

Redescription of the Snailfish *Careproctus rhodomelas* (Cottoidei: Liparidae), with Ontogenetic and Distributional Notes

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The rare Japanese deep-sea snailfish *Careproctus rhodomelas* Gilbert and Burke, 1912 is redescribed based on the holotype and 10 newly-collected specimens (30.0–131.4 mm standard length), with notes on morphological variations in pelvic disk size and body coloration caused by ontogenetic development. An updated distribution of the species is also provided, including the first voucher-supported records off eastern Miyakejima Island and the Hatoma Knoll in the southern part of the Okinawa Trough.

Key Words: Taxonomy, Teleostei, rare species, pelvic disk, body color.

Introduction

Careproctus Krøyer, 1862 is one of the most speciose genera of snailfishes in the family Liparidae, comprising over 130 species distributed worldwide (Chernova et al. 2004; Orr et al. 2019). The former is primarily distinguished from other genera by the following combination of characters: one pair of nostrils; pseudobranch absent; pelvic disk present; pectoral fins typically with fewer rays than anal fin; body color uniformly light or dark, often gradually darkening posteriorly when otherwise light, rarely variegated (Orr and Maslenikov 2007). Additionally, the absence of a coronal pore and small papillae on some cephalic pores, and the teeth usually arranged in band-like rows clearly distinguish *Careproctus* from *Pseudoliparis* Andriashev and Pitruk, 1993, *Allocareproctus* Pitruk and Fedorov, 1993, and *Squaloliparis* Pitruk and Fedorov, 1993, species in the latter three genera had been previously assigned to the former (Andriashev and Pitruk 1993; Pitruk and Fedorov 1993a, b; Orr and Busby 2006). Because many species of *Careproctus* are rare or uncommon, pertinent biological information is often lacking.

Careproctus rhodomelas Gilbert and Burke, 1912, a rare species in Japanese waters, was originally described from the holotype and single paratype, collected off the Bungo Channel and south of Suruga Bay, respectively. In the absence of other reports supported by voucher specimens, Kido (1988) redescribed the species based on two further specimens collected from Tosa Bay (near the type locality). However, morphological variation in the species and its distributional

range are unclear because of the small number of known specimens. Accordingly, *C. rhodomelas* is redescribed herein based on the holotype and 10 newly-collected specimens, with notes on ontogenetic morphological variations and an updated distribution.

Materials and Methods

Counts, measurements, and descriptive terminology followed Orr and Maslenikov (2007), except for cephalic pore terminology, which follows Stein et al. (2001). Vertebral and median-fin ray counts were made from radiographs. Counts of gill rakers were taken from the first gill arch on the right side. Cephalic pores were examined after staining with Cyanine Blue following Saruwatari et al. (1997). Colors of the peritoneum, stomach, and pyloric caeca were noted following dissection. The right pectoral girdle was removed from MSM-20-65, and cleared and stained following Potthoff (1984). Holotype description are given first, followed by non-type descriptive notes in parentheses when different. Standard length and head length are abbreviated as SL and HL, respectively. The specimens examined are deposited in the fish collections of the Faculty of Science and Technology, Kochi University, Japan (BSKU), the Marine Science Museum, Tokai University, Shizuoka, Japan (MSM), and the Smithsonian Institution, National Museum of Natural History, Suitland, USA (USNM).

Careproctus rhodomelas Gilbert and Burke, 1912

[Standard Japanese name: Bara-bikunin]

(Figs 1–5; Table 1)

Careproctus rhodomelas Gilbert and Burke, 1912: 365, fig. 7, pl. 44 (original description, type locality: off the Bungo Channel, Japan, 741 m depth; paratype locality: south of Suruga Bay, Japan, 927 m depth); Jordan et al. 1913: 307 (off the Bungo Channel and south of Suruga Bay, Japan); Burke 1930: 118, figs 37, 38 (description of the type specimens); Taranetz 1937: 134 (off the Bungo Channel and south of Suruga Bay, Japan; key); Okada and Matsubara 1938: 347 (off the Bungo Channel and south of Suruga Bay, Japan; key); Matsubara 1955: 1194 (off the Bungo Channel and south of Suruga Bay, Japan; key); Okamura 1982: 293, pl. 209 (Bungo Channel to Suruga Bay, Japan; description); Kido 1984: 338, pl. 304-J (Bungo Channel to Suruga Bay, Japan; brief description); Kido 1988: 198, fig. 37 (description of third and fourth specimens from Tosa Bay, Japan, 605–750 m depth); Nakabo 1993: 584, unnumbered fig. (Bungo Channel to Suruga Bay, Japan; key); Nakabo 2000: 669, unnumbered fig. (Bungo Channel to Suruga Bay, Japan; key); Shinohara et al. 2001: 320 (Tosa Bay, Japan; listed); Chernova et al. 2004: 15 (Bungo Channel to Suruga Bay, Japan; listed); Nakabo and Kai 2013: 1210, unnumbered fig. [?Sea of Japan (off Oki, Shimane); Bungo Channel; Tosa Bay; Suruga Bay, Japan; key].

