

A Psychrolutid, *Malacocottus gibber*, Collected from the Mesopelagic Zone of the Sea of Japan, with Comments on its Intraspecific Variation

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Malacocottus gibber Sakamoto, is one of the dominant fishes in the deep waters of the Sea of Japan. It is known to live mainly on the bottom between depths of 500–800 m, although it has been recorded from depths of 250–1200 m (Ogata et al., 1973). Generally, cottoid fishes, including psychrolutids, are considered as demersal fishes not leaving the sea bottom except during their larval stages. Taylor (1967) reported *Malacocottus kincaidi* from mid-water layers in Canadian waters, but no additional records have been made.

During the mid-water trawl survey made by the T/S Hokusei-Marui of Hokkaido University in the Sea of Japan off southern Hokkaido, many adult specimens of *M. gibber* were collected from mid-water at 400–420 m (bottom depth 800–1500 m) along with *Theragra chalcogramma*, *Aptocyclus ventricosus*, *Thamnaconus modestus* and *Acanthopsetta nadeshnyi* (Fig. 1). This study documents the occurrence of *M. gibber* in mid-water layers in the Sea of Japan, describes the specimens in detail and discusses intraspecific variation in diagnostic characters of this species. New material was deposited in the Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University (HUMZ) and comparative material was deposited in HUMZ and FAKU (the Department of Fisheries, Faculty of Agriculture, Kyoto University). All specimens were divided into two types: Type I for specimens lacking an accessory spine on the preopercle, and Type II for specimens having an accessory spine on the preopercle. Measurements and counts follow those of Hubbs and Lagler (1958) and Amaoka et al. (1983), except for the pectoral base width, which was measured between the uppermost and lowermost origins of the pectoral fin rays, and the caudal fin length, which was measured from the hidden base of the middle caudal ray to the tip of the fin. In this species the last

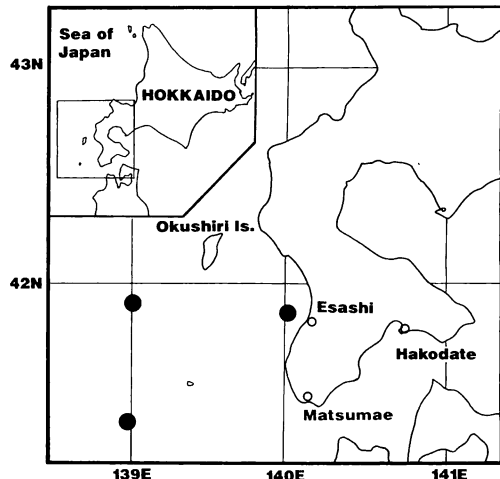


Fig. 1. Collection localities of *Malacocottus gibber* (solid circles), off southern Hokkaido in the Sea of Japan.

element of the dorsal and anal fins is single, being separated from the preceding ray, and it was counted as a full ray. The vertebrae were examined from radiographs.

Malacocottus gibber Sakamoto, 1930 (Japanese name: Seppari-kajika) (Fig. 2)

Material examined. Thirty five specimens. Type I: HUMZ 114057, 114059–114063, 114065–114070, 41°52.8' N, 139°59.8'E (off Esashi, Hokkaido, Japan), Oct. 24, 1987; HUMZ 114081–114084, 114088, 114089, 114091–114096, 114098, 114099, 41°55.8' N, 139°02.9'E (off Okushiri I., Hokkaido), Oct. 25, 1987; HUMZ 114609, 114610, 41°21.7' N, 138°58.5'E (off Matsumae, Hokkaido), Oct. 24, 1989. Type II: HUMZ 114058, 114064, 41°52.8' N, 139°59.8'E (off Esashi), Oct. 24, 1987; HUMZ 114085–114087, 114090, 114097, 41°55.8' N, 139°02.9'E (off Okushiri I.), Oct. 25, 1987.

