

First Records of the Snailfish *Careproctus lycopersicus* (Cottoidei: Liparidae) from the Western North Pacific

Yoshiaki Kai^{1,3}, Koji Matsuzaki², and Toshiaki Mori²

¹Maizuru Fisheries Research Station, Field Science Education and Research Center, Kyoto University, Nagahama, Maizuru, Kyoto 625-0086, Japan
E-mail: mebaru@kais.kyoto-u.ac.jp

²Marine Science Museum, Fukushima (Aquamarine Fukushima), Onahama, Iwaki, Fukushima 971-8101, Japan

³Corresponding author

(Received 8 March 2019; Accepted 14 May 2019)

Four specimens (168.6–204.4 mm standard length) of *Careproctus lycopersicus* Orr, 2012, previously recorded from the Bering Sea and eastern Aleutian Islands, were collected from the southern Sea of Okhotsk (the Nemuro Strait, eastern Hokkaido, Japan). These specimens represent the first records of the species from the western North Pacific. A detailed description is provided for the specimens, including the intraspecific variations. The new standard Japanese name “Tomato-kon'nyaku-uo” is proposed for the species.

Key Words: Teleostei, Actinopterygii, Sea of Okhotsk, Japan, distribution.

Introduction

Snailfishes of the family Liparidae Scopoli, 1777 compose a large and diverse group in the suborder Cottoidei, having an unusually wide geographic range and habitat range (Chernova *et al.* 2004; Nelson *et al.* 2016; Betancur-R *et al.* 2017). The family comprises over 30 genera with 430 species in the world, and has been estimated to have exceptionally high rates of species formation (Murasaki *et al.* 2017; Rabosky *et al.* 2018; Fricke *et al.* 2019). Of these genera, *Careproctus* Krøyer, 1862 is the most diverse with about 130 species, including 27 from Japanese waters (Kai *et al.* 2011; Machi *et al.* 2012; Nakabo and Kai 2013; Orr *et al.* 2015; Matsuzaki *et al.* 2017; Murasaki *et al.* 2017; Kai *et al.* 2018; Fricke *et al.* 2019). *Careproctus* can be diagnosed by the following characters: a single nostril; pseudobranch absent; 6 branchiostegal rays; pelvic disk present, small to large; pectoral fins typically with fewer rays than anal fin; body color uniformly dark or light, rarely variegated (Kido 1988; Orr and Maslenikov 2007; Orr 2016).

Since 2004, the Marine Science Museum, Fukushima (Aquamarine Fukushima, AMF) has conducted the deep-sea faunal surveys in the Nemuro Strait, off Shiretoko Peninsula, eastern Hokkaido, Japan (southern Sea of Okhotsk) for display and reproductive studies of various organisms (e.g., Komai and Hibino 2019). During the survey, four specimens of *Careproctus lycopersicus* Orr, 2012, known only from the Bering Sea and eastern Aleutian Islands, were collected by shrimp traps and gill nets operated by local fishermen. They represent the first records from the western North Pacific and are described here.

Materials and Methods

Counts, measurements, and descriptive terminology follow Orr and Maslenikov (2007). Counts of median-fin rays and vertebrae were taken from radiographs. The right pectoral girdle was dissected and stained by alcian blue and alizarin red following the methods of Kawamura and Hosoya (1991). Standard length and head length were abbreviated as SL and HL, respectively. The specimens examined in this study are deposited in the fish collections of the Kyoto University, Kyoto and Maizuru, Japan (FAKU), the Hokkaido University Museum, Hakodate, Japan (HUMZ), the Smithsonian Institution, National Museum of Natural History, Suitland, USA (USNM), and the Burke Museum, University of Washington, Seattle, USA (UW). Diagnosis of the species was based on all specimens examined here and the original description (Orr 2012), and the description was based on the specimen from Japan.

Careproctus lycopersicus Orr, 2012

[New standard Japanese name: Tomato-kon'nyaku-uo]
(Figs 1, 2; Table 1)

Careproctus lycopersicus Orr, 2012: 257, figs 1A, 2A (original description, type locality: 56.0153°N, 168.8771°W, Bering Sea, 1096 m depth).