Materials examined. Holotype: USNM 73334, 111.1 mm SL, male, off the Bungo Channel, Japan, Albatross station 4958, 32.606°N, 132.408°E, 741 m depth, 23 August 1906.

Non-types (10 specimens, 30.0–131.4 mm SL): BSKU 20294, 117.8 mm SL, male, off eastern Miyakejima Island, Japan, 34.058°N, 140.000°E, 1160 m depth, 14 November 1972; BSKU 46963, 131.4 mm SL, sex unknown, Tosa Basin (off-shore from Tosa Bay), Japan, 32.895°N, 133.678°E–32.913°N, 133.694°E, 996–1010 m depth, 8 November 1989, R/V *Tansei-maru* (KT89-16, T1), beam trawl; BSKU 102864, 87.4 mm SL, male, Hatoma Knoll, southern Okinawa Trough, Japan, latitude and longitude unknown, 1530 m depth, 10 May 2005; MSM-20-63, 40.2 mm SL, immature female, South Komagoe Submarine Canyon, Suruga Bay, Japan, 34.947°N, 138.550°E–34.947°N, 138.578°E, 534–821 m depth, 5 February 2008, R/V *Hokuto*, epibenthic ring net; MSM-20-64, 30.0 mm SL, immature, off the Fuji-gawa River estuary mouth, Suruga Bay, Japan, 35.060°N, 138.643°E–35.063°N, 138.683°E, ca. 910 m depth, 16 December 2009, R/V *Hokuto*, epibenthic ring net; MSM-20-65, 75.5 mm SL, male, Hagaromo Submarine Canyon, Suruga Bay, Japan, 35.003°N, 138.553°E–35.003°N, 138.617°E, 400–1196 m depth, 12 December 2012, R/V *Hokuto*, beam trawl; MSM-20-66, 52.1 mm SL, immature male, collected with MSM-20-65; MSM-20-67, 35.7 mm SL, immature, collected with MSM-20-65; MSM-20-71, 30.4 mm SL, immature, Hagaromo Submarine Canyon, Suruga Bay, Japan, 35.005°N, 138.538°E–35.005°N, 138.617°E, 414–1208 m depth, 16 January 2013, R/V *Hokuto*, beam trawl; MSM-

20-72, 30.5 mm SL, immature, Hagaromo Submarine Canyon, Suruga Bay, Japan, 35.003°N, 138.560°E–35.005°N, 138.615°E, 460–1209 m depth, 15 March 2013, R/V *Hokuto*, beam trawl.

Diagnosis. A species of *Careproctus* distinguished from all currently recognized congeners by the following combination of characters: total vertebrae 60–63, dorsal-fin rays 54–58, anal-fin rays 48–51, pectoral-fin rays 28–31, teeth on both jaws strongly trilobed, gill slit entirely above pectoral-fin base or extending ventrally to 1st–3rd pectoral-fin ray base, longest ray of lower lobe pectoral fin longer than or nearly equal to HL (90.0–128.0% HL), peritoneum and stomach black.