Comparative material. *Malacocottus gibber*: 12 specimens (99.4–187.5 mm SL, collected by bottom trawl). Type I: HUMZ 42696, 42°05.4' N, 139°39.6'E, 700 m (Sea of Japan near Okushiri I.); HUMZ 53823, 39°16.7' N, 135°02.7'E, 360 m (Yamato Bank, Sea of Japan); HUMZ 109961, Sea of Japan off Kumaishi, Hokkaido; FAKU 13754, 13755, 13757, 13758, 14777–14779, Toyama Bay off Uozu, Toyama Pref., Japan, 250–300 m. Type II: HUMZ 42687, 42°05.4' N, 139°39.6'E, 700 m (near Okushiri I.); FAKU 13863, Toyama Bay off Uozu, 250–300 m. *Malacocottus zonurus*: 41 specimens (74.2–233.0 mm SL, collected by bottom trawl): HUMZ 48861, 45°54' N, 141°31'E, 95–115 m (northern Sea of Japan). HUMZ 51554, 51561, 42°



Fig. 2. *Malacocottus gibber*, HUMZ 114609, 109.2 mm SL.

03°N, 143°43'E, 327 m, (off Hiroo, Pacific coast of Hokkaido, Japan); HUMZ 51632, 51691, 42°01.5'N, 143°43'E, 323 m, (off Hiroo); HUMZ 51673, 51674, 42°03'N, 143°42'E, 307 m, (off Hiroo); HUMZ 51700, 42°01.5'N, 143°43.0'E, 323 m (off Hiroo); HUMZ 52667-52670, 52675, 42°01.9'N, 143°44.4'E, 360 m (off Hiroo); HUMZ 57750, 58°35'N, 148°56'E, 127 m (northern Sea of Okhotsk); HUMZ 58012, 58013, 56°40'N, 143°22'E, 310 m (Sea of Okhotsk); HUMZ 59639, off Miyako, Pacific coast of Iwate Pref., Japan; HUMZ 60318, 49°27'N, 155°41'E, 203 m (northern Kuril Is.); HUMZ 71401, off Onahama, Pacific coast of Fukushima Pref., Japan; HUMZ 83143, 54°43.22'N, 167°19.24'W, 500 m (eastern Bering Sea); HUMZ 84990-84992, 58°38.8'N, 174°46.4'W, 230 m (eastern Bering Sea); HUMZ 85194, 61°14.6'N, 178°01.4'W, 156 m (eastern Bering Sea); HUMZ 86095, 59°47.1'N, 175°28.8'W, 132 m (eastern Bering Sea); HUMZ 86120-86122, 60°38.1'N, 179°00.2'W, 295 m (eastern Bering Sea); HUMZ 86139, 59°00.8'N, 174°00.1'W, 125 m (eastern Bering Sea); HUMZ 86152, 59°30.8'N, 177°02.3'W, 154 m (eastern Bering Sea); HUMZ 86424, 60°22.4'N, 179°21.2'W, 790 m (eastern Bering Sea); HUMZ 86894, 87749, off Muroran, Pacific coast of Hokkaido, Japan, 310-474 m; HUMZ 89316, 89317, 51°38.0'N, 178°15.2'W, 167 m (near Kanaga I. of Aleutian Is.); HUMZ 97873, 45°02.2'N, 144°06'E, 230 m (Kitami-Yamato Bank, Sea of Okhotsk); HUMZ 97886, 44°55.8'N, 143°12.2'E, 135 m (Kitami-Yamato Bank); HUMZ 97917, 44°56.7'N, 144°23'E, 320 m (Kitami-Yamato Bank); HUMZ 102645, 102647, 102250, 53°15.6'N, 166°36.1'W, 235 m (near Unalaska I. of Aleutian I.); HUMZ 102682, 55°34.5'N, 155°08.5'W, 717 m (near Chirikof I., Alaska).

Description. Measurements and counts are shown in Table 1.

