

Cucumaria fedotovi, a New Species of Holothurian (Holothuroidea, Dendrochirotida, Cucumariidae) from the Karaginskii Gulf, Bering Sea

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Abstract—A new species of dendrochirotid holothurian, *Cucumaria fedotovi* sp. nov. (Holothuroidea, Dendrochirotida, Cucumariidae), has been described in the Karaginskii Gulf, Bering Sea, Russia, from the depths of 31–34 m. The new species differs from the other species of the genus *Cucumaria* by the shape of ossicles of the body skin and by tube feet. The new species is characterized by ossicles in form of large lobed perforated plates with sharp teeth on the outer edge. In the tube feet, large, specific, lacinate, stellate plates predominate (up to ten rays), with numerous holes and sharp teeth along the outer edge.

Keywords: Holothuroidea, Dendrochirotida, Cucumariidae, *Cucumaria fedotovi*, taxonomy, new species, Bering Sea, Karaginskii Gulf

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INTRODUCTION

Currently, at least 45 species of holothurians belong to the genus *Cucumaria* Blainville 1834 (WoRMS, 2019), but it is necessary to clarify the systematic position for a number of taxa. For example, the species *Cucumaria sachalinica* Djakonov 1958 should be attributed to the genus *Leptopentacta* Clark 1938, according to many authors (Levin and Gudimova, 1997; Smirnov, 2013; Stepanov and Panina, 2016). Smirnov (2013) believes that the species *Cucumaria diligens* Djakonov et Baranova in Djakonov, Baranova et Saveljeva 1958 should be attributed to the genus *Stereoderma* Ayres 1851. The species *Cucumaria fallax* Ludwig 1874, *C. koreaensis* Östergren 1898, and *C. pusilla* Ludwig 1886 should be attributed to genus *Pseudocnus* Panning 1949 (Panning, 1949; Smirnov, 2013; Stepanov and Panina, 2016). Taking this into account, the world fauna of holothurians of the genus *Cucumaria* comprises 40 species to date. The taxonomy of the Cucumariidae family has also been discussed by a number of authors (Thandar, 1991; Massin, 1992; Solís-Marín and Laguarda-Figueras, 1999; Martins and Souto, 2015).

In the Far Eastern seas of Russia, eleven species of the genus *Cucumaria* are known: *C. anivaensis* Levin 2004, *C. conicospermium* Levin et Stepanov 2002, *C. djakonovi* Baranova 1980, *C. fusiformis* Levin 2006, *C. insperata* Djakonov et Baranova in Djakonov, Baranova et Saveljeva 1958, *C. japonica* Semper 1868, *C. levinii* Stepanov et Pilganchuk 2002, *C. obscura* Levin 2006, *C. okhotensis* Levin et Stepanov in Levin 2003, *C. savelijevae* Baranova 1980, and *C. vegae* Théel 1886. Some of them are quite large: the body length of *C. djakonovi* reaches up to 155 mm (Baranova, 1980), *C. japonica*, up to 400 mm (Levin and Gudimova, 1997), *C. okhotensis*, up to 185 mm (Levin, 2003), and *C. savelijevae*, up to 130 mm (Baranova, 1980). Two species, *C. japonica* and *C. okhotensis*, are commercial. When studying the holothurians from the collections of an expedition conducted in 2016 by the Pacific Scientific Research Institute of Fishery and Oceanography, a new holothurian *Cucumaria fedotovi* sp. n. was discovered in the Karaginskii Gulf. This species is characterized by a large body size and differs greatly from other species of the genus by the shape of ossicles of the skin of the body and tube feet.