Materials examined. FAKU 145976, 168.6 mm SL, male, off Rausu, Menashi, Hokkaido, Japan, 500–750 m depth, 5 September 2017, F/V *Houyu-Maru*. FAKU 145977, 176.3 mm SL, male, off Rausu, Menashi, Hokkaido, Japan. FAKU 146592, 204.4 mm SL, male, 44.313°N, 145.416°E, off Rausu, Menashi, Hokkaido, Japan, 800–1000 m depth, 14 May 2018, F/V *Houyu-Maru*. FAKU 146593, 182.4 mm SL,

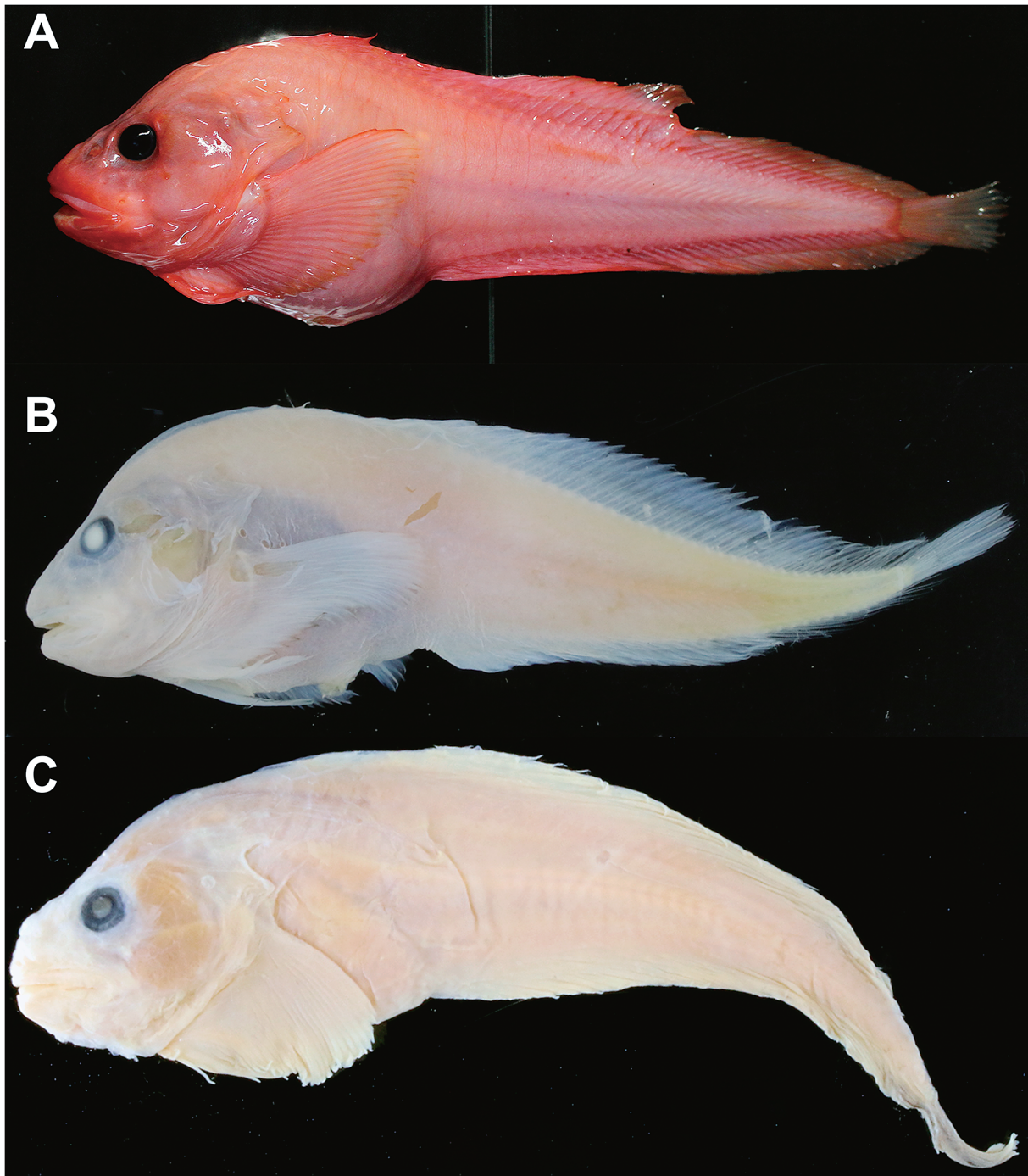


Fig. 1. *Careproctus lycopersicus* from the Nemuro Strait, Hokkaido, Japan (A: FAKU 146593, 182.4 mm SL, fresh condition; B: FAKU 145976, 168.6 mm SL, preserved condition) and one of the paratypes from the Bering Sea (C: UW 119816, 113.5 mm SL, preserved condition).

female, 44.062°N, 145.364°E, off Rausu, Menashi, Hokkaido, Japan, 570–825 m depth, 25 August 2018, F/V *Houyu-Maru*.

