

A New Species of Snailfishes (Liparidae) of the Genus *Careproctus* from the Northern Slope of the Aleutian Basin (Bering Sea)

N. V. Chernova^{a, *}, E. V. Vedischeva^b, and A. V. Datskii^b

^a Zoological Institute, Russian Academy of Sciences—ZIN RAS, Saint-Petersburg, Russia

^b All-Russian Research Institute of Fisheries and Oceanography—VNIRO, Moscow, Russia

*e-mail: nchernova@mail.ru

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Abstract—A new species of snailfishes *Careproctus schmidti* sp. nov. from the northwestern part of the Bering Sea is described. The specimen was caught in the mesobenthos of the Aleutian Basin at a depth of 852–862 m (holotype ZIN no. 56620—female *TL* 194 mm). It is distinguished from the majority of congeners of the North Pacific Ocean by a set of features: a large number of vertebrae (63) and rays in the fins (*D* 56, *A* 50, *P* 34, *C* 10), the presence of two pairs of pleural ribs, a relatively elongated (21% *SL*) pectoral fin with a notch and short lower lobe (12% *SL*), two suprabranchial pores, simple teeth, naked skin, and black peritoneum. In terms of meristic features, the new species is similar to three North Pacific species, but it differs from *C. colletti* in a short lower lobe of the pectoral fin, a flattened disc of triangular outlines, and a longer gill slit. It differs from *C. roseofuscus* by a lower body, a pectoral fin ventrally located and anus which opens immediately behind the disc. It differs from *C. ambustus* in purple-lilac color, fewer in number simple teeth with sharp apices, in vertical and higher disposition of gill slit, shorter lower lobe of the pectoral fin, disc shape and position of the anus. The presence of an ovipositor may indicate existence of complicated reproductive behavior (such as carcinophilia or other types of reproductive commensalism). The northwestern slope of the Aleutian Basin, where a specimen of *C. schmidti* was caught, is located in the zone of influence of the Bering Slope Current and seasonal upwelling associated with the rise of deep waters. The composition of the ichthyofauna in the area of capture is given, including up to 20 species, dominated by Macrouridae.

Keywords: *Careproctus schmidti* sp. nov., Liparidae, new species, Aleutian Basin, Bering Sea

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INTRODUCTION

Family Liparidae includes up to 32 genera and over 400 species (Chernova et al., 2004; Orr et al., 2019), distributed mainly in temperate and cold sea waters and at the depths of the ocean. They are difficult to study because of their scaleless and gelatinous body. The taxonomy of the group is being actively developed. New species are still described, including those from the North Pacific Ocean (Orr and Maslenikov, 2007; Sakurai and Shinohara, 2008; Machi et al., 2012; Orr, 2012; Orr et al., 2015, 2020; Murasaki et al., 2017; Chernova et al., 2020; Matsuzaki et al., 2020). The genus *Careproctus* is the most speciose in the family, with up to 140 taxa; about 50 of species live in the North Pacific Ocean.

This article presents a description of a new species from the northwestern part of the Bering Sea. The *Careproctus* specimen caught on the continental slope of the Aleutian Basin (Fig. 1) differs from all known species in a number of features.

MATERIALS AND METHODS

Research work was carried out in the West Bering Sea zone of commercial zoning from board of the R/V *TINRO* on September 26–28, 2018. Six trawls were performed in the area with coordinates 61°10′–61°37′ N 175°55′–176°52′ E, at depths of 852–968 m. The bottom trawl DT/TV 27.1/24.4 with a horizontal opening of 16 m, equipped with a soft ground rope was used as a fishing gear; with a 10 mm square mesh size in codend. The trawl exposure was 30 min at a vessel speed of 2.3–2.4 knots.

The specimen was photographed and fixated with 4% formaldehyde solution upon capture. Further work was carried out at the Zoological Institute of the Russian Academy of Sciences (ZIN). Measurements of the fixed specimen are given relative to the standard length (*SL*—from the tip of the snout to the base of the rays of the caudal fin) and relative to the length of the head (*c*—from the tip of the snout to the end of the opercular lobe).