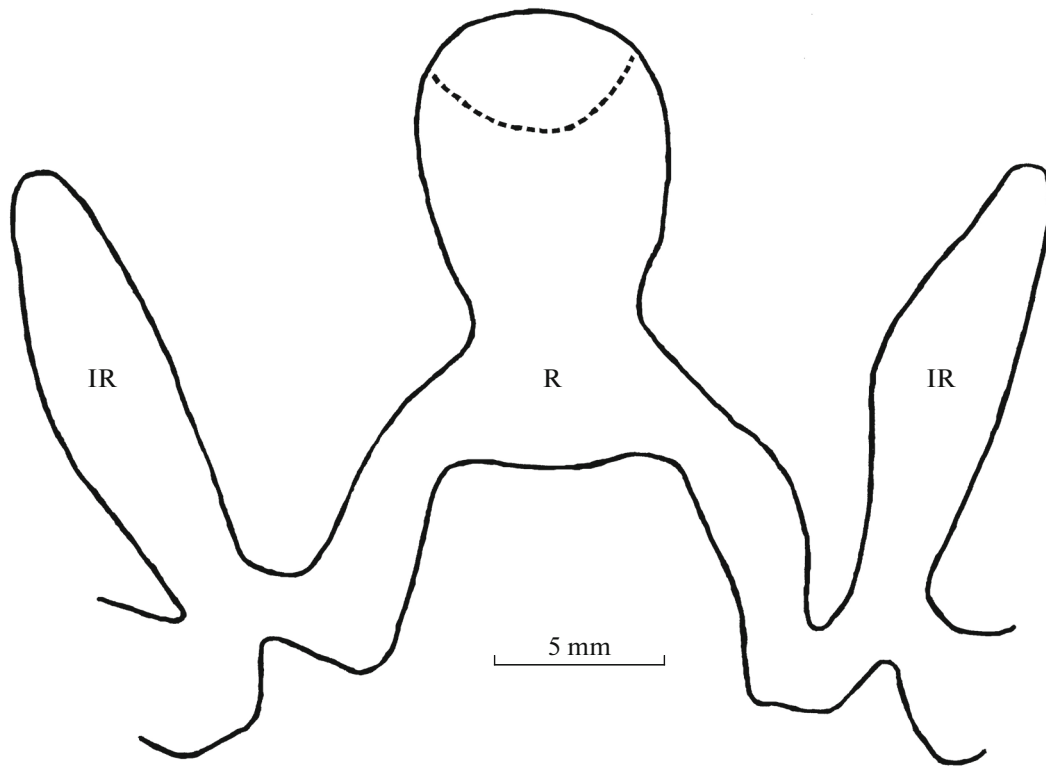


Fig. 1. The segments of the calcareous ring (R, radial segment; IR, interradian segments) of *Cucumaria fedotovi* sp. n. (hereinafter, holotype). The dashed line is the attachment point of retractor muscles.

MATERIALS AND METHODS

The material was obtained in an expedition of the Pacific Scientific Research Institute of Fishery and Oceanography in 2016 in the Karaginskii Gulf (Bering Sea).

The holothurian was fixed in 70% ethanol. Ossicles preparations were made according to the generally accepted method: tissue samples were dissolved in tubes with sodium hypochlorite (NaClO); the ossicles that settled on the bottom of the tube were washed with water and placed on a glass slide. After drying, they were mounted in Canada balsam. Ossicles were studied using a CamScan scanning electron microscope at the Department of Electron Microscopy, Biological Faculty, Moscow State University.

RESULTS AND DISCUSSION

The systematic position and description of the new species, as well as drawings of the ossicles and calcareous ring, are given below.

Phylum Echinodermata Bruguière 1791 [ex Klein 1734]

Class Holothurioidea Selenka 1867

Subclass Holothuriacea Smirnov 2012

Order Dendrochirotida Grube 1840 [nom. transl. Pawson et Fell 1965 (ex. Dendrochiroten Grube 1840)]

Family Cucumariidae Ludwig 1894

Subfamily Cucumariinae Ludwig 1894, sensu Pan-ning 1949

Genus *Cucumaria* Blainville 1834 emended Pan-ning 1949

Cucumaria fedotovi Panina, Stepanov et Martynov sp. n.

Diagnosis. Large holothurian, 140 mm long. The skin and tentacles are dark brown, the tube feet are orange. There are 10 dendriform tentacles of equal length. Polian vesicle is one, very long (16.5 cm) and narrow (width does not exceed 5 mm). Calcareous ring is massive. Radial plates of about 20 mm high, they have a wide base with a very deep and wide recess along the posterior margin, expansion in the front and narrowing in the middle. Interradial plates are high, narrow, xiphoid, with a small notch along the posterior margin; they reach a length of 16–18 mm and are 2–3 mm wide in the expanded part. In the body skin, large lacinate, dissected by 2–4 lobes and elongated plates dominate, one side of which, as a rule, has a smoother margin and round holes, the opposite side of which is characterized by more elongated holes and

