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New species of *Docosaccus* (Euplectellidae: Euplectellinae) from the Bering Sea

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ABSTRACT: A new species of *Docosaccus* (Euplectellidae: Euplectellinae) from the abyss of the Bering Sea is described. This species has a new type of the body shape — cup-like and additional types of microscleres with sigmoidal and onychoidal secondary rays. These new data allows to complete the previous generic diagnosis.
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KEY WORDS: sponges, Bering Sea, abyssal, new species description, Hexactinellida.

Новый вид *Docosaccus* (Euplectellidae: Euplectellinae) из Берингова моря

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РЕЗЮМЕ: Описан новый вид рода *Docosaccus* (Euplectellidae: Euplectellinae) из абиссали Берингова моря. Этот вид характеризуется новым для рода типом тела — в виде стакана и наличием добавочных микросклер с сигмоидными и онихоидными вторичными лучами. Новые данные дают основания для пересмотра родового диагноза.
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КЛЮЧЕВЫЕ СЛОВА: губки, Берингово море, абиссаль, описание нового вида, Hexactinellida.

Material and methods

The material was collected during the cruise of the RV 'Akademik Mstislav Keldysh' voyage 22 with Sigsbee trawls and HOV 'Mir'; RV 'Akademik M.A. Lavrentyev' voyage 82 ROV 'Comanche'. The collected materials were fixed in alcohol 80°, some fragments were fixed in alcohol 96° and stored at –18 °C. For light microscopy, spicule preparations were made by the method described by Janussen *et al*. (2004): a $K_2Cr_2O_7$ solution was made with water ($K_2Cr_2O_7$ powder: water ~1:1 vol%) and H_2SO_4 (96% conc.) was added ($K_2Cr_2O_7$ solution: H_2SO_4 ~1:1 vol%). A dry sponge sample was placed on the microscopic slide; 1–2 drops (depending on sample size) of the $K_2Cr_2O_7$ solution were added. The microscopic slide was heated (ca. 50–70 °C) for a few minutes to let the solution react. After evaporation of the fluid, the slide was removed from the heat and placed on a cold surface (ca. 20 °C) and a few drops of water were added. The water solution was removed by one or several small pieces (at one time) of normal filter paper. Water was added again and the spicule carefully stirred by needles, and again filter paper was used to remove excess water (occasionally it was necessary to repeat this procedure several times). The dry preparations were covered by Canada balsam and cover glass. The preparations were examined with a BIOLAR optical microscope with PA-7 camera lucida adopted for it.

Abbreviations: avg — average; D, d — diameter; IORAS — Shirshov Institute of Oceanology of Russian Ac. of Sci.; L — length; max — maximum; min — minimum; ROV — remotely operated vehicle; RV — research vessel; n — number of measures; sta. — station; std — standard deviation.

Systematics

Euplectellidae Gray, 1867
Euplectellinae Schulze, 1886
Docosaccus Topsent, 1910

DIAGNOSIS. Lophophytous, fixed by several tufts of anchor-like basalia. Body with expanded lower part, plate-like or cup-like with thin walls. Principalia are hexactins with long tangential rays and diactins. Choanosomal spicules are diactins, hexactins and their derivatives. Dermalia are hexactins, atrialia are hexactins or pentactins. Microscleres are combinations of spicules with floricoidal, sigmoidal, onychoidal, oxyoidal and discoidal secondary rays; they are spicules with hexactinic, hexaster and hemihexaster construction: floricomes, sigmatocomes (these two types have dermal location), onychohexactins, onychohemihexasters, onychohexasters, oxyhexactins, oxyhemihexasters, oxyhexasters, discohemihexasters and discohexasters.