Description. Counts and measurements given in Table 1. Body slender, rounded in cross section anteriorly, tapering gradually and becoming moderately compressed posteriorly, deepest at nape region (Fig. 1). Skin lacking prickles, containing thin subdermal gelatinous layer. Head small, dorsal profile rounded from nape to snout. Snout deep, slightly (or not) projecting. Mouth subterminal, small, oral cleft extending to below center of orbit (or anterior margin of orbit); maxilla extending to below posterior margin of orbit (or between center and posterior margin of orbit) (Fig. 2A). Lower jaw slightly inferior, mandibular tooth plates somewhat behind premaxillary tooth plates. Teeth on both jaws short, strongly trilobed; inner teeth larger than outer teeth (Fig. 2B). Premaxillary teeth in about 10 (6–10) oblique rows of 3–6 (3–9) teeth forming bands. Mandibular teeth in about 9 (5–9) oblique rows of 4–6 (3–8) teeth forming bands. Diastema absent at upper and lower jaw symphyses. Single nostril tube-like, horizontally level with center of orbit. Orbit size moderate, dorsal contour not touching dorsal profile of head; pupil round. Cephalic lateralis pores small, almost same size or smaller than nostril, nasal pores 2, maxillary pores 6, preoperculomandibular pores 7, suprabranchial pores 2; pore pattern 2-6-7-2 (damaged in holotype) (Fig. 2A). Coronal pore absent. Chin pores (=anteriormost preoperculomandibular pores) paired, opening separately, not in common pit. About 13–20 free neuromasts forming irregular rows, originating from around nape and extending posteriorly to about two-thirds of body length (damaged in holotype). Gill slit short, upper margin horizontally level with upper margin of orbit; lower margin entirely above pectoral-fin base or extending ventrally to 1st–3rd pectoral-fin ray base (damaged in holotype). Gill rakers restricted to lower part of arch, blunt and minute (status in holotype unknown). Pseudobranch absent (status in holotype unknown). Opercular flap angular (or slightly rounded), supported by two spines; upper spine (from opercle) and lower spine (from subopercle) extending posteriorly to just before vertical through dorsal-fin origin.

Dorsal- and anal-fin rays deeply buried in gelatinous tissue anteriorly. Anteriormost pterygiophore of dorsal fin with ray, inserted between 4th and 5th (or 3rd and 4th) neural spines. Membrane of posterior dorsal-fin rays continuous with caudal fin, overlapping 40.7–51.0% of caudal-fin length (damaged in holotype). Anal-fin origin below 9th (7th–9th) dorsal-fin ray base. Membrane of posterior anal-

Table 1. Counts and measurements of *Careproctus rhodomelas*.

	Holotype	Non-types	<i>n</i>
SL (mm)	111.1	30.0–131.4	10
Counts			
Vertebrae (abdominal+caudal)	61 (10+51)	60–63 (9 or 10+50–53)	10
Dorsal-fin rays	55	54–58	10
Anal-fin rays	48	48–51	10
Pectoral-fin rays	31	28–31	10
Caudal-fin rays	10	10–13	10
Principal caudal-fin rays (upper+lower)	9 (4+5)	9 or 10 (4 or 5+5)	10
Procurent caudal-fin rays (upper+lower)	1 (1+0)	1–3 (1 or 2+0 or 1)	10
Branchiostegal rays	6	6	10
Gill rakers	Unknown	6–8	7
Pyloric caeca	Unknown	7–10	5
Measurements in percent of SL (HL)			
Head length	18.7	18.0–22.7	10
Head width	12.3 (65.9)	11.9–16.2 (57.1–74.8)	10
Maximum body depth	16.7 (88.9)	15.8–17.7 (72.2–88.6)	10
Body depth at pelvic disk	15.7 (83.7)	14.0–17.7 (72.2–81.5)	10
Body depth at anal-fin origin	14.0 (74.5)	9.9–14.4 (46.2–72.0)	10
Snout length	5.1 (27.4)	5.2–7.7 (27.5–35.4)	10
Maxilla length	7.7 (40.9)	7.0–10.9 (38.0–52.8)	10
Mandible length	7.5 (39.9)	6.5–10.5 (36.2–50.6)	10
Mouth width	8.9 (47.6)	8.2–10.4 (37.7–49.4)	10
Orbit length	4.6 (24.5)	4.2–6.2 (22.2–27.5)	10
Interorbital width (flesh)	8.1 (43.3)	7.0–10.9 (37.6–48.7)	10
Interorbital width (bony)	2.9 (15.4)	2.2–3.9 (11.9–18.5)	10
Suborbital to maxilla length	2.7 (14.4)	2.8–4.0 (14.1–17.7)	10
Gill slit length	Unknown	2.9–4.6 (12.8–22.2)	9
Pectoral-fin ray length (upper lobe)	12.2 (64.9)	10.9–14.6 (50.8–69.9)	10
Pectoral-fin ray length (lower lobe)	ca. 20.6 (ca. 110.1)	18.5–23.0 (90.0–128.0)	10
Pectoral-fin ray length at notch	Unknown	4.2–7.7 (20.6–41.3)	10
Pelvic disk length	2.3 (12.5)	2.3–5.0 (12.7–22.1)	10
Pelvic disk width	2.2 (11.5)	2.1–4.5 (11.4–20.3)	10
Caudal fin length	10.1 (53.8)	9.2–14.3 (46.2–64.6)	10
Predorsal fin length	20.9 (111.5)	19.9–25.8 (101.1–122.0)	10
Snout to pelvic disk	11.2 (59.6)	10.5–16.9 (53.8–77.2)	10
Mandible to pelvic disk	8.2 (43.8)	8.8–14.4 (47.3–70.0)	10
Snout to anus	16.4 (87.5)	17.3–25.6 (89.0–115.0)	10
Mandible to anus	14.7 (78.4)	15.4–23.6 (77.9–107.2)	10
Pelvic disk to anus	4.5 (24.0)	3.4–7.9 (16.0–34.8)	10
Preanal fin length	31.9 (170.2)	29.9–34.8 (135.2–183.9)	10
Anus to anal-fin origin	16.5 (88.0)	9.2–15.2 (41.2–84.7)	10
Dorsal-fin origin to anal-fin origin	22.3 (119.2)	18.1–20.1 (81.2–109.3)	10