The position of the Liparidae family in the system of fish (in the order Cottiformes) is accepted after the

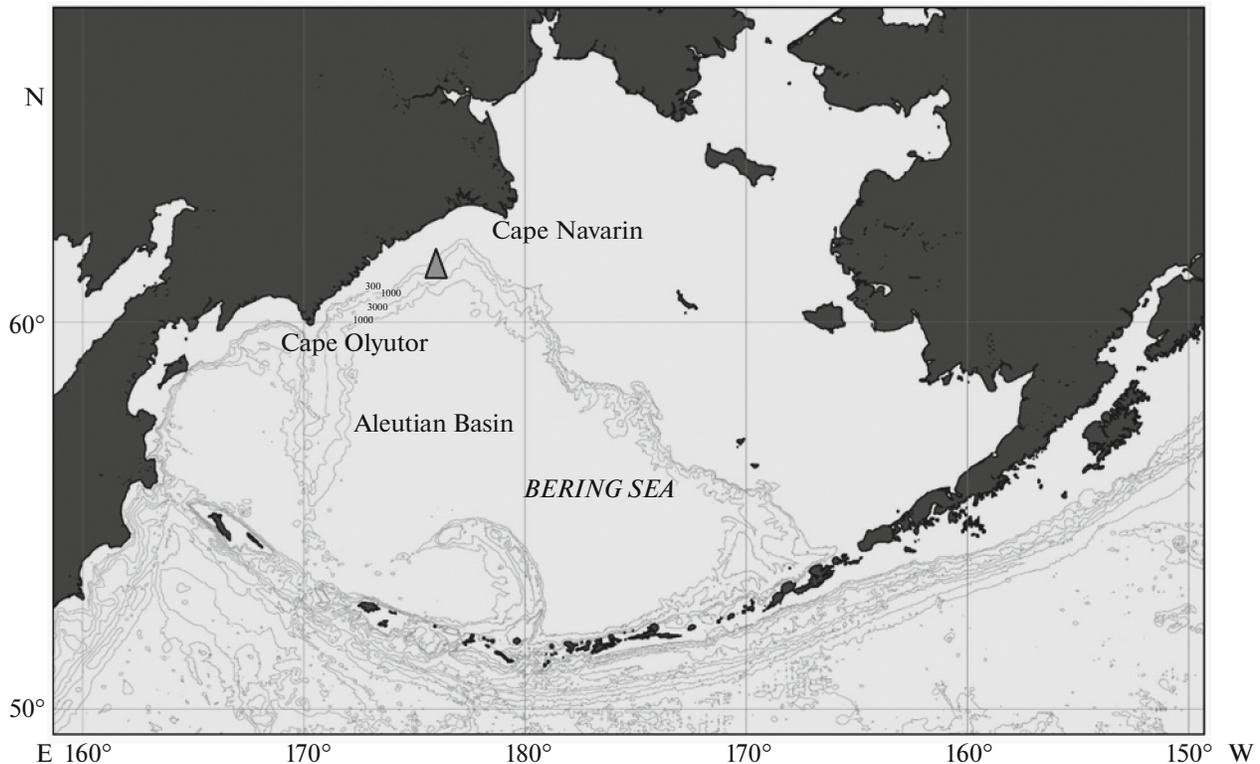


Fig. 1. The region of (▲) *Careproctus schmidti* capture in the Bering Sea; (—)—isobaths: 300, 1000, 3000 m.

latest data, according to which the suborder Cottoidei Berg, 1940 has been raised to the rank of the order (Imamura and Yabe, 2002; Wiley and Johnson, 2010). The formula for sensory pores is given according to Burke (1930) and Andriyashev (2003). The teeth were counted according to the method of Able and McAllister (1980). The pectoral fin (*P*) formula includes the number of rays of the upper lobe (counting the shortest ray of the fin notch) and its lower lobe (Andriyashev, 2003). When comparing with other species, we used the characters of type specimens from the original descriptions, since widespread snailfishes can represent themselves species complexes, as is shown for *C. melanurus*/*C. ambustus* (Orr et al., 2020).