REMARKS. The newly found species, described bellow, has a new type of the body shape — cup-like and additional types of microscleres with sigmoidal and onychoidal secondary rays. These new data allows to complete the previous generic diagnosis (Topsent, 1910, 1913; Tabachnick, 2002; Kahn *et al*., 2013). Very likely that the cup-like body form of the new species is a mature growth stage, which characterizes the entire genus. A close genus *Holascus* can be differentiated from *Docosaccus* by a single tuft of basal spicules and pinular-shaped free ray of dermal and atrial hexactins. The dissimilarity — one tuft of basalia in *Holascus* and several tufts in *Docosaccus* — is the most important feature in differentiation of these two genera. Hence it is problematic to differentiate correctly fragments of these genera. Besides the grows manner of these genera may differ.

Several tufts of basalia are known also in a monospecific genus *Chaunangium* (Tabachnick, 2002).

Docosaccus rappi **sp.n.**
Figs. 1–4, Tab. 1.

MATERIAL. Holotype: IORAS 5/2/3822. RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 22, spec. 10–1, 55°30"51.6" N 167°19"37.8" E, depth 3607 m. Paratypes: IORAS 5/2/3818, 5/2/3810, 5/2/3823, same data as holotype. IORAS 5/2/2248, 5/2/2305. RV 'Akademik Mstislav Keldysh' – 22, sta. 2316,