Body robust, tadpole shaped; depth of body greatest at origin of dorsal fin. Head large, cuboid, slightly compressed. Mouth large, terminal and oblique. Upper jaw slightly projecting. Villiform teeth on both jaws, in 3 or 4 rows. No teeth on

prevomer and palatines. Anterior nostril in short cylindrical tube with its posterior margin produced into bifid flap; posterior nostril with low rim. Nasal spine absent. Eye large, oval. Interorbital space broad, its width more than half orbital diameter. A pair of protuberances on dorsal surface of occipital region. Four preopercular spines; the uppermost (1st) projecting posterodorsally, the 2nd posteriorly, and the 3rd and the 4th ventrally. An accessory preopercular spine usually absent, but 7 specimens have an accessory spine projecting laterally from the base of the 2nd preopercular spine (three specimens with a spine on left side only) (Fig. 3A, B). Upper margin of operculum separated from temporal region, pointed at posterior tip. Gill membrane broadly fused to isthmus, not forming a free fold. Origin of first dorsal fin above and slightly behind gill opening. Spines of dorsal fin slender, flexible. First two spines more closely set than others. Second dorsal fin separated from first dorsal fin by a deep notch. Soft rays of dorsal fin longer than spines. Pectoral fin reaching above anus. Pelvic fin small and thoracic. Origin of anal fin below origin of 2nd dorsal fin. Base of anal fin slightly shorter than that of 2nd dorsal fin. Distal margins of dorsal and anal fins incised. Length of caudal peduncle apparently greater than its depth. Caudal fin slightly rounded. No scales except upper region of cornea, which has scattered, prickly-like scales. No cirri on head and body. Terminal chin pore paired.

Color in alcohol. Head and body grayish brown. Iris black. Caudal peduncle, middle portion and posterior margin of caudal fin white. Body, especially dorsally, from neck to caudal peduncle scattered with light brown specks.

Skull arches (Fig. 4: A1-A5). Four bony arches on the frontal and one on the pterotic. First arch

(A1) very narrow, its lateral insertion close to the anterior margin of orbit. Second arch (A2) narrow, over anterior half of interorbital space, its lateral insertion distant from anterodorsal margin of orbit; median insertion weakly united to its antimeres. Third arch (A3) slightly broader than others, its lateral insertion very distant from dorsal margin of orbit. Two small, additional openings present between A2 and A3. Fourth arch (A4) narrow, its lateral insertion distant from posterodorsal margin of orbit. Fifth arch (A5) somewhat narrow, having a small anterior projection at its top. Extensive

spaces between these arches, part of the lateral line system on the head.

Remarks. It is generally thought that cottoid fishes are benthic and that mesopelagic occurrences are rare or represent unusual behavior, because they lack a swimbladder and are rather poor swimmers. However, Taylor (1967) reported mesopelagic occurrence in *M. kincaidi* which is thought to be a closely related species. It is interesting that two species of the genus *Malacocottus* occur mesopelagically. Although 36 mid-water trawl tows were done in the same area (trawling depth 35–490 m) during

Table 1. Comparison of range of measurements between two types of *Malacocottus gibber* caught by midwater trawl (Type I, accessory spine is absent from preopercle; Type II, accessory spine is present on preopercle).

*¹ Data from 27 specimens; *² Data from 26 specimens in Type I; *³ Data from 25 specimens; *⁴ Data from 6 specimens.