Specimens of snailfishes from the collections of the Oregon State University (OSU) and ZIN were studied for comparative purposes.

C. cypselurus (Jordan et Gilbert in Jordan, Evermann, 1898): OSU No. 013014—female *TL* 265 mm, *SL* 233 mm, Bering Sea, 60°45' N 179°28' W, 28.07.1983, vessel 515, voyage 821, st. 86.

C. melanurus Gilbert, 1892: OSU No. 1925—adult male *TL* 213 mm, *SL* 196 mm, Oregon, Fur Farm, 17.03.1959; OSU No. 0747—1 specimen *TL* 151 mm, *SL* 136 mm, Oregon, “Yaquina No. 6606”, 06/08/1966, depth 640–650 m.

C. roseofuscus Gilbert et Burke, 1912: ZIN no. 56432—male *TL* 180 mm, *SL* 157 mm and female

TL 165 mm, *SL* 146 mm, Sea of Okhotsk, 57°46' N 151°24' E, depth 209–207 m, 08.16.2006, “Captain Malamud”, trawl 154, collector M.V. Nazarkin, identified by D.L. Pitruk.

RESULTS AND DISCUSSION

Careproctus schmidti sp. nov.—Schmidt’s snailfish

(Figure 2)

Holotype. ZIN No. 56620—female with immature eggs, *TL* 194 mm, *SL* 169 mm; Bering Sea, 61°20'–61°22' N, 176°17'–176°18' E, depth 852–862 m, September 26, 2018, R/V *TINRO*, trawl 96, bottom temperature 3.1°C, collector E.V. Vedisheva.

Diagnosis. Vertebrae 63, *D* 56, *A* 50, *P* 34, *C* 10. There are two pairs of pleural ribs. The teeth are simple. Pores 2–6–7–2. The pectoral fin is located ventrally: its upper ray is at the level of the mouth. The upper lobe of pectoral fin is elongated (21% *SL*); the lower lobe of *P* is shorter than the upper one (12% *SL*). Pelvic disc 4% *SL* (16% *c*), flattened. There is no distance between the posterior edge of the disc and the anus. The gill slit does not reach the base of the pectoral fin slightly; its length is 1.4 times the length of the eye. The skin is scaleless. The color is lilac with a pink tint, the end of the tail and the edges of the fins are black, the peritoneum is black.



Fig. 2. *Careproctus schmidti* sp. nov.—female *TL* 194 mm, *SL* 169 mm, holotype ZIN № 56620 before (a, b) and after (c–e) fixation: a, d—lateral view; b—the chin pores are not brought together, a tubular ovipositor is located behind the disc; c—the disc is flattened, triangular in shape, the anus and ovipositor are located immediately behind the disc; e—head: the pectoral fin is low, the gill opening does not reach its upper ray.



Fig. 3. X-ray of the holotype of *Careproctus schmidtii* sp. nov.: pleural ribs are present on two pre-caudal vertebrae.

Etymology. The species is named after Petr Yulievich Shmidt (1872–1949), Russian and Soviet zoologist and ichthyologist, employee of the Zoological Museum of the USSR Academy of Sciences (now ZIN), author of fundamental works on the fish fauna of the Far Eastern seas (Shmidt, 1904, 1948, 1950).

Description. The body is rather low, elongated, its height is 5.0 times in *SL*. The dorsal contour slopes gently backward from the beginning of *D*. The head is large and compressed laterally, head length is 3.9 in *SL*, and its height is 1.7 times its width. The eye is 4.5 in *c*, the pupil is round. Interorbital distance 1.7 times the eye. The snout is rounded, slightly protruding above the upper jaw, 1.6 times as long as the eye. The mouth is horizontal; the oral slit reaches the vertical of the beginning of the eye, the posterior end of the upper jaw reaches the vertical of the posterior edge of the pupil. The lower jaw is slightly shorter than the upper jaw. The teeth are simple, small, and the posterior teeth in rows are pointed; at least 30 oblique rows are present on each jaw, four to five teeth in full rows in front. The gill opening is vertical, slightly not reaching to the base of the upper ray of *P* (by 1/2 of the eye diameter); its length 1.4 times as long as the eye (Figs. 2d, 2e). The opercular lobe is wide triangular and rounded at the apex; the opercular process is directed backward, its end is at the level of the lower edge of the eye. Sensory pores 2–6–7–2. The chin pores are not close together (Fig. 2b).