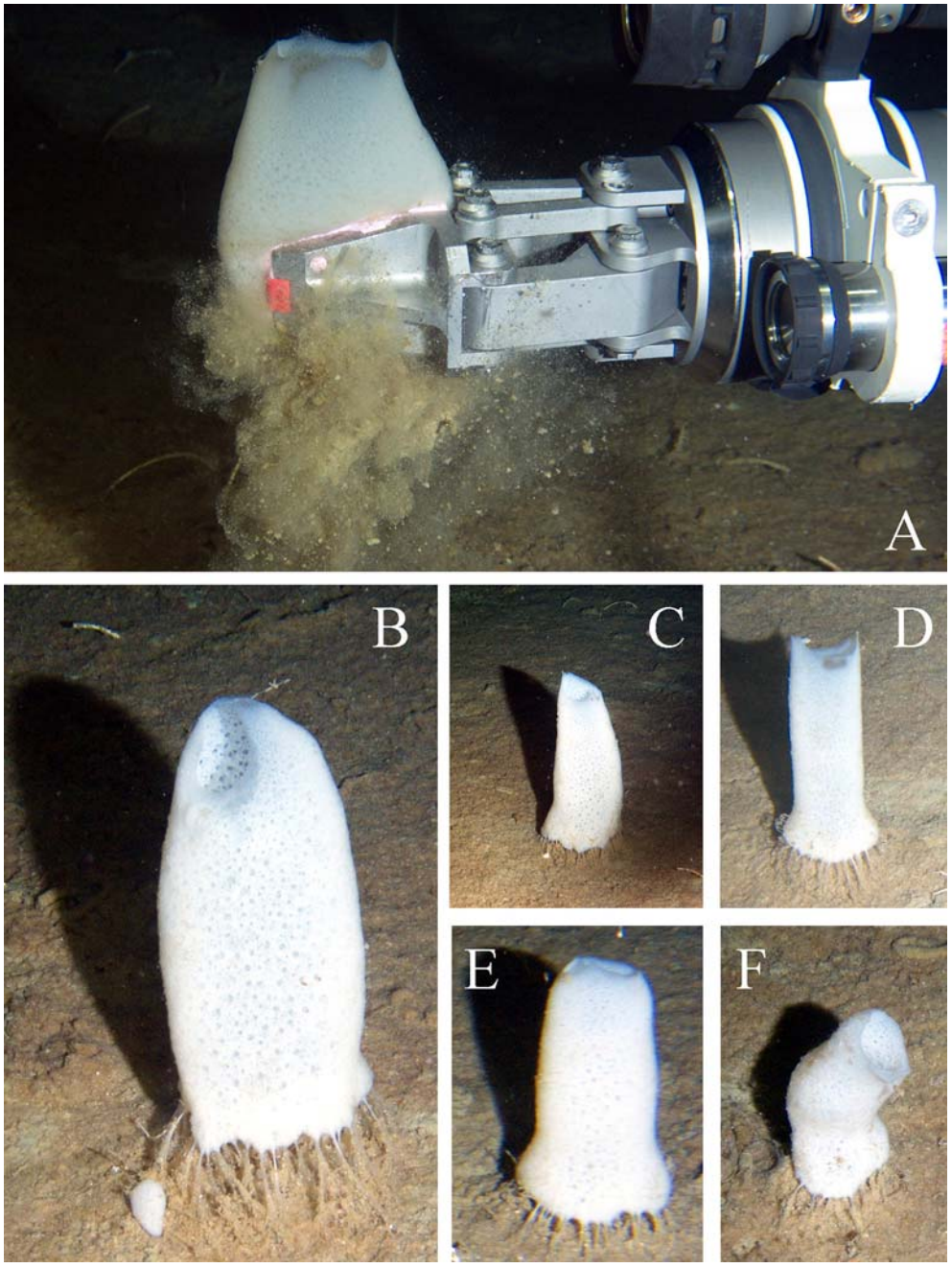

Fig. 1. *Docosaccus rappi* sp.n., ROV 'Comanche' photographs. A — capturing of the holotype IORAS 5/2/3822; B–F — ROV observations; B — specimen with irregular margin and well resolvable wall surface; C–F — different specimens.

Рис. 1. *Docosaccus rappi* sp.n., необитаемый подводный аппарат «Команч». A — момент взятия образца (голотипа IORAS 5/2/3822); B–F — фотографии, выполненные подводным необитаемым аппаратом; B — экземпляр с неправильным (неровным) краем и хорошо различимой поверхностью стенки тела; C–F — различные экземпляры.

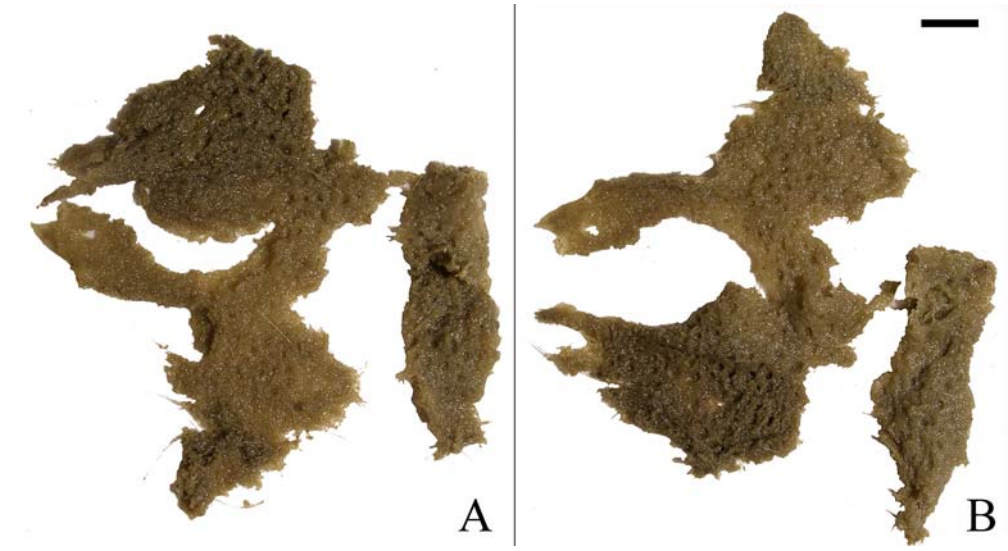

Fig. 2. *Docosaccus rappi* sp.n., holotype IORAS 5/2/3822, photographs on deck. Scale 10 mm. A–B — view from different sides.
Рис. 2. *Docosaccus rappi* sp.n., голотип IORAS 5/2/3822, фотографии, выполненные на палубе. Масштабный отрезок 10 мм. A–B — вид с разных сторон.

trawl, 55°36.08'–35.00' N 167°23.04'–24.46' E, depth 4200–4294 m.