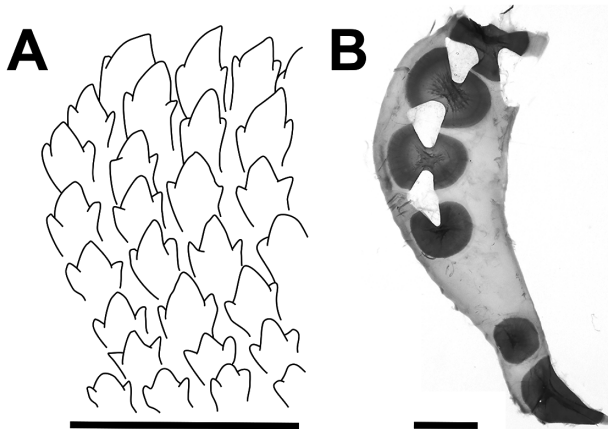
Diagnosis. *Careproctus lycopersicus* is distinguished from all other species of *Careproctus* by the following combination of characters: vertebrae 45–50; dorsal-fin rays 42–45; anal-fin rays 34–38; pectoral fin deeply notched with 33–38 rays; large pelvic disk > 29.9% HL (> 9.0% SL); teeth strongly trilobed on both jaws, inner teeth weakly trilobed or shouldered; cephalic pore pattern 2-6-7-1, chin pores paired; gill slit extending ventrally to pectoral rays 4–12; body bright red in life.

Description of Sea of Okhotsk specimens. Measurements are given in Table 1. Body robust, tapering posteriorly, rounded in cross section anterior to anus, deepest at nape. Skin relatively thick; prickles absent. Head robust and large, dorsal profile strongly sloping from nape to snout. Snout blunt, slightly protruding beyond tip of upper jaw. Mouth terminal and large; maxilla extending to mid orbit or to posterior margin of orbit; oral cleft extending to anterior margin of orbit. Pre-maxillary teeth strongly trilobed in 8–10 oblique rows forming broad bands; inner teeth becoming larger, weakly trilobed or shouldered. Mandibular teeth trilobed in 8 oblique rows; inner

Table 1. Proportional morphometric characters for *Careproctus lycopersicus*.

| | Western North Pacific <i>n</i> =4 | Eastern North Pacific (paratypes) <i>n</i> =2 |
|-------------------------------------|--------------------------------------|--|
| Standard length (mm) | 168.6–204.4 | 113.5–142.6 |
| In % of standard length | | |
| Head length | 30.5 (29.4–31.4) | 31.0 (28.6–33.5) |
| Snout length | 10.1 (8.9–11.1) | 10.7 (10.1–11.4) |
| Orbit length | 5.5 (5.0–6.0) | 5.3 (4.9–5.8) |
| Interorbital width | 9.2 (8.6–9.9) | 8.8 (8.5–9.1) |
| Maxilla length | 14.7 (14.1–15.4) | 14.3 (13.7–14.9) |
| Gill-slit length | 11.8 (10.9–13.6) | 13.5 (12.1–14.9) |
| Body depth at pelvic disk* | 27.6 (24.8–30.3) | 25.6 (25.0–26.3) |
| Pectoral-fin length (upper lobe) | 20.1 (18.7–21.1) | 17.8 (17.2–18.5) |
| Pectoral-fin length (lower lobe) | 18.0 (15.9–19.9) | 18.1 (17.9–18.3) |
| Predorsal length | 32.7 (32.0–33.6) | 31.7 (31.2–32.1) |
| Snout to anus length | 33.4 (31.6–34.4) | 31.3 (29.8–32.7) |
| Pelvic disk length | 10.6 (9.7–11.0) | 11.3 (10.7–11.9) |
| Pelvic disk width | 9.7 (9.1–10.0) | 10.3 (10.2–10.4) |
| Caudal-fin length | 14.9 (14.1–15.8) | 14.2 (14.1–14.2) |
| In % of caudal-fin length | | |
| Dorsal-fin connection to caudal fin | 41.0 (35.2–51.1) | 43.6 (42.8–44.5) |
| Anal-fin connection to caudal fin | 46.1 (43.1–49.7) | 49.9 (44.9–54.9) |