X-ray (Fig. 3). Vertebrae, including urostyle, 63 (10 + 53), rays *D* 56, *A* 50, *C* 10 (5/5). There are two

pairs of pleural ribs on the posterior pre-caudal vertebrae. The pterygiophore of the 1st ray of *D* is located between the neural processes of the 4th and 5th vertebrae. Free interneuralia 2, between the neural processes of the 2nd and 3rd, 3rd and 4th vertebrae. There are seven *D* rays in the pre-caudal region. One pterygiophore (with ray *A*) in front of the 1st haemal process. The hypural plate is distally divided by a slit.

The pectoral fins are located low: the upper ray is at the level of the mouth, the base of the lower ray is under the anterior half of the eye. *P* 34 (27 + 7). The upper lobe is elongated (21% *SL* and 81% *c*) and reaches the 6–7th ray of the anal fin. The lower lobe of *P* is noticeably shorter than the upper lobe (12% *SL* and 46.5% *c*); its rays are distally divided into 2/3 of their length and slightly thickened; the most elongated (6th from below) ray reaching to vertical 2/3 of the postorbital distance. The notches of the right and left pectoral fins are shallow: the length of the shortest (8th from below) ray is 9 and 10% *SL* (35 and 37% *c*). The fin membranes of the pectoral fins in front of the disc are separated (do not form a transverse fold).

The dorsal and anal fins are low; the anal expands in height in the anterior third of its length, the dorsal in the middle third; each not exceeding half the height of these parts of the body. *D* and *A* are connected to the caudal fin at about 40% of its length.

Disc flattened and small (4% *SL*, 16% *c*), triangular in shape; its central part is large, the marginal part is narrow; the musculature is poorly developed, the skin margin is thin and curled inward. The anus opens

immediately behind the disc (there is no distance from the posterior edge of the disc to the anus) and is located on the vertical of the posterior edge of the eye. The ovipositor located behind the anus is tubular (Figs. 2b, 2c); its length is 4% *SL*. Distance from anus to beginning of *A* 1.6 times the length from chin to anus. The skin is naked. During life, the body is gelatinous.

Holotype is a young female (gonad maturity stage III), diameter of immature eggs in the ovaries does not exceed 1 mm.

Measurements in % *SL* (% *c*): head length 25.4, head width 11.8 (46.5), snout length to orbital margin 8.9 (34.9), diameter of the open part of the eye 5.6 (22.1), orbital diameter 6.5 (25.6), postorbital distance from the edge of the eye to the end of the opercular lobe 11.8 (46.5), the interorbital distance 9.8 (38.4), the length of the upper jaw 11.8 (46.5), the width of the mouth 9.8 (38.4), the length of the gill slit 8.0 (31.4), the height of the head 20.1 (79.1), maximum body height 20.1 (79.1), height at the beginning of *A* 20.1 (79.1), predorsal distance 28.7 (112.8), preanal distance 34.3 (134.9), distance from the symphysis of the mandible to anus 12.4 (48.8), the same to the disc 7.2 (28.4), the length of the disc is 4.1 (16.3), its width is 3.0 (11.9); distances: from the anus to the beginning of *A* 19.5 (76.7), from the disc to the anus 0, from the symphysis of the lower jaw to the symphysis *P* 5.9 (23.3); pectoral fin length: upper lobe 20.7 (81.4), short ray of notch 9.5 and 8.9 (37 and 35), lower lobe 11.8 (46.5).

Color in life lilac with a pink tint (Fig. 2a). The preoperculum and abdomen appear dark because of the black lining of the branchial and abdominal cavities. The end of the tail and the edges of the fins are black; the pectoral fin is blackish. After fixation of the specimen, the red tones of the color disappear, the black melanophore pigmentation remains (Fig. 2d). The skin around the mouth and the region of the gill slit, the underside of the head and the disc are gray; the inner surface of the pectoral fins is blackish. The oral cavity is dark gray, the branchial cavity and peritoneum are black.

