected in the Gulf of Mexico. None of these forms or their congeners have been previously reported from the Pacific Ocean.

The systematic position of this family has been intensely argued, especially since Marshall (1961) suggested that *Macristium* might be “a modern ctenothrissoid” (Patterson, 1964; Berry and Robins, 1967; Okiyama, 1970a; Ida and Tominaga, 1971). Recent study of Rosen (1971) using the third specimen of *Macristium* led him to the following con-

clusion: “*Macristium* may be referred to the young bathysaurid and *Macristiella* also to the larval form of the ipnopid”. He seems to be right, at least in referring “*Macristiella*” to the family Ipnopidae in the order Myctophiformes, since the additional material of this genus from the Pacific, upon which this article is based, provided positive information to confirm his view. In this paper is given the speculation on the identification of “*Macristiella*” specimens along with their anatomical observation.

Material and methods

Collection data for the four Pacific specimens studied were given in Table 1. They were all collected from the larva net (1.3–2.0 m in mouth diameter) hauls at surface in various time of the day. All specimens are deposited in the Zoological Department, University

Table 1. Collection data for the four specimens of “*Macristiella*” from the tropical western Pacific.

	Locality	Date	Time	W.T.(°C)	Vessel
ZUMT 52504	4°43' S 153°41' E	1965–X–30	07: 30 – 07: 50	28.4	Shunyo Maru
ZUMT 52505	19°08.5'S 176°59' E	1965–XI–15	11: 30 – 11: 50	25.3	Shunyo Maru
ZUMT 52506	4°39' S 164°27' E	1965–XI–25	07: 30 – 07: 50	29.1	Shunyo Maru
ZUMT 52507	6°18' N 144°20' E	1968–IV–10	01: 45 – 02: 00	—	Kaiko Maru

Museum, the University of Tokyo (ZUMT). The osteological studies were based exclusively on the cleared and alizarin-stained specimen (ZUMT 52507). Terminology for bones follows Rosen and Patterson (1969) and Rosen (1971). The urostyle (PU_1+U_2) is not included in the vertebral counts as in Nielsen (1966). The drawings were made by me with the aid of the Hamanoshiki Drawing Apparatus used with a binocular microscope.

Description

General appearance: Counts and proportional measurements for the Pacific specimens are given in Table 2, together with the relevant characters available for the Atlantic one. They range 13.1 to 39.3 mm in standard length and are closely similar in appearance. The best preserved and smallest specimen (ZUMT 52504) was illustrated (Fig. 1).

Table 2. Counts and proportional measurements for the known specimens of "*Macristiella*."

Specimen	Tropical western Pacific				Atlantic (Berry and Robins, 1967)
	ZUMT 52504	ZUMT 52505	ZUMT 52506	ZUMT 52507	
Standard length (mm)	13.1	20.2	25.4 (heavily twisted)	39.3	28.5
Dorsal fin rays	ca. 12	12	13	12	12
Anal fin rays	15	15	13	13	12
Pectoral fin rays (R/L)	13/14	13/13	15/15	15/15	15
Pelvic fin rays	ca. 8	8/8	8/8	8/8	8
Caudal fin rays	1+10+9+2	5+10+9+5	5+10+9+5	6+10+9+5	6+10+9+4
Branchiostegals	10~11(5+5~6)	14(5+9)	15(5+10)	16~17(5+11~12)	16(5+11)
Gill rakers (1st arch)	—	—	8+13	7+1+14	7~8+1+16
Myotomes (or vertebrae)	ca. 64	ca. 64	ca. 62	(64)	69
Teeth on:					
Premaxillary (R/L)	2/2	3/3	7/6	10/11	11/10
Dentary (large canines)	2/2	4/4	6(2)/7(2)	8(2)/10(2)	6(2)/8(2)
Vomer	1/1	—	4/4	4/1/4	4/4
Palatine	0/0	0/0	1/1	3/3	1/1
Basihyal	1/1/1	2/1/2	6/6	3/1/3	2/1/2*
In % of standard length:					
Snout to dorsal fin	41.1	39.1	44.5	36.9	
Snout to anal fin	68.7	64.9	69.3	65.1	
Snout to ventral fin	37.3	35.6	40.9	35.9	
Snout to anus	44.4	43.6	51.2	44.5	
Head length	22.7	21.0	25.6	22.1	
Greatest body depth	16.2	15.1	18.5	17.3	
Dorsal fin base	ca. 13.4	9.6	13.0	11.7	
Anal fin base	17.2	14.6	15.0	13.2	
Longest dorsal fin ray	4.1	7.7	—	—	
Longest anal fin ray	7.6	8.2	12.3	—	
Longest pectoral fin ray	25.3	23.8	26.0	—	
Longest pelvic fin ray	7.2	11.1	28.3	—	
Longest caudal fin ray	17.2	17.3	27.4	—	
In % of head length:					
Snout	19.1	20.7	24.0	23.0	
Eye diameter	20.8	24.5	19.4	14.9	
Interorbital	49.7	51.5	52.9	44.8	

