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A New Species of the Deep-Sea Fish Genus *Parabrotula* (Parabrotulidae) from Sagami Bay with Notes on its Ecology

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Abstract *Parabrotula tanseimaru* sp. nov. (Zoarcoidei: Parabrotulidae) is described from Sagami Bay, central Japan, as the second species of the genus. The new species is readily distinguished from the known species, *P. plagiophthalma*, by dorsal fin ray counts (44–50 vs. 37–43) and higher total vertebral counts (64–73 vs. 54–64). *P. tanseimaru* is viviparous, occurring in pseudoceanic meso-/bathypelagic depths and feeding primarily on copepods.

The deep-sea family Parabrotulidae hitherto comprised two monotypic genera represented by *Parabrotula plagiophthalma* Zugmayer, 1911 and *Leucobrotula adipata* Koefoed, 1952 (Nielsen, 1968; Nielsen et al., 1990). From Japanese waters, Kimura et al. (1990) reported the occurrence of *P. plagiophthalma* and Nielsen et al. (1990) noted the existence of an undescribed *Parabrotula* species occurring in Sagami Bay. The latter is herein described as a new species on the basis of 25 specimens.

The new species is placed in *Parabrotula* rather than *Leucobrotula* because it agrees with all the diagnostic characters of *Parabrotula* as revised by Nielsen et al. (1990): color of skin black, profile of head slender, tail pointed and posterior dorsal and anal fin rays short.

Materials and methods

All specimens were collected around a fixed station located near the center of Sagami Bay (35°00′N, 139°20′E, ca. 1500 m soundings) during a series of 21 cruises of the R. V. Tansei Maru of the Ocean Research Institute, University of Tokyo. For detailed descriptions of the sampling methods and data, see Miya and Nemoto (1986, 1987, 1991). Abbreviations of the sampling gear used are as follows: 80-cm Motoda Horizontal Net (MTD); Ocean Research Institute net with 0.69/1.0 mm mesh (ORI-69/ORI-100); 10-foot Isaacs-Kidd Plankton Trawl (IKPT); and 10-foot Isaacs-Kidd Midwater Trawl (IKMT).

Specimens fixed in 5–10% seawater-buffered formalin on board were later transferred by two steps (25% and 50%) to 70% ethanol. All measurements were made after transfer to ethanol to the nearest 0.1 mm, although shrinkage occurred at an average of 7.1% (range, 2.8–13.8%) of standard length (SL) after 6-months preservation in ethanol. Vertebral counts (including urostyle) and vertical fin ray counts were made from either radiographs or cleared and stained specimens. Measurements and counts follow those of Hubbs and Lagler (1958). All material for the present study is deposited at Natural History Museum and Institute, Chiba (CBM), National Science Museum, Tokyo (NSMT) and Zoological Museum, University of Copenhagen (ZMUC).

Comparative material. *Parabrotula plagiophthalma* (8 specimens, 22.0–48.0 mm SL): CBM-ZF 48 (48.0 mm SL, female), 21 : 57–23 : 04, 31 Nov. 1972, 35°02.5′N, 139°21.3′E, ORI-100, 0–? m; CBM-ZF 124 (47.5 mm SL, female), 16 : 28–18 : 58, 15 June 1985, 34°57.0′N, 139°22.7′E, IKPT, 0–1350 m; CBM-ZF 125 (45.0 mm SL, female, cleared and stained), 18 : 51–23 : 00, 3 Aug. 1983, 35°01.1′N, 139°22.0′E, MTD, 774–1098 m; CBM-ZF 1028 (33.0 mm SL, ?, cleared and stained), 06 : 48–09 : 38, 8 Aug. 1983, 34°38.1′N, 140°00.1′E, IKMT, 0–1130 m; CBM-ZF 107 (32.0 mm SL, female), 06 : 48–09 : 38, 8 Aug. 1983, 34°38.1′N, 140°00.1′E, IKMT, 0–1130 m; CBM-ZF 1025 (29.5 mm SL, male, cleared and stained), 15 : 58–18 : 19, 16 Sept. 1986, 35°02.7′N, 139°14.7′E, IKPT, 0–1085 m; CBM-ZF 1023 (28.5 mm SL, female), 09 : 15–11 : 25, 10 Nov. 1985, 35°02.5′N, 139°21.8′E, IKPT, 0–961 m; CBM-ZF 118 (22.0 mm SL, male), 05 : 38–08 : 46, 9 Nov. 1985, 35°02.4′N, 139°20.8′E, IKPT, 0–1210 m.