Comparative notes. The new species differs from the majority of North Pacific species in a complex of features listed in the diagnosis. In terms of meristic characters, it is most similar to three North Pacific snailfishes, *C. colletti* Gilbert, 1896, *C. roseofuscus*, and recently described *C. ambustus* Orr, 2020. A characteristic features of *C. colletti* described from waters south of the Alaska Peninsula are noticeably elongated lower lobe of the pectoral fin, much longer than the rays of its upper lobe, a small (lesser than the diameter of the eye) gill slit and a deeply concave (cup-shaped) disc (Gilbert, 1896). In *C. schmidti*, on the other hand, the lower lobe of the pectoral fin is shorter than its upper lobe; gill slit 1.4 times larger than eye, disc flattened.

C. roseofuscus, described from the Sea of Okhotsk from Sakhalin Island, is similar to the Schmidt's snailfish in the shape of the pectoral fin, the lower lobe of which is not elongated. Unlike *C. schmidti*, it has fewer primary *C* rays (8 versus 10); the anus does not open immediately behind the disc, being located at a distance (6% *SL*), similar to the disc diameter (5.5% *SL*) (Gilbert and Burke, 1912a). In addition to the aforementioned differences the specimens of *C. roseofuscus* studied for comparison (Fig. 4), had a leaf-like, laterally compressed and very high body (constituting 29–31% *SL* versus 20% in *C. schmidti*); the pectoral fin is located laterally; its upper ray is at the level of the eye (in *C. schmidti*, at the level of the mouth); the disc is almost twice as large (7.5–8.4 versus 4.1% *SL*), the distance from the chin to the anus is twice as large (23–27 versus 12% *SL* in *C. schmidti*).

Our species differs from *C. ambustus* in a number of features. In *C. ambustus*, the jaw teeth are weakly three-lobed and small (form 23–45 oblique rows of 11–27 teeth each), the disc is longitudinally oval and concave, the anus opens at some distance from the disc (equal to about 1/3 of the disc length); the lower lobe of *P* is almost equal in length to the upper lobe (on average, 16.7 and 18.5% *SL*, respectively) (Orr et al., 2020, Table 1). The holotype of *C. ambustus*, caught in the Pacific Ocean south of Amlia Island (Aleutian Archipelago) at a depth of 330 m, has a pink-red skin with an orange tint (Orr et al., 2020, Fig. 2); its back is humped in the middle part of the body (the height of the body in this area is noticeably greater than the height at the occiput); the gill slit is oblique and located low (its upper end is at the level of the lower edge of the eye); the opercular process is directed ventrally reaching noticeably below the orbit. In *C. schmidti*, the jaw teeth are simple with sharp apices (four to five teeth in rows), the flattened disc has triangular shape, the anus opens immediately behind the disc, the lower lobe of *P* is noticeably shorter than the upper one (12 versus 21% *SL*); the skin is violet-lilac, the height of the body does not increase towards the middle of its length, the gill opening is vertical and located higher (below the level of the upper edge of the eye), the opercular process is directed caudally.

Other species, habitually more or less similar to Schmidt's snailfish, also differ from it: *C. nigricans* Schmidt, 1950 have three-lobed teeth; *C. entomelas* Gilbert, 1896, *C. cryptocanthoides* Krasnyukova 1984, *C. bathycoetus* Gilbert, 1896 and *C. melanuroides* Schmidt, 1950 possess fewer rays in the pectoral fin (26–28); *C. longifilis* Garman, 1892, *C. filamentosus* Stein, 1978 and *C. microstomus* Stein, 1978 have a different pore formula (2–6–7–1) (Garman, 1892; Gilbert, 1896; Schmidt, 1950; Stein, 1978; Krasnyukova, 1984).

Several new *Careproctus* species have recently been described from the West Pacific: *C. iacchus* Kai, Tohkairin, Fujiwara et Hamatsu, 2018, *C. kamikawai* Orr,



Fig. 4. *Careproctus roseofuscus*—female TL 165 mm, SL 146 mm, Okhotsk Sea, ZIN No. 56432.