Abbreviations: SL, standard length; HL, head length.

fin rays continuous with caudal fin, overlapping 43.5–51.0% of caudal-fin length (damaged in holotype). Caudal fin truncate. Hypural plates fused with terminal vertebral centrum, upper and lower plates separated by a narrow slit. A single epural. Two (or three) paired minute pleural ribs on posterior abdominal vertebrae (rarely absent in immature specimens).

Pectoral fin deeply notched, shortest ray at notch shorter than or almost equal to half length of longest ray in both lobes (damaged in holotype). Upper lobe rays slightly free from membrane at tip; 2nd (2nd–4th) ray from dorsalmost longest, reaching to below 7th (6th–9th) dorsal-fin ray base. Lower lobe rays more prominent than upper lobe rays; 5th

(3rd–5th) rays from ventralmost longest, longer than (or nearly equal to) head. Rays in notch more widely spaced than on either lobe. Uppermost pectoral-fin base at about 1/2 body depth, lowermost pectoral-fin base below posterior margin of orbit. Proximal radials 4 (3+1), robust, rounded, lacking notches or interradiial fenestrae (Fig. 2C). Scapula and coracoid with short stout helve, lacking notches. Distal radials supporting all pectoral-fin rays.

Pelvic disk triangular (rarely slightly oval in immature specimens), longer than wide, anterior lobe well developed and moderately upturned (Fig. 3). Relative size of pelvic disk widely variable (Table 1), apparently becoming smaller with growth, particularly between 30.0 mm SL and 87.4 mm



Fig. 1. Fresh specimens of *Careproctus rhodomelas*. A: MSM-20-65, 75.5 mm SL, male; B: MSM-20-63, 40.2 mm SL, immature female; C: MSM-20-64, 30.0 mm SL, immature.