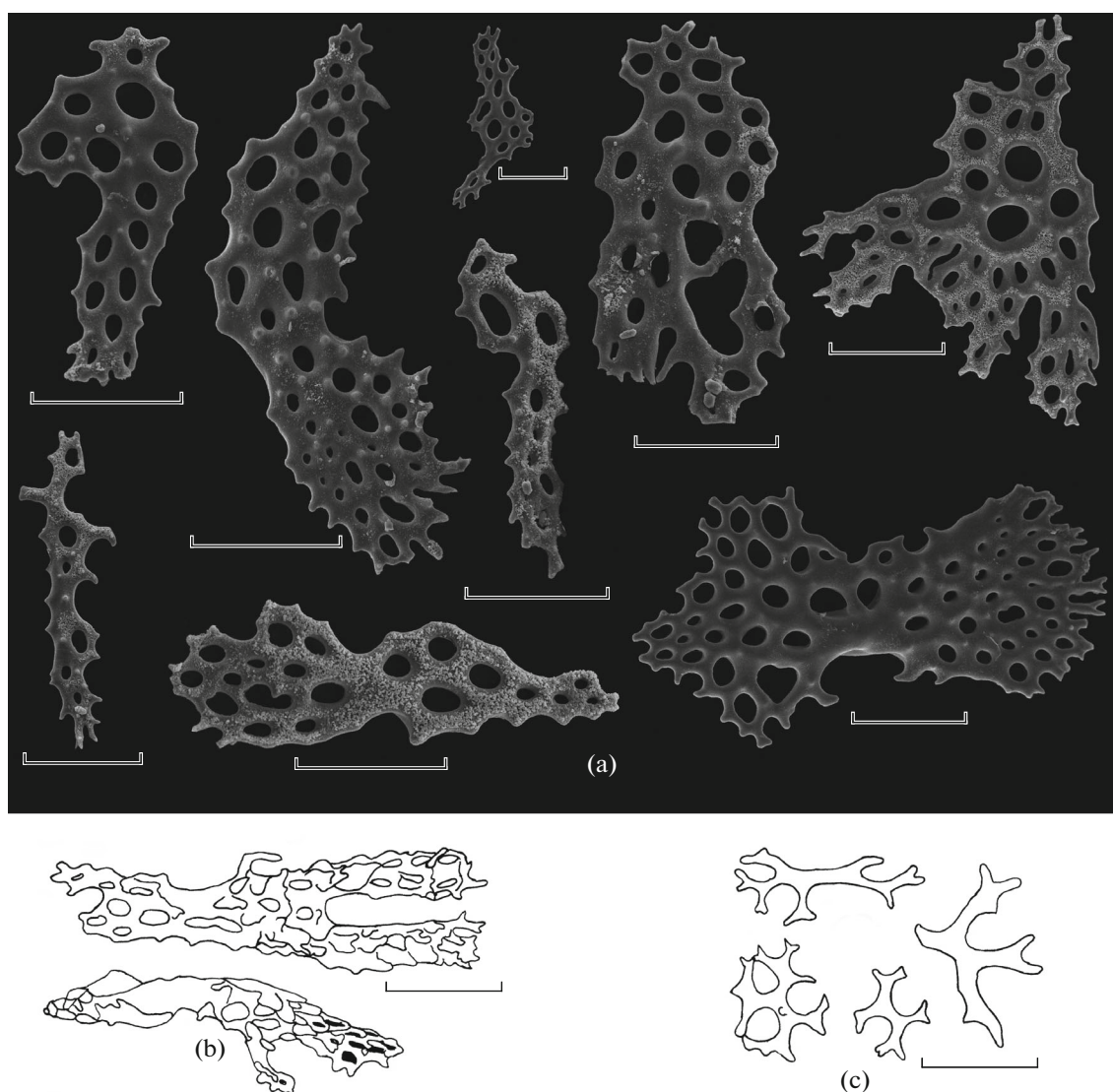


Fig. 2. Ossicles of the dorsal side of the body of *Cucumaria fedotovi* sp. n. : (a) perforated plates; (b) voluminous rod-shaped ossicles; (c) cruciform ossicles. Scale: 100 μ m, here and in Figs. 3–8.

sharp spikes along the margin (some elongated plates have a thickening or constriction in the middle). In addition, the plate surface has many holes and tubercles. The most characteristic ossicles of the tube feet are large stellate plates with 5–10 rays, many holes and tubercles; holes in the center of the plates are large, and smaller on the rays.

Type location. Bering Sea, Karaginskii Gulf.

Material. Holotype (no. 736/733), June 23, 2016, TINRO-Center, Bering Sea, *Potapovo* refrigerated seiner-trawler, trawl no. 174. 59°02'–59°03.6' N, 163°29.3'–163°30.5' E, depth 31–34 m, collector P.A. Fedotov (one specimen). The holoturian is stored in Kamchatka Branch, Pacific Geographical Institute, Far East Branch, Russian Academy of Sciences, Petropavlovsk-Kamchatsky, Russia.

Holotype description. Female. The body is fusi-form, 140-mm long. The body skin is thick and soft. The skin and tentacles are dark brown. Tube feet are orange, very large, partially nonretractable; on the trivium, they are located only at radii in three stripes, the transverse row of which contains three tube feet; on the bivium, the tube feet are arranged in two rows, a small number of them are scattered in the dorsal interradia. There are ten tentacles, of equal length, one dorsal tentacle is reduced. The diameter of the oral disc is about 35 mm. The retractor muscles are wide (up to 1 cm in the expanded part), their length in the fixed specimen reaches 3 cm; they are attached to the body wall at a distance of about 9 cm from the anterior end. Longitudinal muscles up to 8 mm wide. The stone canal is one, bright red. Polian vesicle is one, very long (16.5 cm) and narrow (the width does not

