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Rossellidae (Porifera: Hexactinellida) from the Bering Sea and off Bering Island

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ABSTRACT: Members of the family Rossellidae are the main contributors to the hexactinellid fauna and even to the macrobenthic fauna in the deep waters of the North Pacific. Representatives of this family often reach a larger size than other Hexactinellida, Porifera and even other representatives of benthic invertebrates.

Description of Rossellidae from the Bering Sea collected by trawls, submersibles and remotely operated vehicles (ROVs) during the expeditions of RVs 'Akademik M.A. Lavrentyev' and 'Akademik Mstislav Keldysh' are given. Subgenera, species and subspecies in five genera are described and include: *Acanthascus* (*Acanthascus*) *alani profundus*; *A.* (*Acanthascus*) *alani microdiscoctasterus* ssp.n.; *Acanthascus* (*Rhabdocalyptus*) *borealis*; *Acanthascus* (*Rhabdocalyptus*) *heteraster*; *Acanthascus* (*Rhabdocalyptus*) *mirabilis*; *Acanthascus* (*Staurocalyptus*) *tylotus*; *Aulosaccus ijimai*; *Bathydorus laniger*; *B. spinosus*; *B. spinosissimus*; *B.* sp.; *Caulophacus* (*Caulophacus*) *elegans*; *C.* (*Caulophacus*) *hyperboreus*; *C.* (*Caulophacus*) *miri* sp.n.; *C.* (*Caulophacus*) *subarcticus* sp.n.; *C.* (*Caulophacus*) sp.; *Hyalascus giganteus*; *H. keldishi* sp.n.

We suggest a new name *B. levis neospinosus* ssp.n. for *B. levis spinosus* of Wilson to avoid the homonymy with *B. spinosus* Schulze and simultaneously we offer it as a lower synonym of the latter. Meantime *B. levis* and *B. spinosus* are considered to be different species.

The subdivision of Rossellidae into Rossellinae and Lanuginellinae has no reasonable morphological grounds in their diagnoses anymore and support for uniting these two subfamilies is provided.

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KEY WORDS: Rossellidae, Bering Sea, species and subspecies descriptions, Hexactinellida.

Rossellidae (Porifera: Hexactinellida) из Берингова моря и у острова Беринга

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РЕЗЮМЕ: Губки семейства Rossellidae являются основными представителями Шестилучевых губок и вцелом макробентоса в глубоководной зоне северной части Тихого океана. Эти губки часто достигают значительных размеров среди других Шестилучевых губок, представителей других классов губок и даже других бентосных беспозвоночных.
Приводятся описания представителей Rossellidae из Берингова моря и тихоокеанской части острова Беринга собранные тралами, обитаемыми и необитаемыми подводными аппаратами в ходе экспедиций на кораблях "Академик Мстислав Келдыш" и "Академик М.А.Лаврентьев". Пять родов включают ряд видов, подвидов и подродов: *Acanthascus* (*Acanthascus*) *alani profundus*; *A.* (*Acanthascus*) *alani microdiscoctasterus* ssp.n.; *Acanthascus* (*Rhabdocalyptus*) *borealis*; *Acanthascus* (*Rhabdocalyptus*) *heteraster*; *Acanthascus* (*Rhabdocalyptus*) *mirabilis*; *Acanthascus* (*Staurocalyptus*) *tylotus*; *Aulosaccus ijimai*; *Bathydorus laniger*; *B. spinosus*; *B. spinosissimus*; *B.* sp.; *Caulophacus* (*Caulophacus*) *elegans*; *C.* (*Caulophacus*) *hyperboreus*; *C.* (*Caulophacus*) *miri* sp.n.; *C.* (*Caulophacus*) *subarcticus* sp.n.; *C.* (*Caulophacus*) sp.; *Hyalascus giganteus*; *H. keldishi* sp.n.
Новое название *B. levis neospinosus* ssp.n. предложено для *B. levis spinosus* Wilson для избегания ононимии с *B. spinosus* Schulze и одновременно назначается младшим синонимом последнего. В тоже время *B. levis* и *B. spinosus* различаются как разные виды.
Подразделение Rossellidae на Rossellinae и Lanuginellinae в настоящее время лишено достоверных морфологических оснований, их диагнозы неразличимы, приводятся доводы по ликвидации этих двух подсемейств.
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КЛЮЧЕВЫЕ СЛОВА: Rossellidae, Берингово море, видовые и подвидовые описания, Hexactinellida.