*Including pelvic disk thickness

Fig. 2. Mandibular teeth (A) and right pectoral girdle (B) of *Careproctus lycopersicus* (FAKU 145977, 176.3 mm SL). Scale bars 1 mm (A) and 5 mm (B).

teeth becoming larger, weakly trilobed or shouldered (Fig. 2A). Diastema absent at symphysis of upper and lower jaws. Orbit round, relatively small. Nostril single, with short tube at level with middle of orbit. Pores of cephalic lateralis of moderate size: nasal pores 2, maxillary pores 6, preoperculo-mandibular pores 7, suprabranchial pores 1; cephalic pore pattern 2-6-7-1. Chin pores paired in separate pits. Interorbital pore absent. Gill slit large, upper margin well above level of dorsal margin of orbit, extending ventrally to pectoral rays 4–12. Opercular flap angular or rounded, pointing posterodorsally.

Vertebrae 47–48, precaudal 12 and caudal 35–36. Dorsal-fin unlobed, rays 42–44, tip of rays slightly exerted. Anterior-most dorsal-fin pterygiophore inserted between neural

spines 3 and 4, bearing single short ray. Membrane of posterior dorsal-fin rays continuous with caudal fin. Anal-fin rays 35–36. Anal-fin origin below vertebrae 14. Membrane of posterior anal-fin rays continuous with caudal fin. Caudal fin slightly rounded. Principal caudal-fin rays 10; dorsal procurrent rays 2, ventral procurrent ray 1. Hypurals and parhypural fused into single plate. Pleural ribs 2 pairs, on abdominal vertebrae 9–10 or 10–11.

Pectoral fin deeply notched, with 34–38 rays, just reaching or not reaching to level of anal-fin origin; upper lobe with 27–28 rays; lower lobe moderately elongate with 9–10 rays, 6th ray from ventral side longest, just reaching to anus. Tip of pectoral-fin rays free of membrane, lower rays more strongly exerted. Uppermost pectoral-fin base level with region between ventral margin of orbit and cleft. Lowermost pectoral-fin base posteriorly below posterior margin of orbit. Proximal pectoral radials 4 (3+1) (Fig. 2B). Upper and lower part of radials 1 and 2 deeply notched; upper part of radial 3 deeply notched, crescent shaped; radial 4 rounded. Interradial fenestrae 3, blunt triangular shaped, extending between scapula and proximal radials 1–3. Scapula broadly Y-shaped with strong helve, extending closely to uppermost proximal radial. Coracoid with broad triangular head and long thin helve. Pelvic disk large, round; length (31.3–37.4% HL) slightly longer than wide (30.0–34.1% HL). Anus posterior to gill slit, slightly closer to pelvic disk than to anal-fin origin. Pyloric caeca 12–17.

Coloration (Fig. 1). In life, head, body, and fins uniform bright red; distal margins of posterior dorsal, anal, and pectoral fins faintly dark in males. In preservation, head and body pale; distal margins of posterior dorsal, anal, and pectoral fins faintly dark in males; stomach and peritoneum pale or dusky.

Distribution. Known from the Bering Sea, eastern Aleutian Islands, and southern Sea of Okhotsk (Nemuro Strait) at depth of 304–1096 m (Orr 2012; this study).

Remarks. The present specimens from the southern Sea of Okhotsk were identified as *Careproctus lycopersicus* on the basis of having a deeply notched pectoral fin with 34–38 rays, a large pelvic disk > 31.3% HL (> 9.7% SL), strongly trilobed teeth on both jaws, a cephalic pore pattern of 2-6-7-1, paired chin pores, and a large gill slit (Orr 2012). The shape of the pectoral-fin girdle and most of the measurements are also similar between the specimens from the Sea of Okhotsk and the type specimens, however, the ventral margin of gill slit (extending ventrally to pectoral-fin ray 4–11 in the former vs. 8–12 in the latter) is slightly different (Table 1; Orr 2012). In addition, the type specimens of *C. lycopersicus* have strongly trilobed teeth in 9–20 oblique rows forming the broad bands and have 8–13 pyloric caeca (Orr 2012; this study), but the present specimens have strongly trilobed teeth in 8–10 oblique rows, inner teeth becoming larger, weakly trilobed or shouldered (Fig. 2B) and have 12–17 pyloric caeca. The previously known maximum size of the species is 142.6 mm SL (UW 119817), but the present specimens were much larger, 168.6–204.4 mm SL. We herein considered the above continuous differences between the specimens from the Sea of Okhotsk and the type specimens are attributed to intraspecific