* According to the illustration (Berry and Robins, 1967 : fig. 3), this character seems to be 4/4

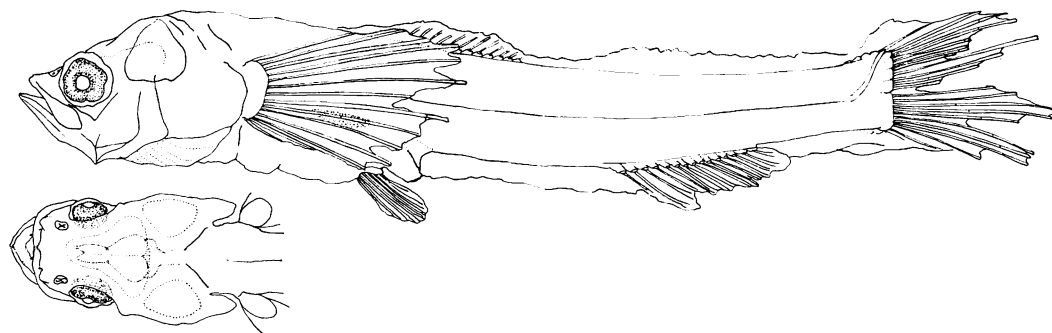


Fig. 1. A specimen of "*Macristiella*" from the Pacific Ocean, 13.1 mm in standard length (ZUMT 52504). The smallest specimen hitherto known.

The body is extremely slender especially in the smaller specimens, somewhat compressed laterally and tapering evenly from head to tail. The head is moderately large, rather wide, and dorsoventrally flattened. In the lateral profile, dorsal rim of the eye is visible over the slightly concave forehead. The nostril is completely formed in the larger three specimens. The anus opens at about middle of the body or slightly anterior to it. The anus is located in advance of the anal fin and close to the pelvic fin insertion, where the body depth is the greatest. The orbit is irregular but nearly rounded; its relative size ranges from 14.9 to 24.5 percent of the head length in these specimens. The mouth is terminal, oblique, and large, extending to a point vertical of the center or slightly posterior of the eye. The lower jaw is slightly protruded beyond the tip of the snout. The opercular flap is very large with broad branchiostegal membrane which is free from the isthmus. The principal fin rays are developed in all individuals. The dorsal fin originates opposite or slightly behind the insertion of pelvic fins; the anal fin is located at about half way of the tail; their bases are rather short, 13.2–17.2 percent and 15.2–18.5 percent of the standard length, respectively. The pectoral fin is midlateral and moderately large, its length being nearly constant at about one fourth of the standard length, whereas the length of the pelvic and caudal fins vary markedly. The adipose fin is not distinct, but a

membranous structure like a hyaline fold develops posterior to the dorsal fin and in the area between the anus and anal fin even in the largest specimen. This fold might disappear with growth. The scales are not yet differentiated. The pigmentation is scant in all specimens at hand; the external pigment is limited to the eye, and internally there is a pigmented area in the roof of the visceral cavity which is visible through the overlying transparent musculature.