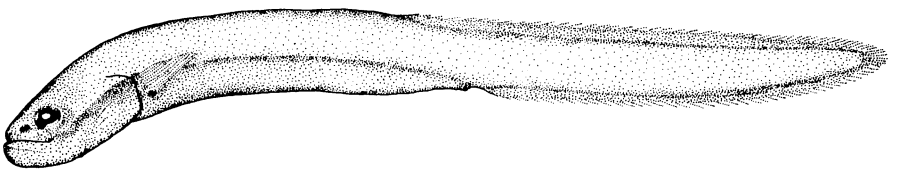

Fig. 1. *Parabrotula tanseimaru* sp. nov., holotype (CBM-ZF 128), female, 49.5 mm SL.

Parabrotula tanseimaru sp. nov.
(New Japanese name: Sagami-nise-itachiuo)
(Fig. 1)

Parabrotula sp. nov., Nielsen et al., 1990
Parabrotula Miya undescribed, Nielsen et al., 1990
Parabrotula sp., Kimura et al., 1990

Holotype. CBM-ZF 128 (49.5 mm SL, female), 23 : 24–01 : 05, 17–18 Oct. 1983, 35°01.1′N, 139°21.1′E, IKMT, 0–920 m.

Paratypes (24 specimens, 12.1–62.5 mm SL). CBM-ZF 108 (26.0 mm SL, male), 14 : 41–16 : 53, 11 Sept. 1986, 35°02.4′N, 139°20.4′E, IKPT, 0–1070 m; CBM-ZF 109 (21.0 mm SL, male), 14 : 52–16 : 36, 13 Mar. 1984, 34°59.9′N, 139°19.2′E, ORI-69, 0–1240 m; CBM-ZF 110 (2 specimens, 23.0, 29.5 mm SL, ?), 15 : 47–18 : 00, 15 Sept. 1986, 35°00.6′N, 139°19.8′E, IKPT, 0–1041 m; CBM-ZF 111 (12.1 mm SL, ?), 16 : 44–18 : 16, 13 Mar. 1984, 35°00.0′N, 139°17.3′E, ORI-69, 0–1300 m; CBM-ZF 112 (22.5 mm SL, ?), 15 : 58–18 : 19, 16 Sept. 1986, 35°02.7′N, 139°14.7′E, IKPT, 0–? m; CBM-ZF 113 (29.5 mm SL, male), 05 : 58–07 : 07, 16 Sept. 1986, 35°01.0′N, 139°19.9′E IKPT, 0–1005 m; CBM-ZF 114 (14.7 mm SL, ?, cleared and stained), 09 : 12–10 : 30, 13 Aug. 1984, 34°59.7′N, 139°20.2′E, ORI-69, 0–910 m; CBM-ZF 115 (40.0 mm SL, male), 00 : 56–02 : 57, 10 Nov. 1985, 35°01.2′N, 139°19.8′E, IKPT, 0–1078 m; CBM-ZF 116 (23.0 mm SL, ?, cleared and stained), 19 : 13–21 : 06, 24 July 1988, 35°00′N, 139°20′E, IKPT, 0–996 m; CBM-ZF 117 (20.0 mm SL, ?), 19 : 03–20 : 56, 9 Nov. 1985, 35°01.8′N, 139°20.5′E, IKPT, 0–910 m; CBM-ZF 119 (17.0 mm SL, ?), 09 : 15–11 : 25, 10 Nov. 1985, 35°02.5′N, 139°21.8′E, IKPT, 0–961 m; CBM-ZF 120 (19.3 mm SL, ?), 13 : 25–15 : 36, 9 Nov. 1985, 35°01.1′N, 139°19.2′E, IKPT, 0–1093 m; CBM-ZF 123 (33.5 mm SL, male), 14 : 01–16 : 05, 24 July 1988, 35°00′N, 139°20′E, IKPT, 0–1199 m; CBM-ZF 129 (62.5 mm SL, female, cleared and stained), 19 : 13–21 : 06, 24 July 1988, 35°00′N, 139°20′E, IKPT, 0–996 m; CBM-ZF 130 (51.0 mm SL, male), 17 : 51–19 : 03, 23 May 1983, 135°01.8′N, 139°21.3′E, ORI-69, 0–680 m; CBM-ZF 218 (23.0 mm SL, ?), 08 : 10–09 : 37, 15 June 1984, 35°00.9′N, 139°20.5′E, ORI-69, 0–1040 m; CBM-ZF 1024 (23.0 mm SL, ?, cleared and stained), 15 : 58–18 : 19, 16 Sept. 1986, 35°02.7′N, 139°14.7′E, IKPT, 0–1085 m; CBM-ZF 1026 (31.0 mm SL, female, cleared and stained), 20 : 57–23 : 08, 23 Nov. 1985, 35°00.1′N, 139°20.4′E, IKPT, 0–1035 m; CBM-ZF 1027 (37.0 mm SL, male, cleared and stained), 00 : 56–02 : 57, 10 Nov. 1985, 35°01.2′N, 139°19.8′E, IKPT, 0–1078 m; NSMT-P 33548 (43.5 mm SL, male), 21 : 24–23 : 41, 2 July 1985, 35°02.7′N, 139°17.8′E, IKPT, 0–1280 m; NSMT-P 33549 (27.5 mm SL, male), 20 : 57–23 : 08, 23 Nov. 1985, 35°00.1′N, 139°20.4′E, IKPT, 0–1035 m; ZMUC P761179 (52.5 mm SL, female), 03 : 49–05 : 41, 3 Aug. 1983, 34°58.9′N, 139°21.1′E, IKMT, 0–? m; ZMUC P761180 (49.5 mm SL, male); 14 : 01–16 : 05, 24 July 1988, 35°00′N, 139°20′E, IKPT, 0–1199 m.