variations, however, further study, including genetics, may demonstrate that they represent two different species.

Among the species of *Careproctus* known from the western North Pacific, *Careproctus sinensis* Gilbert and Burke, 1912 and *Careproctus zachirus* Kido, 1985 are similar to *C. lycopersicus* in having a cephalic pore pattern of 2-6-7-1 (Kido 1985, 1988; Matsuzaki *et al.* 2017; this study). However, *C. lycopersicus* is clearly distinguishable from both species in having a gill slit extending ventrally to pectoral rays 4–12 (*vs.* entirely above the pectoral fin). The cephalic pore pattern of *Careproctus surugaensis* Murasaki, Takami and Fukui, 2017, known only from the holotype collected from Suruga Bay, Japan, is unknown because of the poor condition of the holotype (Murasaki *et al.* 2017). The counts of dorsal-, anal-, and pectoral-fin rays of *C. surugaensis* are similar to those of *C. lycopersicus* (47, 39, and 32 *vs.* 42–47, 33–38, and 33–38), but the pelvic disk length and body depth at pelvic disk of the former (7.9% SL and 16.6% SL) is somewhat smaller than the latter (9.7–11.9% SL and 24.8–30.3%) (Table 1; Murasaki *et al.* 2017). The former is further distinguishable from the latter in having a light orange body (*vs.* a bright red body).

A new standard Japanese name, Tomato-kon'nyaku-uo, is proposed here for *C. lycopersicus*, “tomato” being Japanese for “tomato plant (= *Solanum lycopersicum* Linnaeus, 1753)” applied for its scientific name (Orr 2012). “Kon'nyaku-uo” refers to the species of *Careproctus* in Japanese.

Comparative materials. *Careproctus lycopersicus*: UW 119816, paratype, 113.5 mm SL, 52.650°N, 172.24°W, 397 m depth, 26 June 1997, F/V *Dominator*; UW 119817, paratype, 142.6 mm SL, 60.264°N, 179.168°W, 877 m depth, 12 July 2000, F/V *Morning Star*. *Careproctus sinensis*: USNM 73339, holotype, 57.9 mm SL, 38.583°N, 138.683°E, 366 m depth, 18 July 1906, R/V *Albatross*. *Careproctus zachirus*: HUMZ 88338, holotype, 252.0 mm SL, 51.585°N, 179.360°W, 300–350 m depth, 7 July 1980; FAKU 120206, 206.0 mm SL, 53.300°N, 170.750°E, 131 m depth, 4 October 1980.

Acknowledgments

We are grateful to Shigeki Fujimoto and Shigetada Fujimoto for their help in collecting specimens. Our appreciation is also extended to Y. Abe (Executive Director, AMF) and A. Komoda (General Curator, AMF) for their valuable advice and encouragement, H. Taira, S. Yamauchi, and M. Kamiunten (AMF) for their assistance during the study, H. Imamura, T. Kawai, and F. Tashiro (HUMZ), J. T. Williams, D.G. Smith, S. Raredon, and K. Murphy (USNM) for access to collections, and L. Tornabene and K. P. Maslenikov (UW) for the loan of specimens. J. W. Orr (NOAA, Alaska Fisheries Science Center) critically reviewed the manuscript.