Type (number of specimens)	I (28)			II (7)		
	Range	Mean	SD	Range	Mean	SD
Counts						
Dorsal fin (spines)	8–10	8.9	0.33	9		
Dorsal fin (rays)	13–16	14.3	0.78	14–16	14.7	0.95
Anal fin	10–13	11.5	0.74	11–13	11.8	0.89
Pectoral fin (right + left)	43–46	44.4	0.69* ¹	44–46	44.5	0.78
Pelvic fin	I, 3			I, 3		
Vertebrae	31–33	31.8	0.44	31–32	31.8	0.37
Gill rakers (upper + lower)	9–15	11.1	1.66	11–14	12.0	1.00
Measurements*²						
Total length (mm)	92.8–151.5			114.6–149.6		
Standard length (mm)	68.9–124.0			92.6–120.8		
Proportional measurements (% of standard length)						
Body depth	23.6–35.0	27.2	2.67	24.7–28.4	26.3	1.53
Body width	21.3–30.7	24.2	2.31	21.4–26.8	23.4	1.95
Head length	41.6–49.0	45.1	1.97	42.4–47.5	44.4	1.75
Predorsal length	37.7–42.8	40.3	1.37	37.0–41.6	39.9	1.96
Dorsal base length (1st)	20.2–33.0	24.0	2.58	21.0–25.0	23.8	1.51
Dorsal base length (2nd)	22.6–33.2	28.4	2.60	25.1–33.4	29.5	2.67
Prepelvic length	24.9–34.4	30.2	2.23	25.7–34.5	29.7	1.98
Preanal length	61.4–70.5	66.7	2.61* ³	62.9–70.3	66.3	2.41
Anal base length	20.8–30.6	25.4	2.19* ³	21.7–27.8	25.5	2.44* ⁴
Caudal peduncle length	8.1–14.8	11.8	1.84	8.3–12.8	10.3	1.63* ⁴
Caudal peduncle depth	5.4– 7.7	6.4	0.55	5.7– 7.2	6.4	0.52
Head depth	23.5–30.5	26.8	2.10	24.6–28.1	25.9	1.35
Head width	20.7–27.5	24.4	4.07	20.8–27.5	23.3	2.37
Snout length	10.3–13.6	12.2	1.06	11.2–13.6	11.8	0.79
Eye diameter	9.3–14.6	11.9	1.23	11.5–13.3	12.3	0.72
Upper jaw length	19.5–23.0	20.7	1.02	18.7–21.7	20.2	0.92
Postorbital head length	20.1–25.4	23.6	1.67	21.6–25.4	23.1	1.27
Interorbital width	5.6– 9.3	7.2	0.84	6.3– 8.9	7.3	1.01
Pectoral fin length	19.9–26.2	22.2	1.78	19.7–26.2	22.5	2.43
Pectoral base length	17.4–21.1	18.8	0.99	16.3–20.3	17.9	1.27
Longest pectoral fin length	19.6–25.9	23.2	1.72	20.5–26.1	22.7	2.20
Pelvic fin length	9.8–15.6	12.6	1.49* ³	10.2–13.5	11.8	1.45* ⁴
Caudal fin length	20.3–27.0	23.9	1.90	21.1–26.6	23.7	1.91

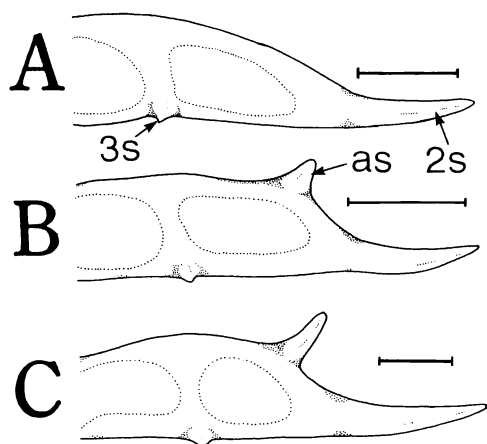


Fig. 3. Ventral view of left preopercular bones. A, *Malacocottus gibber* (HUMZ 114082, 124.0 mm SL); B, *M. gibber* (HUMZ 114064, 92.6 mm SL); C, *M. zonurus* (HUMZ 83143, 130.2 mm SL). as, accessory spine; 2s, second preopercular spine; 3s, third preopercular spine. Bar indicates 3 mm.

the years of 1987–1989 by the T/S Hokusei-Marui (in October) and the T/S Oshoro-Marui of Hokkaido University (in April), all specimens of *M. gibber* were captured only in October. The occurrence of *M. gibber* in mid-water may be seasonal and related with ecological behavior such as active feeding behavior before the breeding season in winter.

There are four nominal species in the genus *Malacocottus*: *M. zonurus* Bean, 1890; *M. kincaidii* Gilbert et Thompson, 1905; *M. gibber* Sakamoto, 1930;