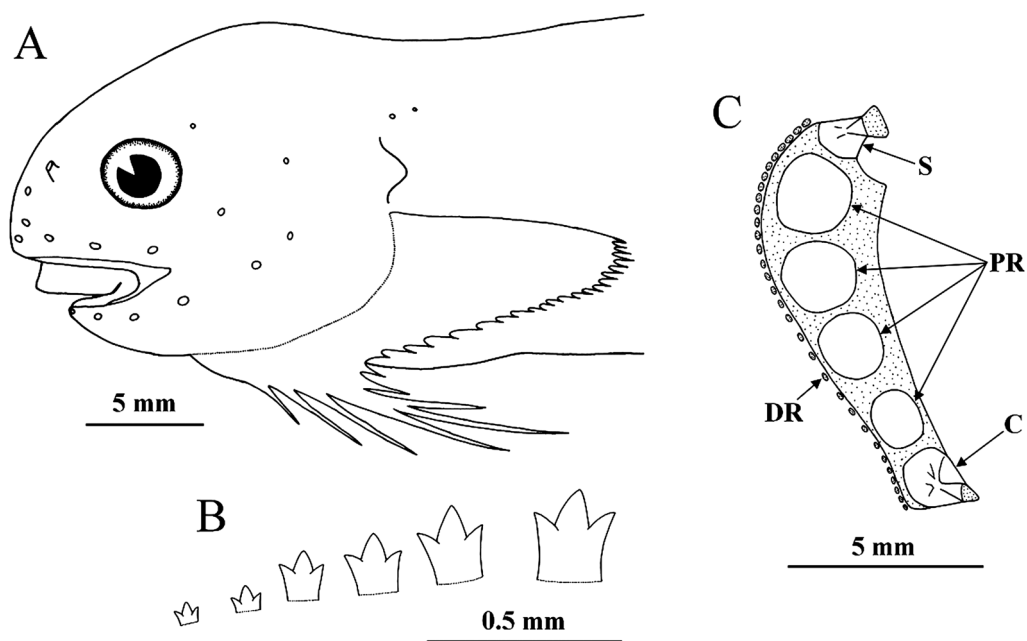


Fig. 2. Sketches of *Careproctus rhodomelas*, MSM-20-65, 75.5 mm SL, male. A: Lateral view of head and anterior part of body; B: premaxillary teeth (right side); C: pectoral girdle (right side). Abbreviations: C, coracoid; DR, distal radial; PR, proximal radial; S, scapula.

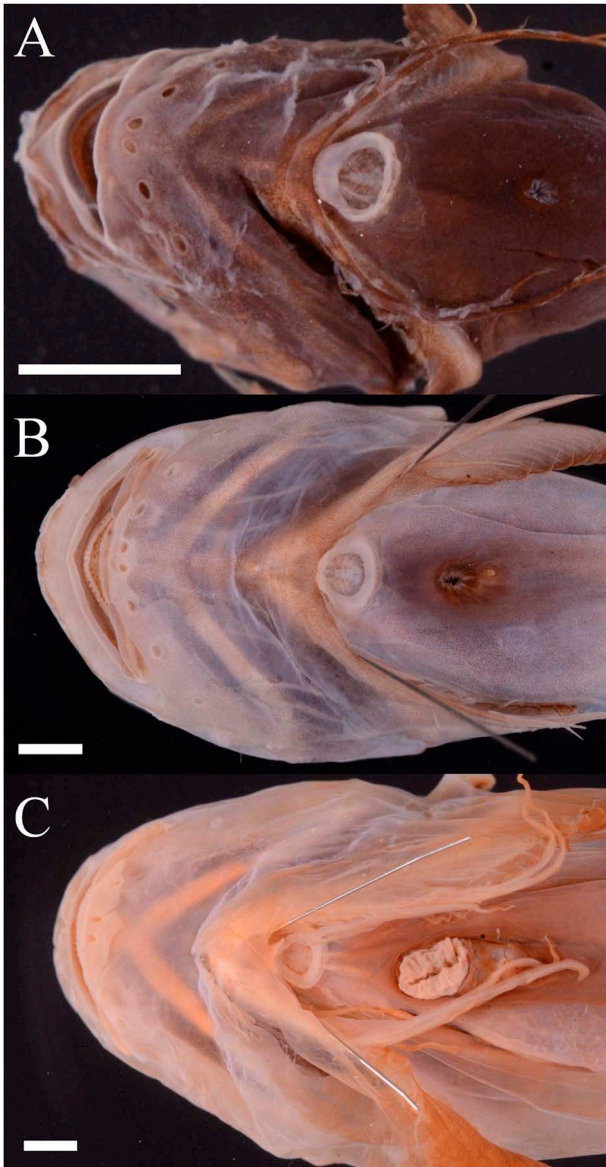


Fig. 3. Ventral views of head and anterior part of body (preserved condition) of *Careproctus rhodomelas*. A: MSM-20-71, 30.4 mm SL, immature; B: MSM-20-65, 75.5 mm SL, male; C: BSKU 20294, 117.8 mm SL, male. Scale bar: 3 mm.

SL (Figs 3, 4). Anus closer to posterior margin of pelvic disk than to anal-fin origin, vertically below dorsal-fin origin. Small conical urogenital papilla present behind anus (absent in immature specimens). Stomach and pyloric caeca located on left side of visceral cavity.