Skeleton (Fig. 2): The upper jaw (Fig. 2B) is consisted of the premaxillary, posteriorly flanged maxillary, and small supramaxillary. The ascending and articular processes of the premaxillary are not so clearly differentiated. The teeth are restricted to the premaxillary which enters deep into the gape; they are canine-like and arranged uniserially with closer space anteriorly. The lower jaw (Fig. 2A) is largely occupied by the deep, powerful dentary; the anterior half of its oral border is toothed with the canine-like teeth in a single row, but two teeth on each side of the symphysis are stronger than others. Among the opercular series (Fig. 2A), the opercle is the largest, occupying the dorsal half of the opercular flap. Ventral to this is a rather large subopercle.

The frontal (Fig. 2C) is a very large bone forming the greater part of the skull roof, with weak ridges on its dorsal surface. The ethmoid region is little stained by alizarin but an unpaired large cartilaginous plate is present

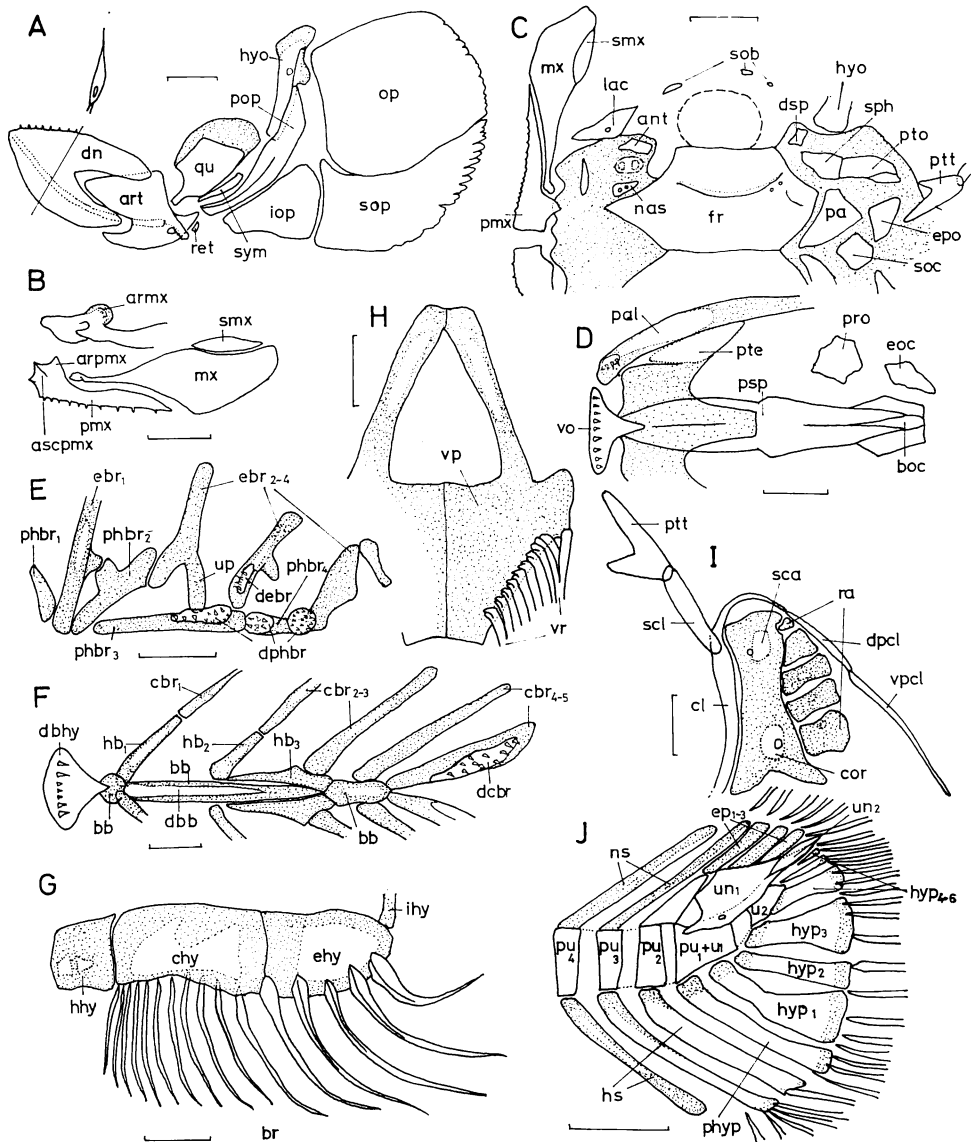


Fig. 2. Skeleton of the largest specimen of "*Macristiella*" from the Pacific Ocean, 39.3 mm in standard length, (ZUMT 52507). A. lateral view of facial bones of left side; B. upper jaw bones; C. dorsal view of cranium; D. ventral view of the same; E. epibranchial and pharyngobranchial elements; F. hyobranchial elements; G. hyoid bar and branchiostegal rays; H. pelvic girdle; I. shoulder girdle; J. caudal skeleton. Cartilaginous portions are dotted. ant. artorbital; armx. articular process of maxillary; arpmx. the same of premaxillary; art. articular; ascpmx. ascending process of premaxillary; bb. basibranchial; boc. basioccipital; br. branchiostegal; cbr. ceratobranchial; chy. ceratohyal; cl. cleithrum; cor. coracoid; dbb. dermal basibranchial; dbhy. basihyal; hb. hyoid bar; hhy. hypohyal; hs. haemal spine; hyo. hyomandibular; hyp. hypural; ihy. interhyal; iop. interopercular; lac. lacrymal; mx. maxillary; nas. nasal; ns. neural spine; op. opercular; pa. parietal; pal. palatine; phbr. pharyngobranchial; phyp. parhypural; pmx. premaxillary; pop. preopercular; pro. prootic; psp. parasphenoid; pte. pterygoid; pto. pterotic; ptt. posttemporal; pu. preural; qu. quadrate; ra. radials; ret. retro-articular; sca. scapula; scl. supracleithrum; smx. supramaxillary; sob. infraorbital; soc. supra-occipital; sop. subopercular; sym. symplectic; u. ural; un. uroneural; up. uncinat process; vo. vomer; vp. pelvic plate; vpcl. ventral postcleithrum; vr. pelvic fin rays. Scales 1 mm.