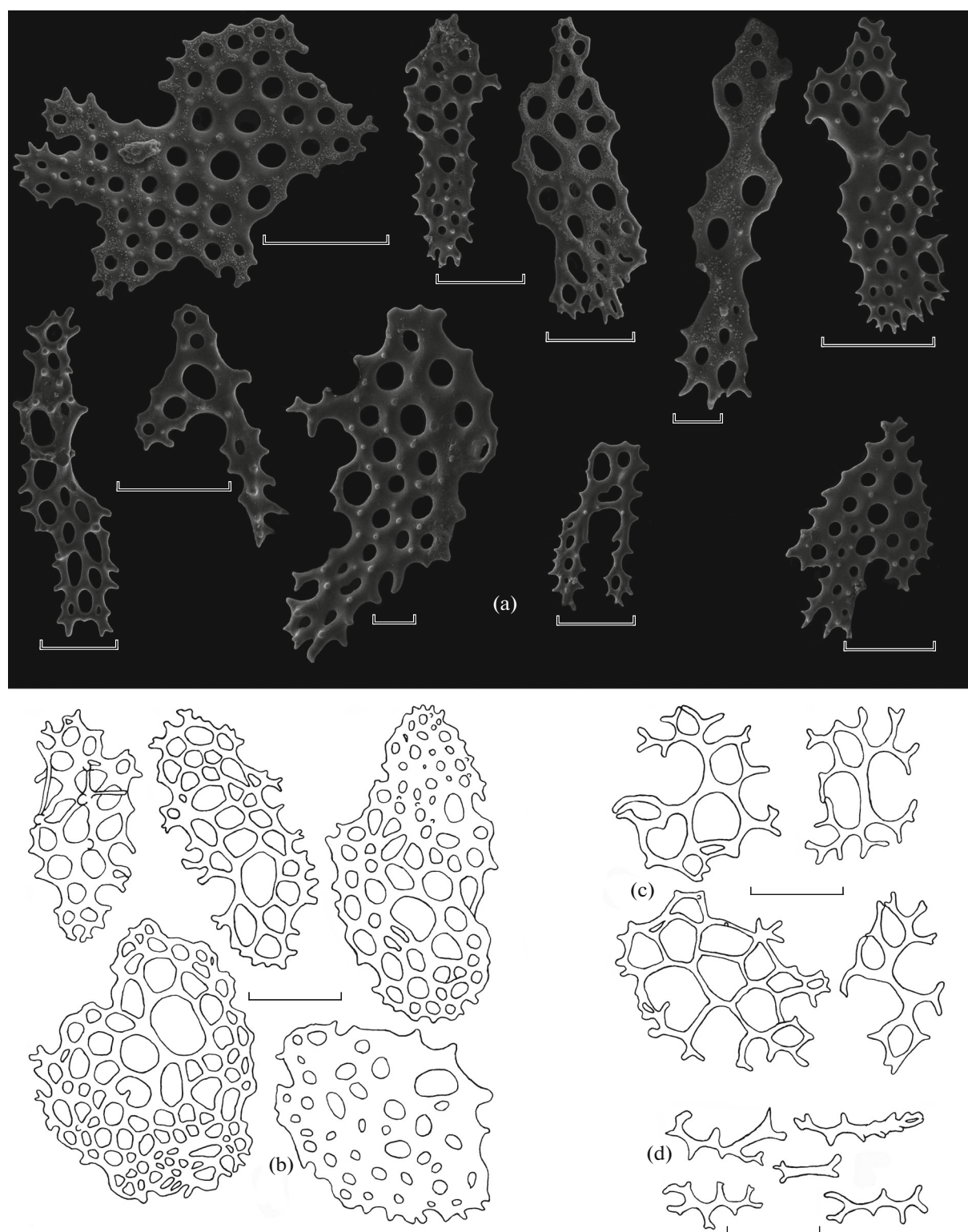


Fig. 3. Ossicles of the ventral side of the body of *Cucumaria fedotovi* sp. n.: (a) dissected and elongated perforated plates; (b) thick perforated plates; (c) open-work perforated plates; (d) sticks.

exceed 5 mm), it originates from the dorsal side of the annular ambulacral vessel. The gonads in the fixed specimen are bright orange. The respiratory trees are light brown.

The calcareous ring is massive (Fig. 1). Radial plates of about 20-mm high, they have a wide base with a very deep and wide recess along the posterior margin, expansion in the front and narrowing in the