2012, *C. lycopersicus* Orr, 2012, *C. nelsoni* Orr, 2016, *C. notosaikaiensis* Kai, Ikeguchi et Nakabo, 2011, *C. rotundifrons* Sakurai et Shinohara, 2008, *C. shigemii* Matsuzaki, Mori, Kamiunten, Yanagimoto et Kai, 2020, *C. staufferi* Orr, 2016, *C. surugaensis* Murasaki, Takami et Fukui, 2017. In all of these of species, teeth are three-lobed and the number of vertebrae is less than in *C. schmidti*, from 42 to 58 versus 63 (Sakurai and Shinohara, 2008; Kai et al., 2011, 2018; Orr, 2012, 2016; Murasaki et al., 2017; Matsuzaki et al., 2020). The deep-sea species *C. pulcher*, *C. globulus*, *C. laperousei*, and *C. brevipectoralis* described from the Bussol Strait of the Kuril Archipelago (Chernova et al., 2020) also have fewer vertebrae, 46 or 55–57 versus 63 in *C. schmidti*.

Geographically, most of the North Pacific *Careproctus* species are known from areas more southerly than *C. schmidti*: from the Sea of Japan and the Sea of Okhotsk, from the Kuril Islands, Southeastern Kamchatka, Aleutian Islands, and from the Gulf of Alaska, off the coast of Oregon and California (Chernova et al., 2004). Few species have been recorded in the northwestern part of the Bering Sea, on the continental slope south of Cape Navarin: *C. colletti*,

C. cypselurus, *C. furcellus* Gilbert et Burke, 1912, *C. melanurus*, *C. ostentum* Gilbert, 1896, *C. rastrinus* Gilbert et Burke, 1912 and *C. simus* Gilbert, 1896 (Balykin and Tokranov, 2010; Parin et al., 2014). They all also differ from the new species. The *C. cypselurus*, described from the eastern part of the Bering Sea (north of Bogoslov Island of the Aleutian Ridge), has more vertebrae (65–70 versus 63); teeth are simple, but very small; the pectoral fin is notched, the anus is spaced from the disc by a noticeable distance equal to half of the postorbital space (Jordan, Gilbert in Jordan and Evermann, 1898, p. 2866; our data: OSU no. 013014). In the type specimen of *C. furcellus*, according to the original description, the head is flattened (its width is 17 versus 12% SL in *C. schmidti*); the interorbital distance is wider (14 versus 10% SL), the body is noticeably higher (27 versus 20% SL), the disc is larger (6 versus 4% SL), the head and anterior part of the body are completely pink (Gilbert and Burke, 1912b). In type specimens of *C. melanurus* (from the waters of Oregon and California), the peritoneum is silvery with black specks; the disc is very small and is 3/5 of the diameter of the eye (Gilbert, 1892). In addition, the gill slit in *C. melanurus* is oblique and low

located (its upper edge is below the level of the eye), the anus opens a short distance behind the disc, and the lower lobe of *P* (on average 16.7% *SL*) is similar in length to its upper lobe (18.5% *SL*) (Orr et al., 2020). *C. ostentum* has three-lobed teeth, a very small disc (~1.3% *SL*), *C* 8 rays, and silvery peritoneum (Gilbert, 1896). In *C. rastrinus*, the skin is densely covered with prickles, the peritoneum is silvery. *C. simus* has three-lobed teeth, the peritoneum is light (Gilbert, 1896).

Distribution. The holotype of *C. schmidti* was caught in the western part of the Bering Sea southwest of Cape Navarin, at the mesobenthal depth of 852–862 m. The area is located on the northern slope of the Aleutian Basin, isolated from the rest of the Pacific Ocean by the Aleutian Ridge and Shirshov and Bowers underwater ridges. The site is located in the zone of influence of the Bering Slope Current, which carries water masses from the southeast of the Bering Sea along its slope in the northwest direction (Stabeno et al., 1999; Panteleev et al., 2012). In the summer period, wind upwelling is formed here, causing the rise of deep waters (Andreev, 2019). The habitat conditions of the species, therefore, are different in hydrological characteristics from those of the *Careproctus* species from the Sea of Okhotsk and the Sea of Japan, each of which differs in the degree of isolation from main waters of the Pacific Ocean and in the features of hydrology.