(Fig. 2C). The parietals, though not yet fully formed, probably meet broadly along the mid-line when more grown. There are four bones in the infraorbital series including the lacrymal which is the largest (Fig. 2C). Two of three small bones around the nasal pores are referred to the antorbital and the nasal, respectively, but the anteriormost bone is not identified. This dermal bone overlies the anterolateral corner of the ethmoid plate. The vomer (Fig. 2D) is nearly triangle in ventral view, and armed with a transverse row of nine teeth distally, which are sharply pointed, similar in size and shape, and fastly attached. The palatine (Fig. 2D) is represented by a narrow, poorly ossified element, and in front of it a small ossified patch with three canines is present. The anterior end of this bone is in contact with the cartilaginous articular process of the maxillary. The parasphenoid is a well-ossified large bone articulating with the vomer anteriorly and the basioccipital posteriorly. The prootic and exoccipital are the other elements that are stained well with alizarin in the ventral side of the cranium (Fig. 2D).

Of the dorsal parts of the branchial apparatus (Fig. 2E), the third pharyngobranchial is the most enlarged with large tooth plate on its posterior half. Other three tooth plates, spherical to ovoidal in shape, are on the anterior part of the fourth pharyngobranchial, on the boundary between the fourth pharyngobranchial and the fourth epibranchial, and on the proximal half of the third epibranchial, respectively. There is a long uncinat process in the second epibranchial articulating with the third pharyngobranchial. Among the hyobranchial elements (Fig. 2F), the basihyal tooth plate is the most advanced in ossification. It is fan-shaped and equipped distally with teeth which are evenly spaced in a transverse row. All teeth of the basihyal are sharply pointed, somewhat recurved inwards, and perhaps depressible; the medial ones tend to be smaller. The fifth pharyngobranchial is absent. In all specimens, the gill rakers are represented by

the simple rod of uniform shape. Branchios-tegals are 16 in total. Of the anterior rays which are hair-like and slender, the anterior-most seven are attached on the medial face and the following four are on the inner surface of the ceratohyal. The posterior five articulating deeply with the outer surface of the epihyal are broad and sharply curved. Of interest is the longitudinal arrangement of the two ossified areas in the hypohyals (Fig. 2G).