Introduction

Investigation of hexactinellid sponges from the Bering Sea started with the description of the US 'Albatross' collection in 1888–1890 from the Aleutian Islands (formally outside the Bering Sea (Schulze, 1899). Several other representatives of Hexactinellida from this area were subsequently described by Schulze (1899). In 1906 a series of trawl stations were made by a subsequent 'Albatross' expedition in the Bering Sea, off Bering Island, off the Kuril Islands, and off Japan. Specimens collected from these stations were examined and described by Okada (1932). Later investigation of the Bering Sea hexactinellids was connected with the SU expeditions of the RV 'Vityaz' and other ships. The results of these expeditions were published by Koltun (1967). Description of hexactinellid sponges from the eastern part of the Bering Sea were published by Stone *et al.* (2011) and Reiswig and Stone (2013), whose materials were sampled by the ROVs dives during US expeditions. We continue here the description of the Bering Sea hexactinellids collected in its western part, generally from the Piip Volcano, Kommandorsk Basin and off Bering Island. Sponges were sampled by trawls, HOVs 'Mir-1' and 'Mir-2' during the 22nd cruise of the RV 'Akademik Mstislav Keldysh'and by the ROV 'Comanche-8' during the 75th and 82nd cruises of the RV 'Akademik M.A. Lavrentyev'. A single hexactinellid representative belonging to a new genus and species — *Ijimaiella beringiana* from the family Euplectellidae — was described earlier by Tabachnick (2002a). Continued descriptions of new taxa show that our knowledge of these large-sized conspicuous animals is still far from being complete. Reef building hexactinellids of families Farreidae and Euretidae from the Bering Sea are described separately (Tabachnick *et al.*, in press).

The representatives of the family Rossellidae, which are the main contributors to the hexactinellid fauna and even to the entire macrofauna in the North Pacific are described below. Representatives of Rossellidae in the genera *Acanthascus* and *Aulosaccus* often reach about half a meter in length. Other species in the genus *Caulophacus*, have peduncles over 1–1.5 m long.

Recently, diverse structural pecularities of Rossellidae (Ehrlich *et al.*, 2008) remain to be also in focus of experts in biomaterials science. Hexactinellids principally have been accepted within this scientific direction as unique sources for biosilica inspired materials chemistry (Ehrlich *et al.*, 2011, 2016) as well as poriferan scaffolding strategies (Tsurkan *et al.*, 2020; Khrunyk *et al.*, 2020). In addition, the recent discovery of actin within skeletal structures of rossellids (Ehrlich *et al.*, 2022) stimulates further research with respect to their morphology, skeletogenesis and structural biology.

Material and methods

The specimens examined for this paper were collected during the cruise of the RV 'Akademik Mstislav Keldysh' voyage 22 with Sigsbee trawls and HOVs 'Mir'; RV 'Akademik M.A. Lavrentyev' voyages 75 and 82 with the ROV 'Comanche'. The collected materials were preserved in 80–96% alcohol and stored at room temperature. 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 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; HOV — human-occupied vehicles; IORAS — P.P. Shirshov Institute of Oceanology of Russian Academy of Sciences; L, l — length; max — maximum; min — minimum; n — number of measures; ROV — remotely operated vehicle; RV — research vessel; sta. — station; std — standard deviation.

Systematics

Rossellidae Schulze, 1885

The latest summary of the early history of Rossellidae and its scope is given by Tabachnick (2002b). This family is in the order Lysaccinosida and was originally subdivided into 3 subfamilies, Rossellinae (characterized by having neither discoctasters nor strobiloplumicomes), Lanuginellinae (characterized by the presence of strobiloplumicomes but no discoctasters), and Acanthascinae (characterized by having discoctasters but no strobiloplumicomes). Tabacknick (2002b) abolished the latter subfamily due to the presence of spicules resembling discoctasters in the holotype of the type species for the genus *Caulophacus* — *C.* (*Caulophacus*) *latus*. This genus together with *Caulophacella* was later moved from the Rossellinae to the Lanuginellinae (Dohrmann *et al.*, 2017; Reiswig *et al.*, 2021). Reiswig and Stone (2013) resurrected the subfamily Acanthascinae, arguing that discoctasters were only found in the three genera within that group, without comment on the possible presence of these distinctive spicules in the genus *Caulophacus*. However, we continue to adhere to contend that the abolishment of the subfamily Acanthascinae is appropriate and suggest consideration of its tree genera status in the lower subgeneric level. As for the two remnant subfamilies of Rossellidae, the only morphological reason for the subdivision of this family was absence in Rossellinae and presence in Lanuginellinae of specific spicules — strobiloplumicomes. The genetic monophyletic charecters of these grpoops sudgested by Dohrmann *et al.* (2017) are not supported by any common morphological features sutable for the separate diagnoses of these two subfamilies. Inspite that the genetic analysis of Lanuginellinae supports keeping this subfamily no relible morphological features could be established to be valid for the diagnosis, which provides its definition from Rossellinae. A weak feature of this subdivision is connected with two facts. The first: absence of a peculiarity (in this case strobiloplumicomes in Rossellinae) is a principally weak taxonomic feature, being alone it does not provide reliable ground for the taxon's characterization – absence of a feature may be a result of multiple loses of it, or the feature has not appeared at all, thus the possibility of a polyphyletic origin of the taxon with such character is highly likely. And the second: strobiloplumicomes were not found in some specimens of monospecific *Mellonympha* — *M. vellata* (a doubtful Lanuginellinae representative) (Tabach-