DESCRIPTION. BODY. The specimens in the collection (including the holotype) are represented by lamellate broken fragments of the wall, 2–4 mm thick. From both dermal and atrial sides numerous cavernous-like depressions, 1–2 mm in diameter and about 1 mm deep are observed as well as on photos *in situ*. The specimens on the photos may be about 100–150 mm high and about 50 mm in diameter, the osculum margin is usually irregular – asymmetrical (displaced) and with ragged edge, but regular forms were also observed from the ROV. Lateral oscula were not observed. Position of dermal and atrial surface is extrapolated from presence or absence of sigmatocomes and floricomes. These microscleres are dermal for all known Euplectellidae.

SPICULES. MACROSCLERES. Basalia are anchorate spicules with 4 teeth, shafts are spiny close to the anchorate part and smooth, conically pointed, proximally. These spicules are about 40 mm long, about 0.007 mm in diameter near the anchorate head and up to 0.044 mm in diameter in the middle part. The anchorate head is 0.022 mm in diameter and 0.022 mm long. Principalia are hexactins and diactins with smooth rays and conically pointed outer ends. These diactins are 8–45/0.03–0.11 mm. Principalia hexactins have tangential rays up to 12–24 mm, and rays directed distally and proximally, notably shorter, 0.5–1.4 mm long; the diameter of these rays is 0.1–0.15 mm. Most choanosomal spicules are smaller and thinner, generally they are hexactins and diactins, one can occasionally find all intermediate types among them (monactins, tauactins, paratetractins, pentactins). These spicules have rough rays and conically pointed outer ends. The diactins, 3–4.5/0.006–0.009 mm, have four rudimentary tubercles or sometimes a widening in the middle. The hexactins have rays 0.46–1/0.009–0.015 mm.

Dermalia and atrialia are hexactins with rough rays and conically pointed outer ends. The rays directed outwardly from the wall seem rougher, in some spicules they are spindle-like or clavate with rounded outer ends. Usually, the ray of dermal and atrial hexactins directed inside the body is the longest, but in some dermal