The pelvic bones are poorly stained with alizarin and simple in structure. Although the iliac process is distinct, the posterior process is obscure (Fig. 2H). In the shoulder girdle (Fig. 2I), the so-called secondary pectoral girdle is more advanced in ossification than the primary one. The posttemporal is distinctly bifurcate. The cleithrum is narrowly developed in a sigmoid form, tapering dorsally to an acutely pointed tip where it is in contact with the dorsal element of the postcleithra. The ventral postcleithrum is a slender straight bone-

There are five actinosts including the dorsal. most small component. The two ossified areas each with a single foramen may represent the centers of the scapula and the coracoid, respectively. The mesocoracoid is seemingly absent.

The full complements of the cylindrical centrum are ossifying, but the haemal and the neural spines are scarcely stained by alizarin. The total number of vertebrae is 64, and the abdominal vertebrae are estimated to be about 24. The dorsal fin start over the 20th vertebra, and the anal below the 42nd. Besides the terminal five vertebrae, two uroneurals, three epurals, six hypurals, and a single parhypural constitute the caudal skeleton (Fig. 2J). The second ural centrum is clearly separated from the first which is fused with the first preural centrum. The second preural neural spine is short, half as long as the preceding spine, but slightly expanded posteriorly. Its distal tip almost touches the first epural. The remaining two epurals of similar size are located above the large first uroneural having a small foramen near the base. Most of the hypurals

become narrower in their central portion, which is most exaggerated in the first bone. No fulcral scales are observed.

Viscera (Fig. 3): The gut is very short and has no windings in the intestine. The stomach is distinctly developed in Y-shape with a small blind sac, but no pyloric caeca are visible. The intestine is a broad tube and nearly ovoidal in the ventral view. The rectum is also broadly developed anteriorly, but becomes abruptly narrower toward the anus. This terminal portion is deflected ventrally from the body. In both the intestine and the rectum, the mucous membrane is forming fine folds in a zigzag row. The gas bladder is not developed. The liver is a nearly symmetrical single lobe locating below the oesophagus and the intestine.

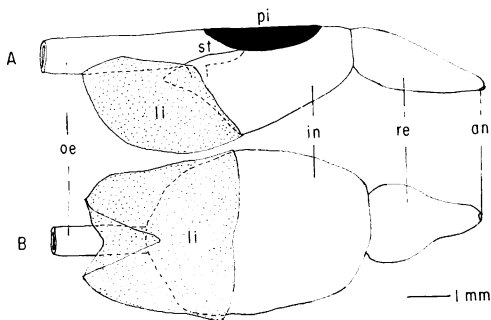


Fig. 3. Viscera of the largest specimen of “*Macristiella*” from the Pacific Ocean (ZUMT 52507). A. lateral view of left side; B. ventral view. an. anus; in. intestine; li. liver; oe. oesophagus; pi. pigment film; re. rectum; st. stomach.

The darkly pigmented film overlies the blind sac of the stomach and the anterior part of the intestine; it is ovoidal in shape and is apparently distinct from the peritoneal membrane. The pigmented film is seen through overlying skin as a ventrolateral spot. In the stomach of this specimen, a fine specimen of isopod belonging to the family Cirolanidae was contained.

Discussion

A comparison of the Atlantic and the

Pacific specimens of “*Macristiella*” disclosed several differences in the number of gill rakers, the myotomes (or the vertebrae), and anal fin rays. There are differences also in the position of the dorsal fin in relation to vertebral number, adipose fin, supramaxillary, and posttemporal. Of these, the higher myotome count in the Atlantic specimen seems to be most striking, because the majority of other differences are probably due to either their sizes or the simple variety within a species. On the other hand, the similarity in many other respects including the peculiar dentition, is also conspicuous, despite isolation in the different ocean basins. However, whether all the known specimens of “*Macristiella*” are conspecific or not still remains open to question.