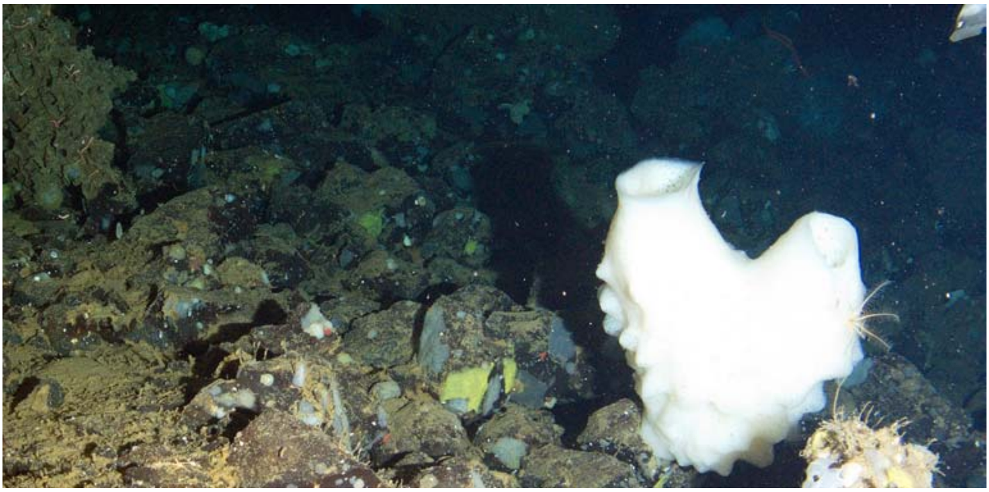

Fig. 1. *Acanthascus* (*Acanthascus*) *alani microdiscoctasterus* ssp.n. Complete specimen before ROV ‘Comanche’ sampling.
Рис. 1. *Acanthascus* (*Acanthascus*) *alani microdiscoctasterus* ssp.n. Целый экземпляр перед взятием образца подводным роботом “Comanche”.

nick, 2002b). Now the new phylogenetic data led to the transferring of the genus *Caulophacus* (it is unclear complete (with numerous subgenera) or only a part of it) and suggestion of a new diagnosis for Lanuginellinae (Reiswig *et al*., 2021). This operation is a final point in the disappearance of the last reliable differences between the two remaining subfamilies and this fact requires the final formal action of the entire abolishment of discussed subfamilies. Thus Rossellidae now is an integral family, which has no subdivision into subfamilies. Meantime the fact of presence or absence of specific microscleres: discoctasters (former specific feature of Acanthascinae abolished by Tabachnick (2002b)) and presence of strobiloplumicomes (specific feature of former Lanuginellinae) can be definitely used in keys to genera and subgenera of numerous rossellid taxa in corresponding chapters suggested by Tabachnick (2002b) following the insubstantial (as it is obvious now) subdivision into groups.

Acanthascus Schulze, 1886
Acanthascus (*Acanthascus*) *alani* Ijima, 1898
Acanthascus (*Acanthascus*) *alani microdiscoctasterus* **ssp.n.**
Figs 1, 2; Suppl. Tab. 1.

MATERIAL. Holotype: IORAS 5/2/3805. RV ‘Akademik M.A. Lavrentyev’ – 75, ROV ‘Comanche’, sta. 18, spec. 5-2, 55.4352° N 167.2668° E, 1420 m.