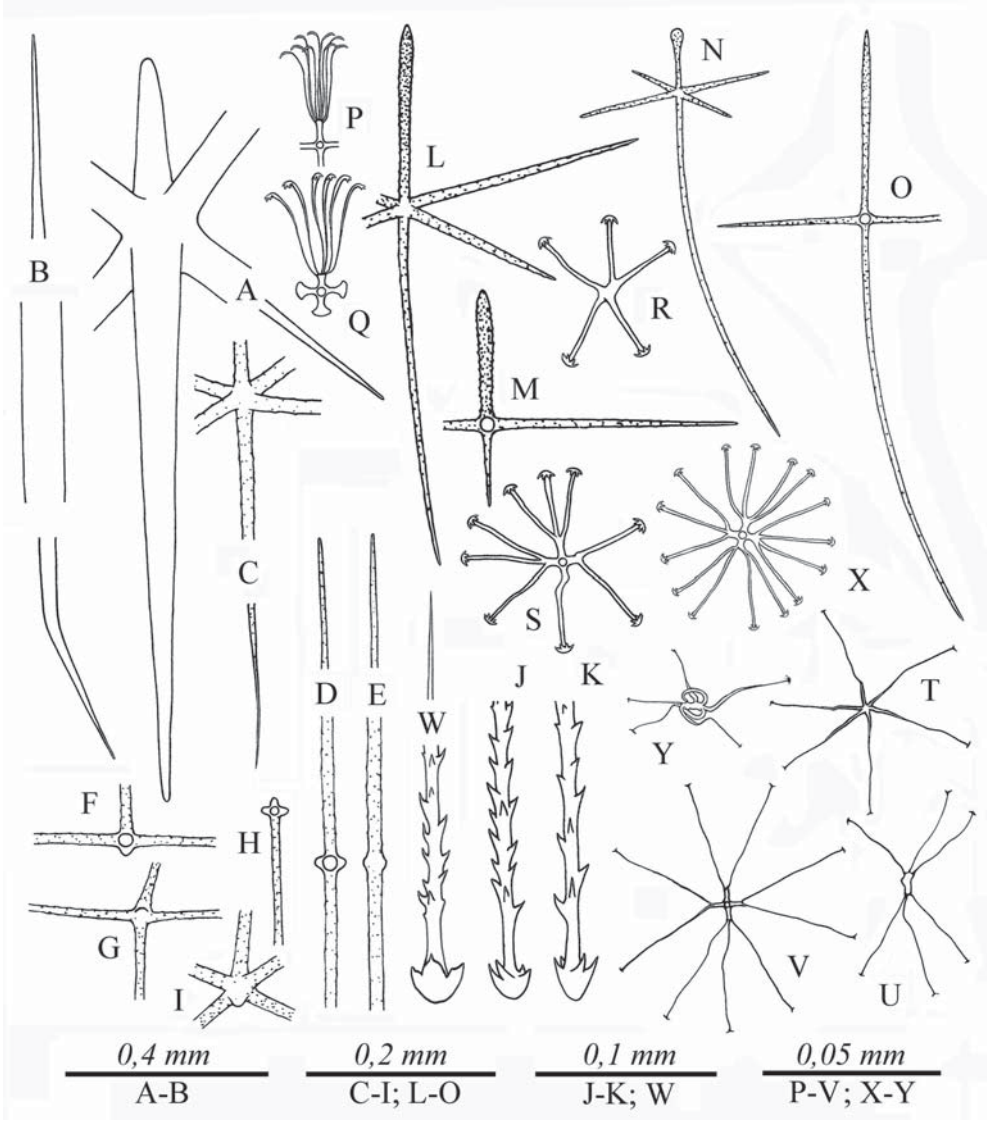

Fig. 3. Spicules of *Docosaccus rappi* sp.n. A–B — principalia; A — principalia hexactin; B — principalia diactin; C–H — choanosomal spicules; C — hexactin; D–E — diactins; F — tauactin; G — stauractin; I — pentactin; H — monactin; J–K, W — anchorate basalia; L–N — dermal hexactins; O — atrial hexactins; P — sigmatocome; Q — floricome; R — abnormal thick-rayed discoidal microsclere; S — thick-rayed discohemihexasters; T — thin-rayed onychohexactin; U, Y — thin-rayed abnormal onychoidal microscleres; V — onychohexaster; X — discohexaster; N, H — paratype 5/2/2248; R — paratype 5/2/2305; X–Z — paratype 5/2/3823; other figures — holotype.

Рис. 3. Спикулы *Docosaccus rappi* sp.n. A–B — принципалии; A — принципалия гексактина; B — принципалия диактина; C–H — хоаносомальные спикулы; C — гексактина; D–E — диактины; F — тауактина; G — ставрактина; I — пентактина; H — моноактина; J–K, W — базалии в виде якоря; L–N — дермальные гексактины; O — атриальная гексактина; P — сигматокома; Q — флорикома; R — необычная дискоидальная микросклера с утолщенными лучами; S — дискогемидексактина с утолщенными лучами; T — тонко-лучевая онихогексактина; U, Y — необычная онихоидальная микросклера с тонкими лучами; V — онихогексастра; X — дискогексастра; N, H — паратип 5/2/2248; R — паратип 5/2/2305; X–Z — паратип 5/2/3823; на остальных иллюстрациях изображен голотип.