Diagnosis. A species of *Parabrotula* with 44–50 dorsal fin rays, 64–73 total vertebrae and the anal fin origin under vertebrae 29–32.

Description of holotype. (Paratypes in parentheses.) D 45 (44–50); A 40 (37–43); C 6 (6); P 8 (6–8). Gill rakers on first arch 9 (5–13). Branchiostegal rays 5 (5–7). Vertebrae 67 (64–73). Origin of anal fin under dorsal fin ray 7 (7–9); under vertebra 29 (29–32). Origin of dorsal fin above vertebra 24 (23–27).

Body proportions (% SL). Head length 15.8 (12.0–22.3); snout length 4.2 (3.7–8.3); upper jaw length 4.8 (3.5–10.1); lens diameter 1.2 (1.2–2.1); predorsal length 47.3 (44.0–50.9); preanal length 53.9 (50.7–59.3).

Body elongate and slender, laterally compressed posteriorly. Skin smooth, loose on body and fins. Vertical fins confluent; origin of dorsal fin at about midpoint of SL; anal fin origin inserted just behind posterior end of body cavity. Pectoral fins inserted at midpoint of body depth. Pelvic fins absent. Gill slits wide, ending at horizontal level of eye; branchiostegal membrane free of isthmus. Minute papillae along lateral line.

Head small, its dorsal profile slightly convex. Anterior nostril just behind midpoint of premaxillary, about half size of posterior one located just in front of eye. Longest axis of nasal rosette about size of lens diameter. Eye small, covered with transparent skin. Interorbital region somewhat flattened. Tip of upper jaw ending just before midpoint of eye. Lower jaw protruding.

Each premaxillary with 6 (6–10) tiny, sharp, recurved teeth in a single row; its posterior part edentate. Each dentary anteriorly with 10 (8–10) slightly larger teeth. Vomer with 2–4 teeth.