DESCRIPTION. BODY. Funnel-like body with smooth dermal and atrial surfaces, about 500 mm high with 2 oscula about 80 mm in diameter. The sponge was attached to rocky substratum; its basal part is about 100 mm in diameter. Some irregular prostalia diactins are observed, they are generally oscularia but some of these spicules are lateralia. The walls of this specimen are up to 25–30 mm in thickness. Only a portion, about 100x100 mm and 10–25 mm in thickness, from the upper part of this sponge was sampled, a largest portion of the holotype specimen was left on the bottom alive. The collected material was reduced to many lamellate fragments during the fixation and transportation.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins with stout, smooth shafts, and rounded, rough outer ends. These diactins are 1.4–4/0.004–0.013 mm. Several hypodermal pentactins with smooth and spiny tangential rays were found among the spicule preparations, they likely belong to other representatives of *Acanthascus* numerously distributed around this specimen. Dermalia and atrialia are very similar, both consisting of pentactins, hexactins, some stauractins and rare diactins with short-spiny rays and rounded outer ends. Most pentactins and some stauractins have tuberculated rudiments of the absent rays. The only difference between dermal and atrial spicules is the dominance of pentactins in the dermal sides of the colony and hexactins in the atrial sides. Dermal pentactins have tangential rays 0.081–0.196 mm long (n=25, avg: 0.150 mm, std: 0.029 mm), the proximal rays 0.104–0.233 mm long (n=25, avg: 0.169 mm, std: 0.032 mm), and rudiments of the distal ray if present 0.007–0.019 mm long (n=19, avg: 0.011 mm, std:

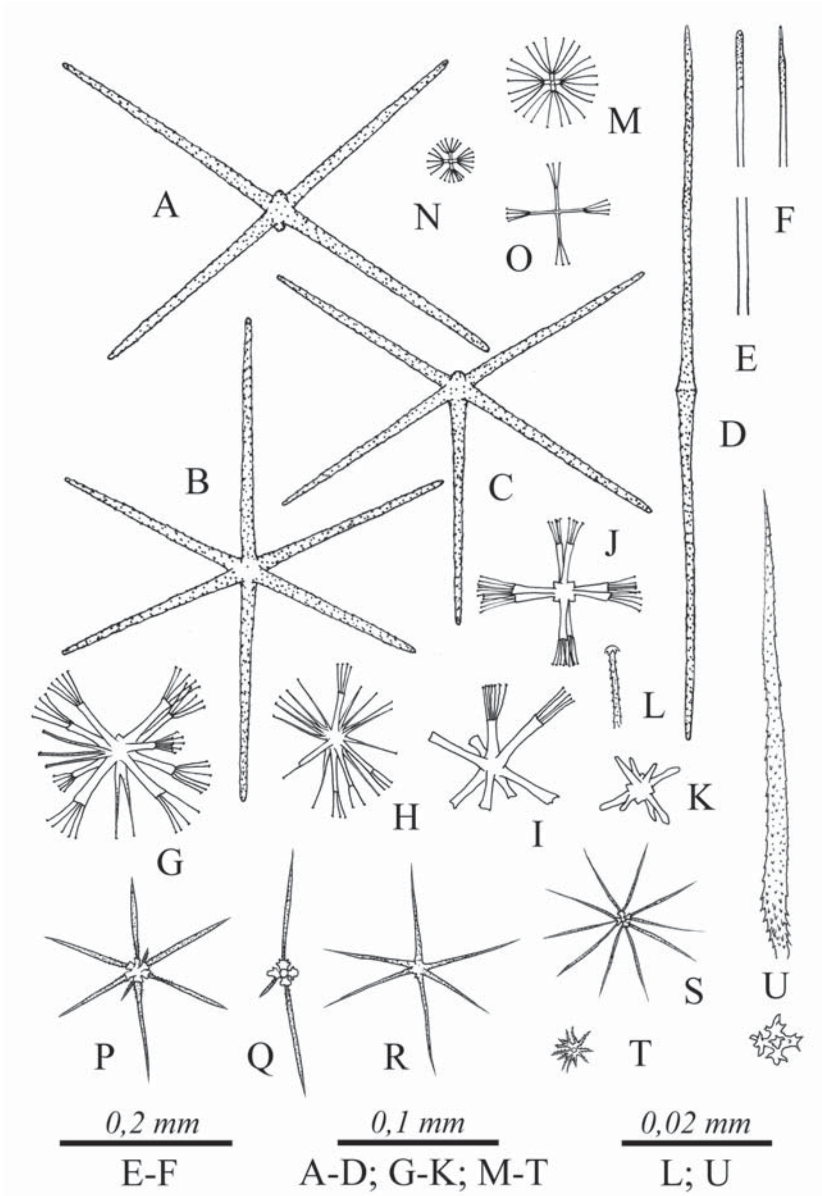

Fig. 2. Spicules of *Acanthascus* (*Acanthascus*) *alani microdiscoctasterus* ssp.n., holotype. A — dermal stauractin. B — dermal hexactin. C — dermal pentactin. D — dermal diactin. E–F — choanosomal diactins and their outer ends. G–J — discoctasters. K — primary rosette of discoctaster, secondary rays not developed. L — secondary ray of discoctaster. M–N — spherical microdiscohexasters. O — stellate microdiscohexaster. P–T — oxyoidal microscleres. U — primary rosette and secondary ray of oxyoidal microsclere.