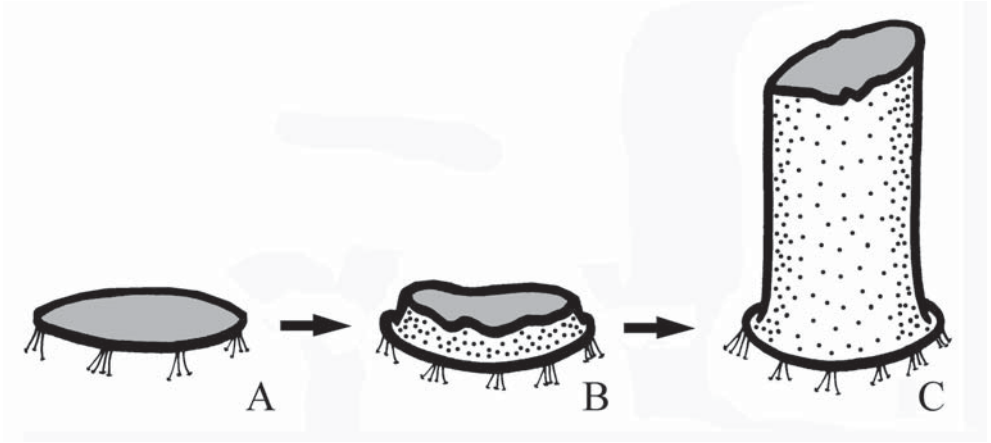

Fig. 4. Scheme of suggested growth of *Docosaccus* through the body forms of known species (dotted — dermal surface, gray — atrial surface) or a row of body forms, which characterize known species of the genus (the type species *D. ancoratus* is known by fragments and its real body form may correspond to any one of the species described below). A — plate-like stage *D. maculatus*; B — ashtray-like stage *D. nidulus*; C — cup-like stage *D. rappi* sp.n.

Рис. 4. Предположительная схема роста *Docosaccus*, основанная на форме тела других видов (точками показана дермальная поверхность, серым — атриальная поверхность), или различные формы тела, характеризующие известные виды рода (типовой вид *D. ancoratus* известен по фрагментам и его истинная форма тела может соответствовать любому из видов, упомянутых ниже). A — стадия в форме тарелки *D. maculatus*; B — стадия в форме пепельницы *D. nidulus*; C — чашевидная стадия *D. rappi* sp.n.

spicules tangential rays are longer, while the distal and proximal ones are shorter. Distal rays of dermal hexactins are 0.099–0.357 mm long, tangential rays are 0.129–0.342 mm, proximal rays are 0.061–1.254 mm, the diameter of these rays is 0.008–0.024 mm. Atrial hexactins have rays directed into the atrial cavity 0.106–0.319 mm long, tangential rays are 0.152–0.319 mm, proximal rays are 0.167–1.444 mm, the diameter of these rays is 0.005–0.019 mm.

MICROSCLERES. Microscleres have sigmoidal, floricoidal, onychoidal and discoidal secondary rays. Sigmatocomes and rare floricomes are located on the dermal surface. The sigmatocomes have 8–14 secondary rays. The diameter of sigmatocomes is 0.032–0.072 mm, the diameter of the primary rosette is 0.007–0.018 mm. The floricomes have about 10 secondary rays with 3 teeth. The diameter of floricomes is 0.040–0.072 mm, the diameter of the primary rosette is 0.007–0.014 mm. The onychohexactins have thin rays 0.041–0.076 mm. The onychohexasters and onychohemihexasters have 1–3 thin secondary rays (sometimes they have discoidal outer ends). The diameter of onychohexasters and onychohemihexasters is 0.036–0.072 mm, their primary rosette is 0.004–0.014 mm. Discohexasters and discohemihexasters with 1–4 (usually 2–3) secondary thick rays, 0.043–0.072 mm in diameter, their primary rosette is 0.004–0.013 mm in diameter.

ETYMOLOGY. The species is named in memory of our colleague from the Bergen University, H.T. Rapp.

DISTRIBUTION. Currently found only off the Piip underwater volcano at 3607–4294 m depth.

REMARKS. Due to the external shape (basalia are not gathered in a single, common tuft), combination of principalia spicules and microsclere set, the newly found specimens definitely belong to *Docosaccus* — Euplectellinae (Tabachnick, 2002). Three species of this genus were known: *D. ancoratus* Topsent, 1910 — Weddell Sea; *D. maculatus* Kahn, Geller, Reiswig et Smith, 2013 — NE Pacific and *D.*

Table 1. Measurements of different spicules of *Docosaccus rappi* sp.n. (in mm).
Таблица 1. Размерные характеристики спикул разных типов у *Docosaccus rappi* sp.n. (в мм).