Knob-like gill rakers present on cerato- and hypobranchials. Relatively long gill filaments on 1st–3rd

Table 1. Frequency distributions of selected meristic characters of *Parabrotula tanseimaru* and *P. plagiophthalma*.

Total vertebrae	N	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
tanseimaru	17											1		3	2	2	5	1	2		1
*plagiophthalma**	7			1		4	1		1												
*plagiophthalma***	113	1	2	12	14	24	31	18	7	3		1									

Dorsal fin rays	N	37	38	39	40	41	42	43	44	45	46	47	48	49	50
tanseimaru	21								1	5	6	3	1	4	1
*plagiophthalma**	6			1	4			1							
*plagiophthalma***	87	2	16	21	27	12	7	2							

Anal fin rays	N	34	35	36	37	38	39	40	41	42	43
tanseimaru	22				2	1	3	6	4	5	1
*plagiophthalma**	6	1		3		2					
*plagiophthalma***	90	7	19	25	23	13	3				

Caudal fin rays	N	4	5	6
tanseimaru	18			18
*plagiophthalma**	8		6	2
*plagiophthalma***	72	1	67	4

DNAOA†	N	2	3	4	5	6	7	8	9
tanseimaru	9						6	1	2
*plagiophthalma**	6			1	2	3			
*plagiophthalma***	108	1	2	26	54	18	5	2	

VNBOD††	N	16	17	18	19	20	21	22	23	24	25	26	27
tanseimaru	9								3	3	2		1
*plagiophthalma**	7					3	4						
*plagiophthalma***	106	1	1	6	26	31	29	7	5				

VNAOA†††	N	21	22	23	24	25	26	27	28	29	30	31	32
tanseimaru	13									3	4	4	2
*plagiophthalma**	7				3	4							
*plagiophthalma***	111	2	6	28	30	35	8	1	1				

* From Japanese waters (present study).

** From other waters, mainly the eastern North Atlantic (Nielsen et al., 1990).

† Dorsal fin ray number above origin of anal fin ray.

†† Vertebral number below origin of dorsal fin ray.

††† Vertebral number above origin of anal fin ray.

arches; short, poorly developed filaments on 4th gill arch.

Copulatory apparatus (holotype, female) with a forwardly directed lobe on each side of urogenital opening located just behind anus. Copulatory apparatus of two male paratypes with relatively long, posteriorly-directed intromittant organ, covered with a fleshy urogenital sinus around its base.

Color immediately after capture: Jet black. Color in preservative: Light brown (dark to light brown depending on the condition of specimens), somewhat darker around peritoneum and vertical fin bases, but faded around orbit.

Comparisons with *P. plagiophthalma*. Selected meristic characters are shown for *P. tanseimaru* and *P. plagiophthalma* (Table 1). The new species can be readily distinguished from *P. plagiophthalma* by dorsal fin ray counts (mean values in parentheses) (44–(46.7)–50 vs. 37–(40.3)–43), total vertebral counts (64–(68.4)–73 vs. 54–(58.3)–64) and position of the anal fin origin in relation to the vertebral number (29–(30.4)–32 vs. 21–(24.6)–28).

The dorsal profile of the snout in specimens larger than ca. 40 mm SL is convex in *P. tanseimaru* and concave in *P. plagiophthalma*. In specimens smaller than 40 mm, the profile is concave in both species.

Nielsen et al. (1990) noted that only five (29–38 mm SL) of 141 specimens examined (10–48 mm SL) of *P. plagiophthalma* have premaxillary teeth, while none of our comparative specimens (22–48 mm SL) have teeth on the premaxillaries. *P. tanseimaru* specimens larger than 49 mm SL (5 of 25 specimens) have teeth along the anterior half of the premaxillaries, while all smaller specimens have edentate premaxillaries. This suggests that the occurrence of premaxillary teeth in *P. tanseimaru* is associated with its ontogeny. This is further supported by the fact that teeth on the dentaries and vomer of *P. tanseimaru* are developed only in specimens larger than 43.5 mm SL.