M. tenuicaudalis Watanabe, 1958. Nelson (1982) suggested that the systematics of this genus was uncertain. The three species other than *M. gibber* are poorly differentiated from each other, whereas *M. gibber* is relatively distinct. The latter is distinguished from the other species by the loss of modified body scales above the lateral line and by the absence of an accessory spine on the preopercle. Among 35 specimens of *M. gibber* collected this time, however, 7 specimens had a weak accessory spine on the base of the 2nd preopercular spine, which was comparatively shorter than that of *M. zonurus* (Fig. 3). These specimens were compared with the 28 specimens without an accessory spine (Table 1). Since there were no significant differences in counts and proportional measurements between the two types in F-test for variance and t-test for mean ($F=1.00-2.71$, $P>0.05$; $|T|=0-1.94$, $P>0.05$), it was concluded that presence of the accessory spine was not of taxonomic significance and that the character exhibits intraspecific variation. The state of this character in *M. gibber* may now be described as “accessory spine on preopercle usually absent, relatively short if present.” The two types of *M. gibber*, including other specimens collected by bottom trawls, were compared with *M. zonurus* collected from a wide area of the northern North Pacific (Tables 2 and 3). Although all proportional measurements and meristic counts overlapped in both species, it was clear that both types of *M. gibber* have more gill rakers (9–15) than *M. zonurus* (4–9). *M. gibber* also tended to have more pectoral fin rays than

Table 2. Comparison of measurements (range and mean shown) between *Malacocottus gibber* (Type I and II) and *M. zonurus*. Type I, accessory spine absent from preopercle; Type II, accessory spine present on preopercle. Comparative materials of both types of *M. gibber* are included. *¹Data from 34 specimens; *²Data from 35 specimens.

Type (number)	<i>M. gibber</i>		<i>M. zonurus</i>
	I (36)	II (10)	(41)
Standard length (mm)	68.9–187.5	92.6–130.3	74.2–223.0
Proportional measurements of SL (%)			
Body depth	23.6–35.0 (27.5)* ¹	24.7–28.4 (26.3)	26.4–37.7 (32.1)
Head length	41.6–49.0 (44.6)* ²	42.4–47.5 (44.3)	40.5–50.5 (45.2)
Postorbital head length	20.1–26.7 (23.3)	21.6–25.4 (23.0)	21.0–26.7 (23.7)
Predorsal length	35.1–42.8 (39.4)	36.0–41.6 (39.5)	33.7–45.6 (39.4)
Prealanal length	58.2–70.5 (65.1)* ²	59.6–70.3 (65.7)	57.5–69.7 (62.5)
Eye diameter	9.3–14.6 (11.7)* ²	10.8–13.3 (12.0)	10.7–14.3 (12.1)
Interorbital width	5.6–9.3 (7.5)* ¹	6.3–8.9 (7.4)	3.6–8.9 (6.9)
Snout length	10.3–14.5 (12.3)	11.2–14.1 (12.1)	11.8–15.8 (13.7)
Caudal peduncle length	8.1–14.8 (11.3)* ²	8.3–12.8 (10.3)	7.6–15.7 (11.4)
Caudal peduncle depth	5.4–7.7 (6.4)	5.7–7.2 (6.4)	7.1–9.5 (8.3)