Since it was originally described, “*Macristiella*” has been referred to different orders such as the Salmoniformes and the Ctenothrissiiformes as a genus of the family Macristiidae. A new family name (Macristiellidae) has once been proposed by Okiyama (1970a). Recently, however, “*Macristiella*”-ipnoid linkage was suggested by Rosen (1971) chiefly on the basis of the general agreement of some meristic and anatomic characters. His observation and discussion are mainly focused on *Macristium* specimens, and general morphologic accounts for the larval *Chlorophthalmus* were also included, revealing the close morphologic similarity in larval stages between these two genera. As can be seen in the foregoing description, the characteristics common to these genera mentioned above, for example, the independent tooth plate on the boundary between the fourth pharyngobranchial and the fourth epibranchial, does exist also in “*Macristiella*”. This tooth plate is so far known to be confined to some members of the Myctophiforme (Nelson, 1969), among the so-called “neoteleosteans” of Rosen and Patterson (1969).

It seems that there are two other features that shared by the myctophiform members and “*Macristiella*”. The one is the development of the large ventrolateral pigment spot in the peritoneal cavity during the larval stages.

Table 3. Comparison of “*Macristiella*” specimens with three ipnopid genera (after Nielsen, 1966; Geistdoerfer et al., 1970).

Genus and species	D.	P.	Vertebrae	Branchiostegals	Dorsal origin over Vertebra
<i>Macristiella</i>	12–13	13–15	64–69 (myotome counts)	14–16	20th
<i>Ipnops</i>	8–11	13–16	51–61	9–12	16–20th
<i>Bathymicrops</i>	8–10	9–10	65–80	8–10	25–33rd
<i>Bathytyphlops</i>	11–13	12–14	62–65	14–17	21–23rd
<i>B. sewelli</i>	11	12	62–63	14	21st
<i>B. marionae</i>	12–13	12–14	62–65	15–17	21–23rd
<i>B. azorensis</i>	12	13	65	?	?

Generally, this kind of spot is bilaterally symmetrical oval patch, but its numbers are variable from species to species or even between the different stages of the ontogeny. So far as I am aware, this is shared only by the larval myctophiform fishes. Apart from “*Macristiella*”, single spotted forms are restricted to the basal myctophiformes such as *Hime japonica* (Okiyama, 1970), *Chlorophthalmus* spp. (Tåning, 1918, and others). Another is the position of the anus in relation to the ventral and the anal fins. Indeed, there are considerable variations in the mode of the vent location, not only between the closely related species but in the ontogeny of the same species. It seems that such may be most diverse in the Myctophiformes. But, the type observed in “*Macristiella*”—wide space between anus and anal fin throughout life—is typical of several families of myctophiform fishes. To these may be added the short but stout gut without gas bladder in “*Macristiella*” as the possible diagnosis bearing its phylogenetic closeness to the order Myctophiformes. From these evidences, “*Macristiella*” specimens may safely be referred to the Myctophiformes.

The Ipnopidae and “*Macristiella*” are compared in Table 3, which contains important characters of three genera of the family Ipnopidae currently recognized (Nielsen, 1966; Geistdoerfer et al., 1970), along with those of “*Macristiella*”. Among the genera in question, “*Macristiella*” may surely be ascribed to *Bathytyphlops*, despite following differences: (1)

scales are completely absent in “*Macristiella*” but well developed in *Bathytyphlops*; (2) pseudo-branch is present versus absent; (3) vomerine teeth are in continuous transverse row versus two separate patches; (4) eye is small versus almost degenerated; (5) gill rakers are similar in size versus almost degenerated except for the single one at angle; (6) maxillary is membranous versus cone-shaped; (7) gape is moderately large versus extremely large. Making due allowance for the larval condition of the former, and the marked metamorphosis in some myctophoids such as the Myctophidae shown by Moser and Ahlstrom (1970), however, most of these differences are not unexpected. The following remarks, “It is difficult to imagine a free-living fish more degenerate than the species of the genus *Bathytyphlops*” (Mead, 1958) may be helpful to fill these gaps, too. Here, the higher myotome count of the Atlantic specimen of “*Macristiella*” raises the question again, since the known vertebral counts in *Bathytyphlops* are less than 65. In view of the fact that the high number of branchiostegal rays is most relevant in separating *Bathytyphlops* from other genera, such a difference is probably ascribed to the specific problem.