	Holotype: IORAS 5/2/3822					Paratype: IORAS 5/2/2248					Paratype: IORAS 5/2/3823				
	n	min	max	avg	std	n	min	max	avg	std	n	min	max	avg	std
L dermal hexactin distal ray	25	0.099	0.251	0.167	0.044	25	0.137	0.357	0.217	0.058					
L dermal hexactin tangential ray	25	0.167	0.342	0.270	0.041	24	0.129	0.274	0.192	0.035					
L dermal hexactin proximal ray	25	0.061	1.117	0.450	0.353	24	0.137	1.254	0.499	0.271					
L atrial hexactin ray directed outside the body	25	0.160	0.319	0.226	0.043	25	0.106	0.251	0.188	0.040					
L atrial hexactin tangential ray	25	0.167	0.281	0.215	0.029	22	0.152	0.319	0.245	0.049					
L atrial hexactin ray directed inside the body	25	0.167	1.064	0.496	0.182	18	0.190	1.444	0.666	0.286					
D floricome	1	0.072	0.072	0.072		2	0.058	0.072	0.065	0.010	15	0.040	0.061	0.056	0.(
d floricome	1	0.013	0.013	0.013		2	0.011	0.014	0.013	0.003	15	0.007	0.014	0.012	0.(
D sigmatocome	10	0.050	0.065	0.057	0.004	25	0.032	0.065	0.055	0.007	25	0.040	0.072	0.054	0.(
d sigmatocome	10	0.011	0.014	0.012	0.002	25	0.007	0.018	0.012	0.003	25	0.007	0.014	0.012	0.(
D onychohexactin	9	0.041	0.065	0.055	0.006	25	0.047	0.076	0.061	0.007	11	0.043	0.065	0.053	0.(
D onychohexaster/onychohemihexaster	25	0.036	0.068	0.053	0.008	21	0.050	0.072	0.059	0.006	25	0.040	0.061	0.052	0.(
d onychohexaster/onychohemihexaster	25	0.004	0.014	0.009	0.002	21	0.004	0.011	0.007	0.002	25	0.004	0.011	0.008	0.(
D discohexaster/discohemihexaster	6	0.054	0.070	0.059	0.006	13	0.050	0.072	0.060	0.007	11	0.043	0.058	0.049	0.(
d discohexaster/discohemihexaster	6	0.005	0.012	0.008	0.002	13	0.005	0.013	0.009	0.002	11	0.004	0.011	0.009	0.(

nidulus Kersken, Janussen et Arbizu, 2019 — NE Pacific. All these species have floricomes and oxyoidal microscleres, *D. ancoratus* has also discoidal microscleres. The new species *D. rappi* has additional types of microscleres with sigmoidal and onychoidal secondary rays.

Floricomes in all representatives of the genus are located close to the dermal surface. In *D. maculatus* floricomes are located on the bottom surface which definitely corresponds to dermal surface.

The external shape of the type species, *D. ancoratus*, is unknown because of the damaged state of the collected materials, trawled by the RV 'Scotia' (Topsent, 1910). Photos of all the other specimens were taken before capturing: *D. maculatus* is a disc-like sponge lying on soft bottom (Kahn *et al.*, 2013); *D. nidulus* is ash-tray-like — sponge with wide bottom and low lateral walls (Kersken *et al.*, 2019) and *D. rappi* specimens are tubular or cup-like specimens, often with irregular osculum margin and wide bottom (same with *D. nidulus*). It is highly likely that *D. maculatus* and *D. nidulus* are described after the young specimens and their shape in its fully grown stages is cup-like too, same may be suspected for *D. ancoratus*, which is known by broken fragments.

The large size of the flat basal part of these sponges allows them to inhabit extremely soft muddy silts, as it was observed for the new species.

This new species is a second representative of the Euplectellinae in the Bering Sea. The other belong to *Euplectella*: *E.* sp. from 3661 m and, likely, *E. oweni* (location unknown, but the Bering Sea is highly likely) (Koltun, 1967).

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