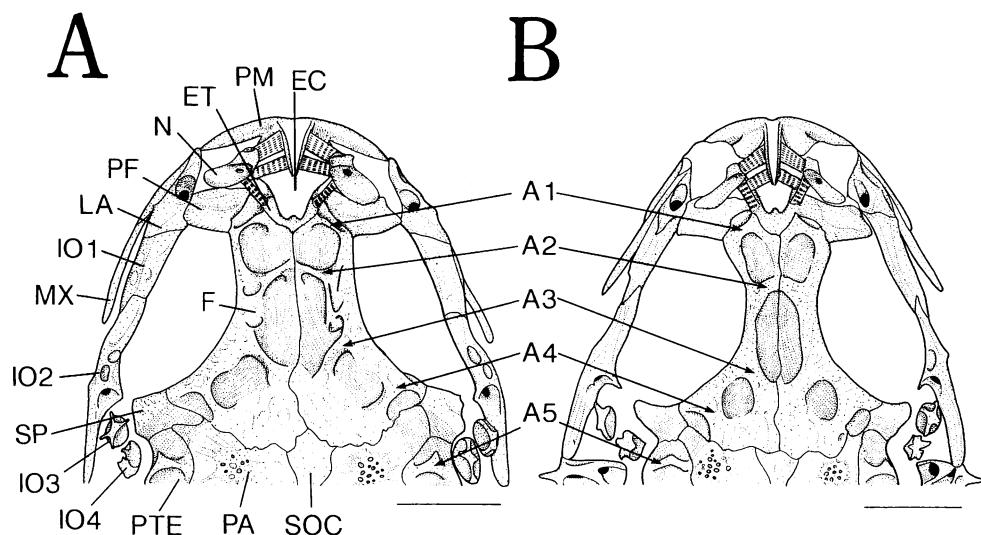


Fig. 4. Dorsal view of head region. A, *Malacocottus gibber* (HUMZ 109961); B, *M. zonurus* (HUMZ 83143). A1–A5, first to fifth cranial arch; EC, ethmoid cartilage; ET, ethmoid; IO1–IO4, first to fourth infraorbitals; LA, lachrymal; MX, maxillary; N, nasal; PA, parietal; PF, prefrontal; PM, premaxillary; PTE, pterotic; SOC, supraoccipital; SP, sphenotic. Bar indicates 10 mm.

Table 3. Frequency distributions of counts of *Malacocottus gibber* (Type I and II) and *M. zonurus*. Type I, accessory spine absent from preopercle; Type II, accessory spine present on preopercle. The counts of comparative materials of both types of *M. gibber* are included. *Data from 37 specimens in Type I.

	Dorsal fin			(spines)				(rays)				Anal fin				
	8	9	10	13	14	15	16	9	10	11	12	13				
<i>M. gibber</i>																
Type I (38)	2	35	1	2	17	16	3		1	15	19	3				
Type II (9)		9			6	1	2			4	2	3				
(total) (47)	2	44	1	2	23	17	5		1	19	21	6				
<i>M. zonurus</i> (41)	8	31	2	7	26	8		2	4	24	11					
Pectoral fin (right+left)*																
	40	41	42	43	44	45	46	47	48	Vertebrae						
										30	31	32	33	34		
<i>M. gibber</i>																
Type I				1	18	10	6	1	1		6	29	2	1		
Type II					4	3	2				2	6	1			
(total)				1	22	13	8	1	1		8	35	3	1		
<i>M. zonurus</i>	3	5	10	11	10	1	1			2	20	17	2			
Gill rakers (upper+lower)																
	4	5	6	7	8	9	10	11	12	13	14	15				
<i>M. gibber</i>																
Type I						6	7	9	10	3	2	1				
Type II							1	3	4	0	1					
(total)						6	8	12	14	3	3	1				
<i>M. zonurus</i>	1	5	14	12	6	3										

M. zonurus. Bony arches on the cranium have been regarded as an important diagnostic character in psychrolutids (Nelson, 1982). Both types of *M. gibber* have narrow bony arches (especially, A1–A3) with a broad but flexible interorbital space, whereas *M. zonurus* has wide bony arches with a comparatively narrow and stout interorbital space (Fig. 4). The difference in interorbital width in both species is not reflected in the proportional measurement, because *M. zonurus* has a wide range of variation (3.6–8.9% of SL) in this character (Table 2). It is concluded that the best characters for distinguishing *M. gibber* from *M. zonurus* are the number of gill rakers and the condition of bony arches on the cranium.

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日本海中深海水層から採集されたセツパリカジカおよびその種内変異

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北海道江差沖の日本海の3海域(最大水深 800–1500 m)から中層トロール (400–420 m) により 35 個体のセツパリカジカ *Malacocottus gibber* が採集された。本種はこれまで日本海の水深 250–1200 m の海底に生息していることが知られていたが、中層域からはこれが初めての記録である。カジカ類の成魚の中層域での採集例としてはカナダのクイーンシャルロット諸島沖で記録された *M. kincaidii* に次ぐものである。またこれらの個体を観察中、本種の特徴とされていた前鰓蓋骨第2棘基部の付属棘の状態に個体変異があることが明らかになり、本種の標徴ではないことがわかった。しかし本属の他種と比較した結果、鰓耙数が 9–15 であることおよび頭蓋骨背面の橋状構造が狭く、柔軟であることが本種の分類形質として有効であることが判明した。

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