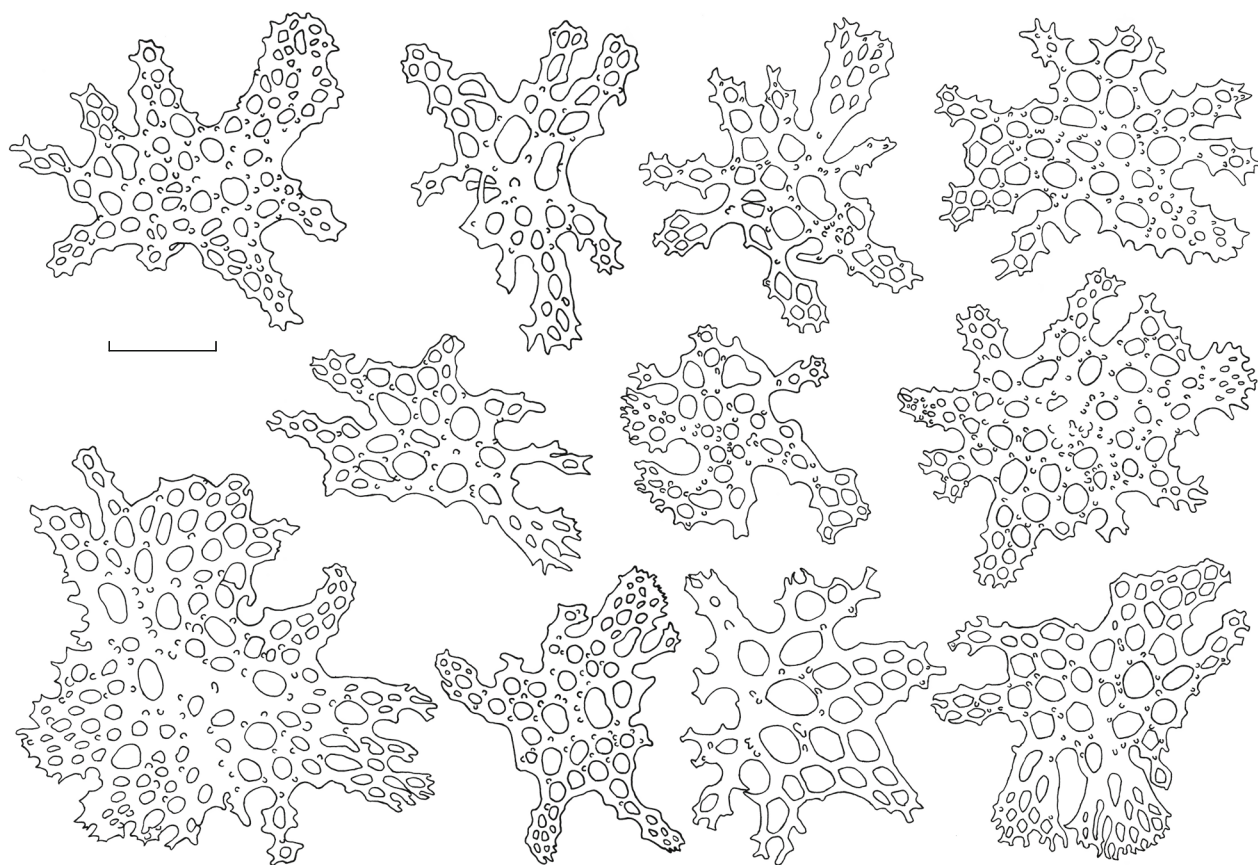


Fig. 4. Stellate ossicles of podia of *Cucumaria fedotovi* sp. n.

middle. Interradial plates are high, narrow, xiphoid, with a small notch along the posterior margin; their length reaches 16–18 mm; width, 2–3 mm in the expanded part.

In the skin of the dorsal side of the body, large dissected (2–4 lobes) and elongated perforated plates dominate. As a rule, on one side of each plate, the margin is smoother and the holes are rounded; on the opposite side, the holes are more elongated and the margin bears sharp spikes (some elongated plates have a thickening or constriction in the middle); the surface of plates bears many holes and tubercles (Fig. 2a). In addition, there are voluminous rod-shaped ossicles with or without slit-like openings (Fig. 2b) and cruciform ossicles (Fig. 2c).

In the skin of the abdominal side of the body, as well as in the skin of the dorsal side, elongated perforated plates, dissected by 2–4 lobes, are present. On one side of each plate, the margin is smoother; on the opposite side, it carries sharp spikes. The surface of the plates has many holes and tubercles (Fig. 3a) and voluminous rod-shaped ossicles with or without slit-like

openings and cruciform ossicles. In addition, there are thick perforated plates without tubercles, with a smooth margin, large holes in the center, and smaller holes to the periphery (Fig. 3b). There are open-work perforated plates without tubercles and with large irregular-shaped holes (Fig. 3c), as well as branched sticks (Fig. 3d).

The large stellate plates with 5–10 rays, many holes and tubercles, with large holes in the center of the plates and smaller on the rays, are the most characteristic and most common ossicles of the tube feet (Fig. 4). In addition, there are ossicles similar to those of the skin of the body: they are round and oval, dissected with 2–4 lobes, with many holes and tubercles (Fig. 5a); thin perforated plates with large irregular-shaped holes without tubercles and cruciform ossicles are minor (Fig. 5b).