Color when fresh. Head, body and fin coloration differ with body size: at 75.5 mm SL - anterior part of head (especially snout and chin) reddish, posterior part of head, body, and basal parts of dorsal and anal fins pink, distal margins of dorsal and anal fins dark red, caudal fin reddish, pectoral fin dark red, except black distal margin of upper lobe (Fig. 1A); at 40.2 mm SL - head, anterior half of body, dorsal and anal fins black, posterior half of body, dorsal and anal fins, and caudal fin pale pink, pectoral fin black (Fig. 1B); at 30.0 mm SL - similar to 40.2 mm SL, except pale (whitish) on posterior half of body, dorsal and anal fins, and caudal

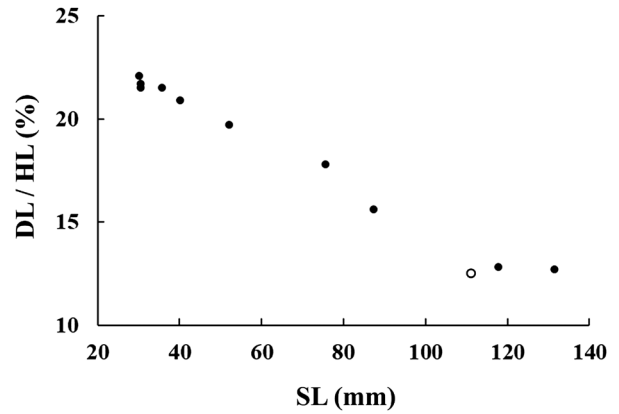


Fig. 4. Relationship between standard length (SL) and pelvic disk length to head length (DL/HL). Open circle, holotype; solid circles, non-types.

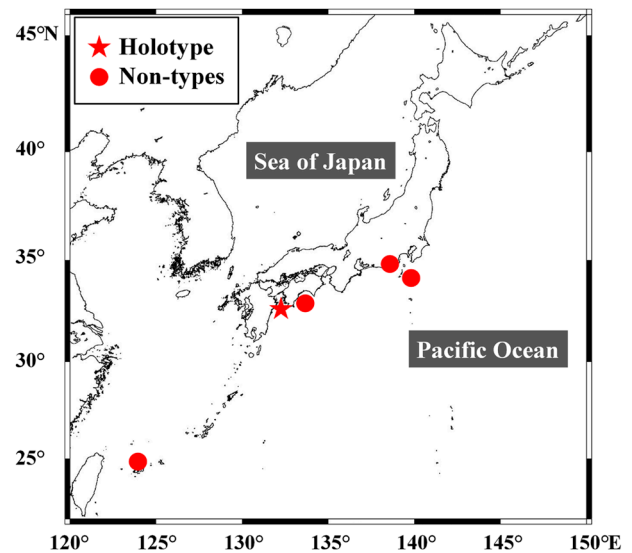


Fig. 5. Distribution of specimens of *Careproctus rhodomelas* examined in this study.

fin (Fig. 1C). Eye black. Gill cavity and peritoneum (visible through skin) black.

Color in alcohol. Fresh reddish or pinkish colors fading to pale white; black coloration unchanged or becoming slightly lighter. Lips and mouth cavity dusky. Gill cavity, peritoneum and stomach black. Pyloric caeca completely black or mottled at tips.

Distribution. Known from the western North Pacific adjacent to southern Japan: off the eastern part of Miyakejima Island, Suruga Bay, Tosa Bay, off the Bungo Channel, and the Hatoma Knoll (southern Okinawa Trough) in 400–1530 m depth (Fig. 5).

Remarks. The newly-collected specimens agreed well with the holotype of *C. rhodomelas* in having similar counts of vertebrae and fin rays, strongly trilobed teeth, long rays in the pectoral fin lower lobe, and a black peritoneum and stomach. Pelvic disk size and body coloration of examined specimens varied with ontogenetic development. Such changes with development have not been noted previously

in species of *Careproctus*, although Burke (1930) referred to the greatly reduced pelvic disk in the type specimens of *C. rhodomelas* relative to other species in the genus. They may indicate a life-style change with growth, such as increasing independence from the sea-floor or some substrates. Kobayashi (1962) noted that the pelvic disk of the smooth lumpsucker *Aptocyclus ventricosus* (Pallas, 1769) belonging to Cyclopteridae [= a sister family of Liparidae (see Orr et al. 2019)] was much smaller in pelagic sub-adult specimens (<122 mm SL) than in benthic adults (160–295 mm SL), and suggested that the size was related to life-style in that species.