References

Betancur-R, R., Wiley, E. O., Arratia, G., Acero, A., Bailly, N., Miya, M., Lecointre, G., and Orti, G. 2017. Phylogenetic classification

- of bony fishes. *BMC Evolutionary Biology* 17: 162, doi 10.1186/s12862-017-0958-3.
- Chernova, N. V., Stein D. L., and Andriashev, A. P. 2004. Family Liparidae Scopoli 1777—Snailfishes. *California Academy of Sciences Annotated Checklist of Fishes* 31: 1–72.
- Fricke, R., Eschmeyer, W. N., and van der Laan, R. (Eds) 2019. Eschmeyer's Catalog of Fishes: genera, species, references. Version 4 February 2019. Available at <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp> (12 February 2019).
- Kai, Y., Ikeguchi, S., and Nakabo, T. 2011. A new species of the genus *Careproctus* (Liparidae) from the Sea of Japan. *Ichthyological Research* 58: 350–354.
- Kai, Y., Tohkairin, A., Fujiwara, K., and Hamatsu, T. 2018. *Careproctus iachus*, a new variegated snailfish (Liparidae) from the Seas of Japan and Okhotsk. *Ichthyological Research* doi 10.1007/s10228-018-0626-7 (1 March 2018), 65: 417–422 (6 November 2018).
- Kawamura, K. and Hosoya, K. 1991. A modified double staining technique for making a transparent fish-skeletal specimen. *Bulletin of National Research Institute of Aquaculture* 20: 11–18.
- Kido, K. 1985. New and rare species of the genus *Careproctus* (Liparidae) from the Bering Sea. *Japanese Journal of Ichthyology* 32: 6–17.
- Kido, K. 1988. Phylogeny of the family Liparididae, with the taxonomy of the species found around Japan. *Memoirs of Faculty of Fisheries Sciences, Hokkaido University* 35: 1–125.
- Komai, T. and Hibino, M. 2019. Three new species of the pandalid shrimp genus *Pandalopsis* Spence Bate, 1888 (Crustacea: Decapoda: Caridea) from the southwestern Sea of Okhotsk, with supplemental note on *P. glabra* Kobjakova, 1936. *Zootaxa* 4545: 1–31.
- Machi, K., Nobetsu, T., and Yabe, M. 2012. *Careproctus rausuensis*, a new liparid fish (Percomorphacea: Cottiformes), Collected from Hokkaido, Japan. *Bulletin of National Museum of Nature and Science, Series A Supplement* 6: 33–40.
- Matsuzaki, K., Taira, H., Mori, T., Nobetsu, T., and Kido, K. 2017. First record of the liparid fish *Careproctus zachirus* from Japan. *Japanese Journal of Ichthyology* 64: 179–184. [In Japanese]
- Murasaki, K., Takami, M., and Fukui, A. 2017. *Careproctus surugaensis* sp. nov. (Liparidae), a new snailfish from Suruga Trough, Japan. *Ichthyological Research* doi 10.1007/s10228-017-0611-6 (22 November 2017), 65: 237–244 (25 April 2018).
- Nakabo, T. and Kai, Y. 2013. Liparidae. Pp. 1205–1218, 2072–2076. *In*: Nakabo, T. (Ed.) *Fishes of Japan with Pictorial Keys to the Species. Third Edition*. Tokai University Press, Hadano. [In Japanese]
- Nelson, J. S., Grande, T. C., and Wilson, M. V. 2016. *Fishes of the World: Fifth Edition*. John Wiley & Sons, New Jersey, xli + 707 pp.
- Orr, J. W. 2012. Two new species of snailfishes of the genus *Careproctus* (Scorpaeniformes: Liparidae) from the Bering Sea and eastern North Pacific Ocean, with a redescription of *Careproctus ovigerus*. *Copeia* 2012: 257–265.
- Orr, J. W. 2016. Two new species of snailfishes of the genus *Careproctus* (Liparidae) from the Aleutian Islands, Alaska. *Copeia* 104: 890–896.
- Orr, J. W., Kai, Y., and Nakabo, T. 2015. Snailfishes of the *Careproctus rastrinus* complex (Liparidae): redescrptions of seven species in the North Pacific Ocean region, with the description of a new species from the Beaufort Sea. *Zootaxa* 4018: 301–348.
- Orr, J. W. and Maslenikov, K. P. 2007. Two new variegated snailfishes of the genus *Careproctus* (Teleostei: Scorpaeniformes: Liparidae) from the Aleutian Islands, Alaska. *Copeia* 2007: 699–710.
- Rabosky, D. L., Chang, J., Title, P. O., Cowman, P. F., Sallan, L., Friedman, M., Kaschner, K., and Alfaro, M. E. 2018. An inverse latitudinal gradient in speciation rate for marine fishes. *Nature* 559: 392–395.