In the tentacles, mostly elongated straight, curved, and lobed plates with many holes and tubercles are found (Fig. 6a). In a small amount, there are straight or curved rod-shaped ossicles without holes or with a small number of holes (1–4) located distally (Fig. 6b),

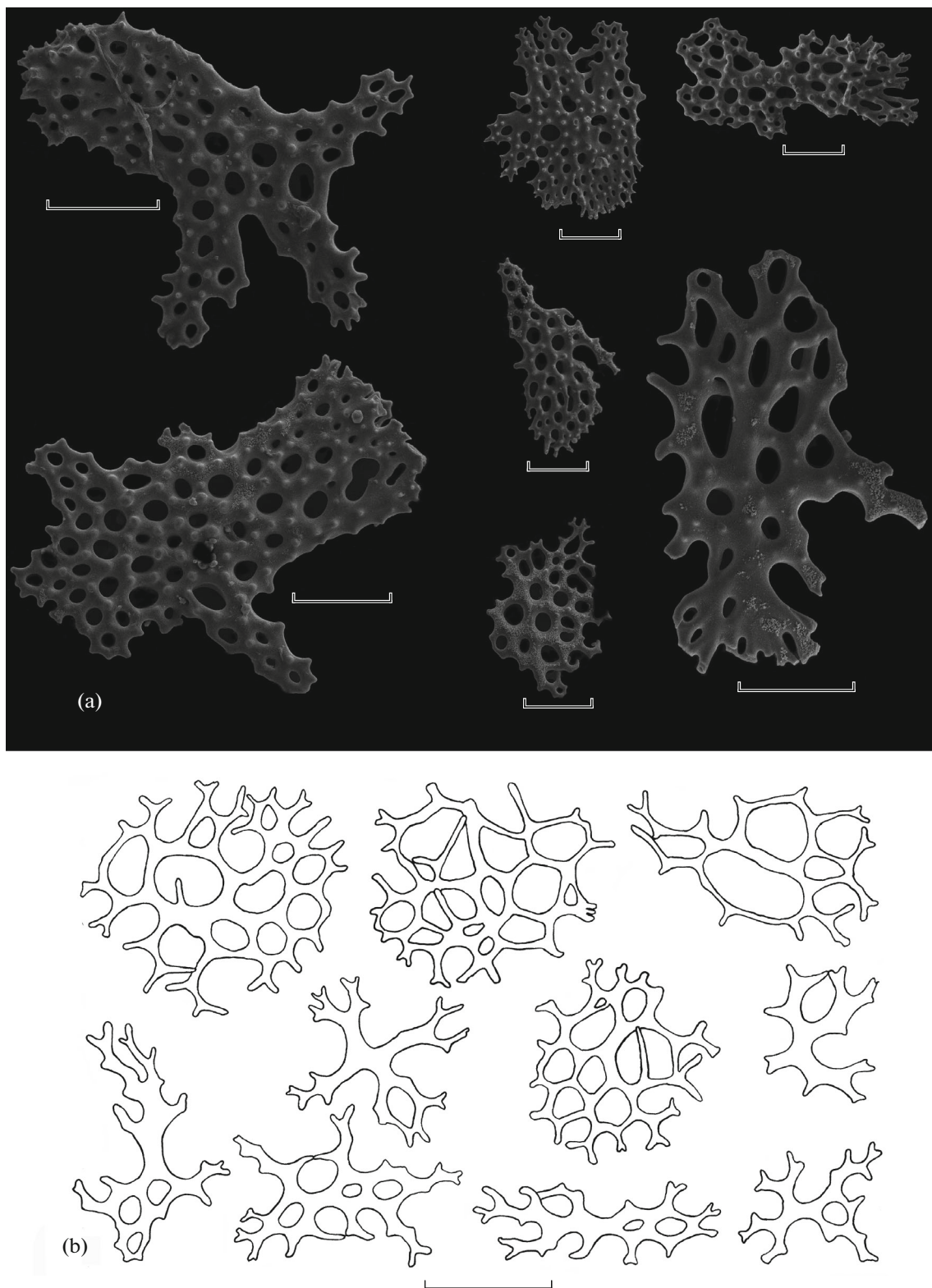


Fig. 5. Ossicles of podia of *Cucumaria fedotovi* sp. n.: (a) dissected, rounded and oval perforated plates; (b) open-work perforated plates and cross-shaped ossicles.