Among the species of *Careproctus* known from the Japanese waters, *C. rhodomelas* shares trilobed teeth and a dark (brown or black) peritoneum with *Careproctus melanurus* Gilbert, 1892, *Careproctus simus* Gilbert, 1896, *Careproctus marginatus* Kido, 1988, *Careproctus rotundifrons* Sakurai and Shinohara, 2008, and *Careproctus surugaensis* Murasaki, Takami, and Fukui, 2017 (Stein 1978; Kido 1985, 1988; Sakurai and Shinohara 2008; Murasaki et al. 2017; this study). However, the former clearly differs from the latter species in having 60–63 total vertebrae (vs. 52–55 in *C. marginatus*, 53–56 in *C. rotundifrons* and 50 in *C. surugaensis*), 54–58 dorsal-fin rays (vs. 47–50 in *C. marginatus* and *C. rotundifrons*, and 47 in *C. surugaensis*), 48–51 anal-fin rays (vs. 40–43 in *C. marginatus*, 41–45 in *C. rotundifrons* and 39 in *C. surugaensis*), 28–31 pectoral-fin rays (vs. 34–40 in *C. rotundifrons*), gill slit entirely above pectoral-fin base or extending ventrally to 1st–3rd pectoral-fin ray base (vs. extending ventrally to 7th pectoral-fin ray base in *C. surugaensis*), long lower pectoral-fin rays, 90.0–128.0% HL (vs. short, 34.8–50.3% HL in *C. simus* and 35.8–58.2% HL in *C. marginatus*), and a black stomach (vs. pale in all five species) (Stein 1978; Kido 1985, 1988; Sakurai and Shinohara 2008; Murasaki et al. 2017; this study). In addition, all teeth on both jaws are trilobed in *C. rhodomelas* (vs. simple teeth mixed in *C. simus*, *C. melanurus* and *C. rotundifrons*) (Stein 1978; Kido 1985; Sakurai and Shinohara 2008; Orr et al. 2019; this study).

The voucher-supported records of *C. rhodomelas* are limited (see Introduction), and other records are uncertain. Yanai (1950) and Kato (1956) listed *C. rhodomelas* from the Sea of Japan without any voucher specimens or descriptive details, and were later cited by several authors (e.g., Shinohara et al. 2014). However, Yanai (1950) failed to list *Careproctus trachysoma* Gilbert and Burke, 1912, despite that species being common in the Sea of Japan, as Nakabo and Kai (2013) pointed out, and may have misidentified *C. trachysoma* as *C. rhodomelas*. Accordingly, the record of *C. rhodomelas* from the Sea of Japan remains unsupported and likely invalid. Takemura et al. (2010) reported reproduction in *C. rhodomelas* collected by a remotely-operated vehicle (ROV) from around the hydrothermal vents on Hatoma Knoll in the southern part of the Okinawa Trough at 1480–1530 m depth (temperature 3.8–3.9°C). According to their report, the species is a year-round spawner, producing a small number of large elliptical eggs (c.f. usually round in snailfishes) ca. 6 mm in maximum diameter. Sakata et

al. (2015) subsequently reported on the visual systems of *C. rhodomelas* from the Hatoma Knoll by the molecular analysis of rhodopsin, and showed that the eyesight of the specimens appeared sufficiently developed to recognize bioluminescence produced by other animals living near the hydrothermal vents. However, those records of *C. rhodomelas* from the Hatoma Knoll without showing any supporting evidence for species identification or museum deposition of the specimens for re-examination. The present specimens from off eastern Miyakejima Island (BSKU 20294) and the Hatoma Knoll, southern Okinawa Trough (BSKU 102864) are the first voucher-supported records of *C. rhodomelas* from those areas, and represent the most eastern, western, and southern records of the species.

Comparative material. *Careproctus surugaensis*: holotype, MSM-17-81, 82.6 mm SL, female, northern part of Suruga Trough, Suruga Bay, 34.978°N, 138.637°E–34.923°N, 138.638°E, 1450–1570 m depth, 28 October 2015.

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