The genus *Bathytyphlops* comprises three species, vis., *B. sewelli*, *B. marionae*, and *B. azorensis*. (Nielsen, 1966; Geistdoerfer et al., 1970). Each species has been represented only by one to four specimens, and is still subject to qualification. So far as the meristic characters are concerned, the “*Macristiella*”

specimens, especially those from the Pacific, are most closely related with *B. marionae*, but this attribution is yet problematic until supported by collection of adults.

The waters where the Pacific specimens were collected were restricted in the western tropical Pacific where no *Bathytrophops* has been recorded as shown in Fig. 4. In this connection, the Gulf of Mexico is unique in that both "*Macristiella*" and *Bathytrophops* have been recorded. The occurrence of *B. marionae* in the western Indian Ocean is also worth mentioning, because this discovery probably suggests the circumglobal distribution of this species.

The depth distribution of the known specimens of *Bathytrophops* and "*Macristiella*" is compiled in Fig. 5, where dots are plotted

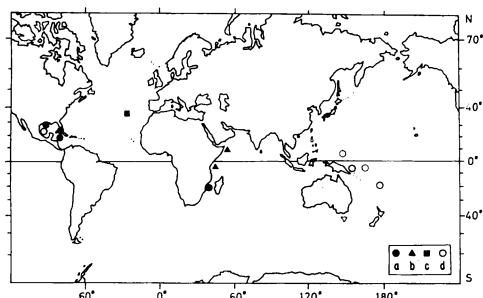


Fig. 4. Geographical distribution of the known specimens of *Bathytrophops* and "*Macristiella*". a. *B. marionae*; b. *B. sewelli*; c. *B. azorensis*; d. "*Macristiella*" specimens.

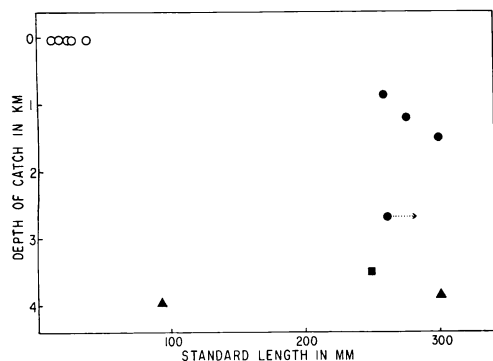


Fig. 5. Depth distribution of the known specimens of *Bathytrophops* and "*Macristiella*". Symbols are the same as in Fig. 4.

against the size of each specimen. This figure emphasizes the differences in their depth distribution as follows: "*Macristiella*" lives in epipelagic zone, *B. marionae* at bathyal depths, and *B. sewelli* and *B. azorensis* at abyssal zone. Although the occurrence of a small specimen of *B. sewelli* (93 mm S.L.) within the same depth range with the adults, and the eurybathic occurrences of *B. marionae* in the bathyal zone, provide interesting ecological evidences in seeking their specific correspondence, it seems still premature to draw any conclusion in this regards.

Acknowledgments

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- (Japan Sea Regional Fisheries Research Laboratory, Nishi-Funamicho, Niigata, Japan)

西部熱帯太平洋岸から採集されたチョウチンハダカ科の幼生, *Macristiella* の形態と帰属 沖山 宗雄

西部熱帯太平洋の表層から、稚魚網採集によって、*Macristiella* と同定される標本が 4 個体 (体長 13.1–39.3 mm) 得られた。これらは太平洋におけるはじめての採集記録である。特に最大の個体を中心に外部および内部形態についての詳細な記載をおこなった。大西洋産の標本を含めて既知の *Macristiella* は、いずれもハダカイワシ目、チョウチンハダカ科、*Bathytyphlops* 属魚類の幼期であることが判明したが、種の帰属に関しては未解決である。

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