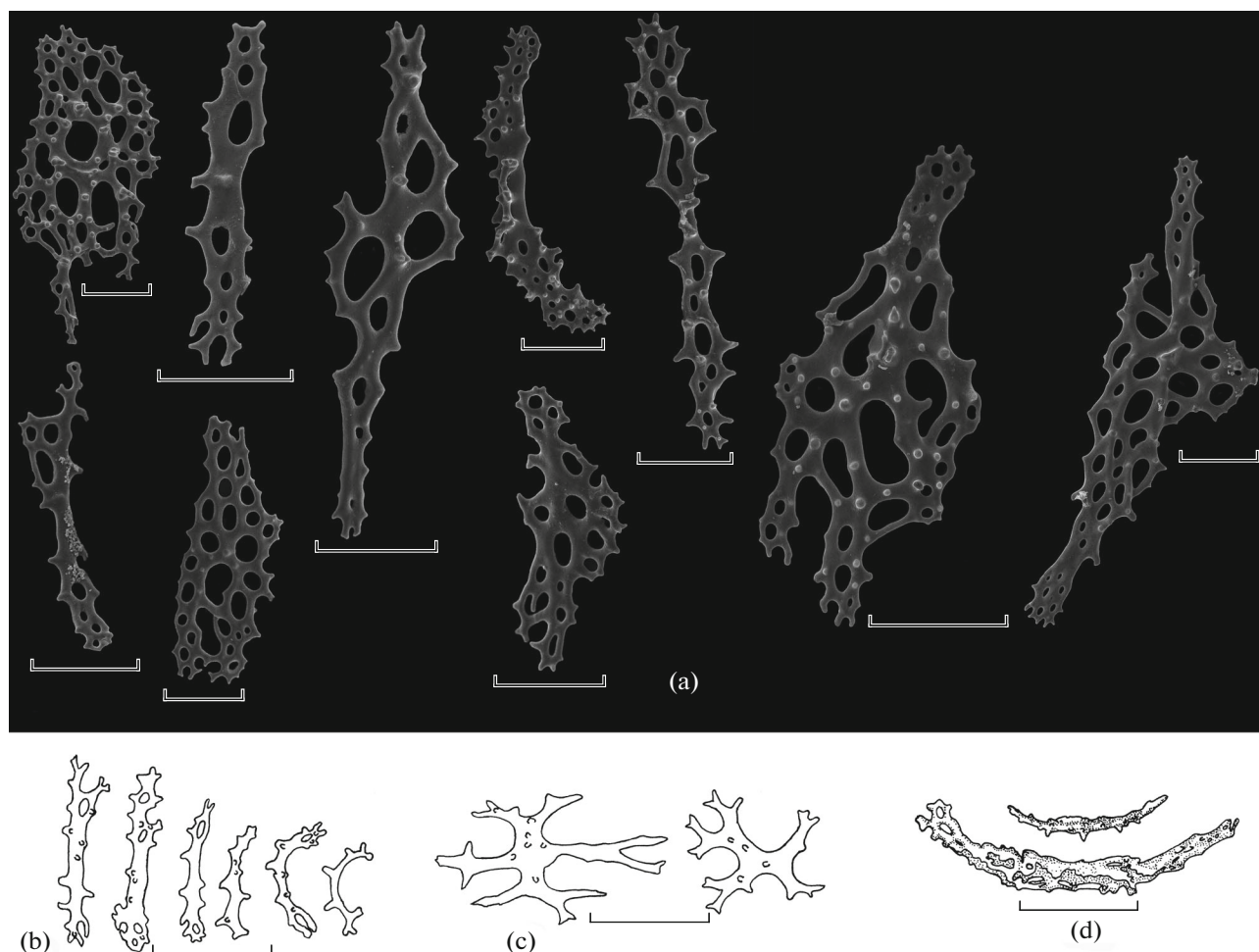


Fig. 6. Ossicles of tentacles of *Cucumaria fedotovi* sp. n.: (a) elongated straight, curved, and lobed perforated plates; (b) rod-shaped ossicles; (c) crosses; (d) voluminous sticks.

and large cruciform ossicles with tubercles (Fig. 6c) and voluminous curved sticks with or without slit-like openings (Fig. 6d).

The introvert ossicles are straight or curved elongated perforated plates with sharp spikes along the outer margin and tubercles on the surface. Some plates have a constriction or thickening in the middle (Fig. 7a). Bridges, covered with sharp spikes, are formed on the surface of some plates (Fig. 7b). There are also small branched sticks and cruciform ossicles.

The ossicles of the oral disc are elongated perforated plates with tubercles on the surface, sharp or smooth spikes on the outer margin, bearing large or slit-like openings; some plates have a constriction or a thickening in the middle (Fig. 8a). In addition, there are large spiked sticks (Fig. 8b) and large crosses (Fig. 8c).

Distribution. The species *Cucumaria fedotovi* is known only from the type location.

Etymology. The species is named after the collector Pavel Alfredovich Fedotov (Pacific Research Fisheries Center, Vladivostok).

Comparison. The new species differs from all other species of the genus *Cucumaria* by the presence of large perforated plates with sharp teeth along the outer margin and many holes and tubercles on the surface. Dissected perforated plates with many holes are also found in the species *C. anivaensis* Levin 2004, *C. conicospermium* Levin et Stepanov 2002, *C. frondosa* (Gunnerus 1767), and *C. levini* Stepanov et Pilganchuk 2002; however, the margins of such plates in these species do not carry sharp spikes. Most ossicles of the tube feet in *C. fedotovi* sp. n. are flat, strongly dissected stellate plates with sharp teeth along the outer margin and many holes and tubercles on the surface. Such types of plates are not found in all other species of the genus *Cucumaria*.