Etymology. After Research Vessel Tansei Maru, University of Tokyo, in recognition of her contributions to the biology of the midwater fishes in Sagami Bay. The name is treated here as a noun in apposition.

Distribution and ecology

Vertical and horizontal distribution. Since *P. tanseimaru* was not captured by any discrete-depth tows, no information is available on its depth range and ontogenetic/daily vertical migration patterns. Nielsen et al. (1990) reported that more than 90% of *P. plagiophthalma* occur within a depth range of 760–1500 m. The shallowest oblique-haul that caught *P. tanseimaru* (CBM-ZF 130) was towed between the surface and 680 m, suggesting that *P. tanseimaru* is a meso/bathypelagic fish like its congener, *P. plagiophthalma* (Nielsen et al., 1990).

Despite its dominance over *P. plagiophthalma* in Sagami Bay (25 specimens vs. 8 specimens), no *P. tanseimaru* were reported from other Japanese localities by Kimura et al. (1990). The meristic data from Kimura et al. (1990) fall within the ranges of *P. plagiophthalma* and all seven localities recorded by them are far off the Japanese east coast. Although only circumstantial evidence is available, these records, together with two specimens of *P. plagiophthalma* from south of Boso Peninsula (CBM-ZF 107 and 1028, see "Comparative material") and the lack of *P. tanseimaru* catch records from oceanic waters, imply a pseudoceanic characteristic of *P. tanseimaru* compared with the more oceanic occurrences of *P. plagiophthalma* (see Nielsen et al., 1990).

Reproduction. Unlike for *P. plagiophthalma* (see Nielsen et al., 1990), no gravid female was found in our catches. However, immature ovaries exhibit quite similar structures to those in *P. plagiophthalma* (Nielsen, 1968), with few oocytes being found in each ovary. Three males (40.0–51.0 mm SL) were equipped with an intromittant organ extending beyond the genital hood (hereafter regarded as ripe according to Nielsen et al., 1990), indicating that the species has internal fertilization and is probably viviparous like its congener.

No distinct reproductive periodicity was recognized. Occurrences of smaller fish (<20 mm SL) were scattered throughout the year (March, August and November) and ripe males were found in May, July and November, a situation quite similar to the occurrence of the smaller fish.

Feeding. The stomach and intestinal contents of 16 specimens (14.5–62.5 mm SL) were removed and examined. Of these, 11 specimens had 1 to 5 prey animals (total, 25 animals), which comprised copepods of various stages and one ostracod. Copepods of the genus *Scolecithricella* were the most abundant prey item (60%: one adult female was identified as *S. ovata*), followed by *Scaphocalanus* spp. (12%), unidentified calanoids (12%), *Oncaea* spp. (8%) and *Chiridius* sp. (4%). Most of these copepod genera occur primarily in the mesopelagic zones (see Roe,

1972), probably reflecting the habitat of *P. tanseimaru*. There was no indication of feeding periodicity.

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We are greatly indebted to the officers, crew members and scientists on board of the R. V. Tansei Maru for their assistance and cooperation at sea. S. Nishida kindly identified the stomach and intestinal contents. S. Kimura provided a copy of his manuscript on the new record of *P. plagiophthalma* from Japanese waters. N. R. Merrett and K. Sasaki read the manuscript and gave us constructive comments. We wish to thank all of them. One of us (MM) is grateful to the late T. Nemoto for his continuous encouragement throughout this study.

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相模湾から採集された中・深層性ニセイタチウオ科魚類の1新種

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相模湾中央部の中・深層から採集された25個体のニセイタチウオ科魚類の標本に基づき，新種サガミニセイタチウオ *Parabrotula tanseimaru* を記載した．本種はニセイタチウオ属2番目の種であり，既知種ニセイタチウオと共に相模湾に出現する．本種は背鰭鰭条数が多いこと(44–50対34–43)および総脊椎骨数が多いこと(64–73対54–64)で既知種と識別される．本種は沿岸寄りの中・深層帯に分布する胎生魚で，主として橈脚類を摂餌している．

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