Ichthyocene of the mesobenthal area of *C. schmidti* capture includes up to 20 species according to the results of six bottom trawlings. The main quantity is made up of grenadiers (Macrouridae): the giant grenadier *Albatrosia pectoralis* (Gilbert, 1892), the popeye grenadier *Coryphaenoides cinereus* (Gilbert, 1896), and the Pacific grenadier *C. acrolepis* (Bean, 1884). Common were lanternfishes *Stenobrachius leucopsarus* (Eigenmann et Eigenmann, 1890) and *S. nannochir* (Gilbert, 1890) (Myctophidae), snailfishes *Elassodiscus* sp. and *Paraliparis* sp. (Liparidae), blobfish *Psychrolutes phrictus* Stein et Bond, 1978 (Psychrolutidae), deep-sea smelt *Pseudobathylagus milleri* (Jordan et Gilbert, 1898) (Bathylagidae) and barbeled dragonfish *Chauliodus macouni* Bean, 1890 (Stomiidae). Of the cephalopods, squid *Gonatus madokai* (Okutani, 1977) predominated in the catches.

In the trawl that caught the new *Careproctus* species, two grenadiers *C. cinereus* and *A. pectoralis* predominated in number (75.7 and 18%). Shares in the catch of the Pacific grenadier *C. acrolepis*, snailfishes *Elassodiscus* sp. (two species) and *Paraliparis* sp., as well as deep-sea smelt *P. milleri* accounted for ~1% of each. The following species met singularly: the Okhotsk skate *Bathyraja violacea* (Suvorov, 1935) (Arhynchobatidae), the Pacific viperfish *C. macouni*, the garnet lanternfish *S. nannochir*, the northern lampfish *S. leucopsarus*, the bulb-fish *Oneirodes bulbosus* Chapman, 1939 (Sebastidae), the blob sculpin *P. phrictus*; eelpouts *Lycodes beringi* Andriashev, 1935,

Lycenchelys ratmanovi Andriashev, 1955, *Lycenchelys* sp., *Bothrocarina* sp. (Zoarcidae), as well as the rex sole *Glyptocephalus zachirus* Lockington, 1879 (Pleuronectidae). All these species were noted earlier in the West Bering Sea fishing area of the Bering Sea (Balykin and Tokranov, 2010; Parin et al., 2014).

Biology. Among the characteristic features of *C. schmidti*, attention is drawn to the presence of an ovipositor in a female, which may indicate a complicated reproductive behavior of the individuals of this species. The biology of liparids has not been studied enough, but cases of reproductive commensalism are known for a number of members of the family. Spongiphilia was described for the Arctic *C. fulvus* Chernova, 2014 from the Kara Sea: the development of eggs occurs in the paragastric cavity of glass sponges *Schaudinnia rosea* (Hexactinellida: Rossellidae) (Chernova, 2014). Carcinophilia is known more widely (Andriyashev, 2003), that is reproductive commensalism of *Careproctus* and craboids of the family *Lithodidae* (Decapoda, Reptantia) (Rass, 1950; Hunter, 1969; Parrish, 1972; Somerton and Donaldson, 1998; Poltev and Mukhametov, 2009; Poltev, 2013). Carcinophilia has an antitropical distribution: it is observed for species living in the North Pacific Ocean, as well as in the southeastern regions of the Pacific and Atlantic. Among North Pacific species, carcinophilia is known for *C. melanurus*, *C. cypselurus*, *C. furcellus*, and *C. rastrinus*. Fertilization is internal. Using their ovipositor females lay eggs under the craboid carapace, where embryonic and larval development takes place. The incubation period in *Careproctus* species is long (lasting several months), and carcinophilia increases the survival rate of juveniles. Apparently, *C. schmidti* also belongs to the group of fish that take care of the posterity.

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