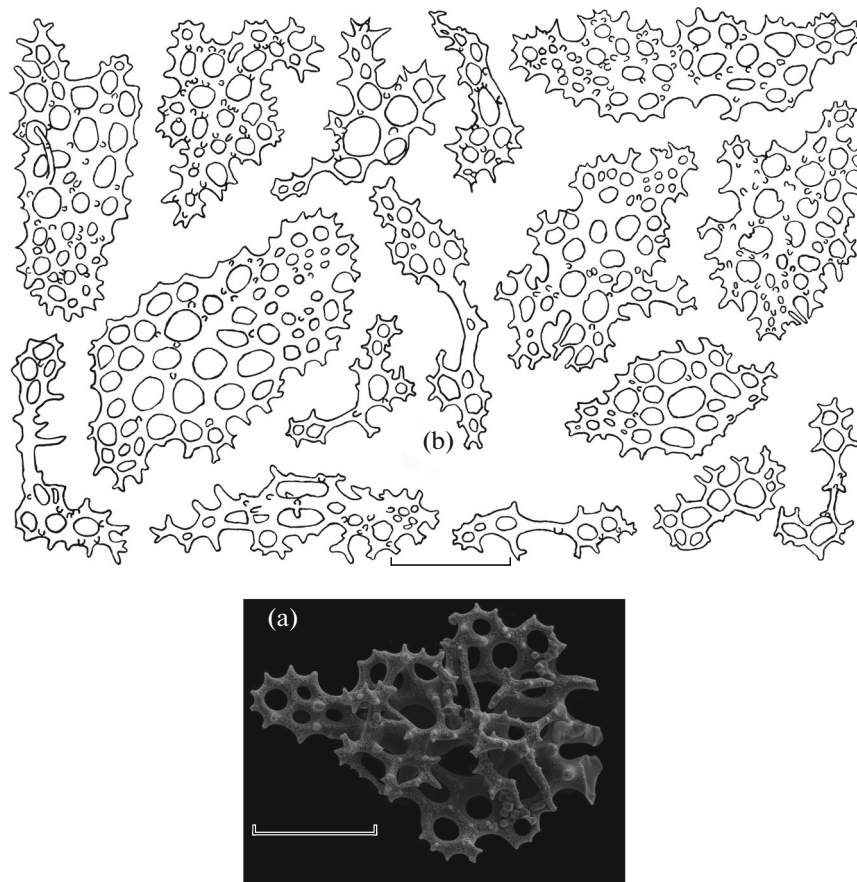


Fig. 7. Introvert ossicles of *Cucumaria fedotovi* sp. n.: (a) perforated plates; (b) fragment of a perforated plate with bridges on the surface.

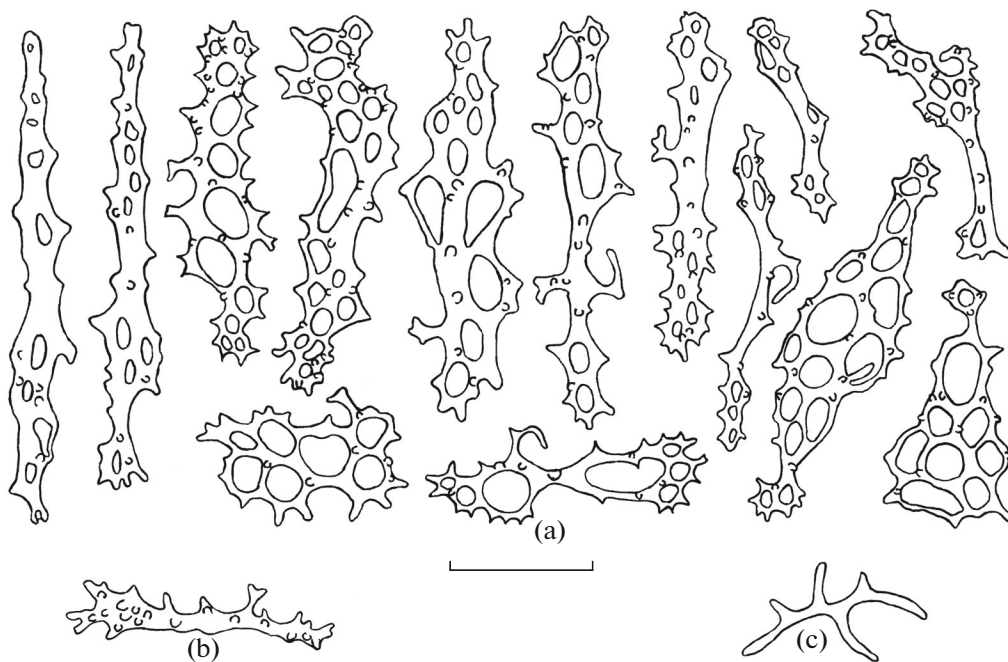


Fig. 8. Ossicles of the oral disc of *Cucumaria fedotovi* sp. n.: (a) perforated plates; (b) stick; (c) cruciform ossicles.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest. The authors declare that they have no conflict of interest.

Statement on the welfare of animals. This article does not contain any studies involving animals or human participants performed by any of the authors.

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