Рис. 2. Спикулы *Acanthascus* (*Acanthascus*) *alani microdiscoctasterus* ssp.n., голотип. A — дермальная ставрактина. B — дермальная гексактина. C — дермальная пентактина. D — дермальная диактина. E–F — хоаносомальные диактины и их концевые элементы. G–J — дископтастры. K — первичная розетка дисоктастра, вторичные лучи не развиты. L— вторичные лучи дископтастра. M–N — сферические микродискогексастры. O — звездчатый микродискогексастр. P–T — оксиоидные микросклеры. U — первичная розетка и вторичные лучи оксиоидной микросклеры.

0.002 mm). The diameter of these rays is 0.009–0.015 mm. Dermal hexactins have rays of equal length 0.159–0.252 mm long (n=3, avg: 0.201 mm, std: 0.047 mm). Stauractins have tangential rays 0.137–0.189 mm long (n=3, avg: 0.158 mm, std: 0.027 mm), their rudimental tubercles if present are 0.007–0.015 mm long (n=3, avg: 0.012 mm, std: 0.004 mm). Some unique diactins have rays about 0.222 mm long with a widening in the middle. Atrial pentactins have tangential rays 0.085–0.178 mm long (n=13, avg: 0.144 mm, std: 0.024 mm), the ray directed inside the body is 0.074–0.204 mm long (n=13, avg: 0.145 mm, std: 0.033 mm), the rudiment of the distal ray if present is 0.007–0.019 mm long (n=13, avg: 0.010 mm, std: 0.003 mm), the diameter of these rays is 0.010–0.011 mm. Atrial hexactins have rays 0.104–0.326 mm long (n=26, avg: 0.170 mm, std: 0.046 mm). Atrial stauractins have tangential rays 0.111–0.144 mm long (n=3, avg: 0.132 mm, std: 0.018 mm), their rudimental tubercles if present are 0.011–0.015 mm long (n=4, avg: 0.013 mm, std: 0.002 mm).

MICROSCLERES. Discoctasters are common and rare discomultiasters are present in this species. Unlike discohexasters, discomultiasters have more than 8 tufts of secondary rays — up to 11, sometimes these additional secondary rays have a single secondary ray, but usually they have 2–8 secondary rays in a tuft. The secondary rays of discoctasters have spiny shafts. Some discoctasters have a specific shape with 4 secondary ray tufts located in one plane distributed at about 90 degree to each 4 other secondary ray tufts which are similar to the former ones are situated below it. Some discoctasters without developed secondary rays were found. The discohexasters are 0.036–0,079 mm in diameter (n=25, avg: 0.061 mm, std: 0.010 mm), their primary rosette is 0.025–0.050 mm in diameter (n=25, avg: 0.038 mm, std: 0.007 mm). Spherical discohexasters with numerous secondary rays are 0.023–0.036 mm in diameter (n=20, avg: 0.028 mm, std: 0.003 mm), their primary rosette is 0.006–0.014 mm in diameter (n=20, avg: 0.009 mm, std: 0.002 mm). An occasional spherical discohexaster is 0.065 mm in diameter with primary rosette 0.011 mm in diameter. A unique stellate discohexaster was also found with 3–4 secondary rays 0.054 mm in diameter with the primary rosette 0.027 mm in diameter. Oxyoidal microscleres are very fragile and in the spicule preparations they were usually broken with their primary rosettes and secondary rays separated. The secondary rays (1–3 in number, but sometimes up to 7) have finest part at base what provides the effect described above, they are covered by numerous spines directed towards the spicular center especially at their basal part. Many oxyoidal microscleres have secondary rays of different length. The oxyoidal microscleres included oxyhexasters, oxyhemihexasters (most of these two forms should be rather called anysooxyhexasters and anysooxyhemihexasters) and hexactins. The oxyhexasters and oxyhemihexasters are 0.067–0.281 mm in diameter (n=26, avg: 0.139 mm, std: 0.035 mm), their primary rosette is 0.008–0.022 mm in diameter (n=20, avg: 0.013 mm, std: 0.003 mm). A unique oxyhexaster was 0.027 mm in diameter with primary rosette 0.009 mm in diameter. The oxyhexactins are 0.126–0.154 mm in diameter (n=7, avg: 0.154 mm, std: 0.025 mm).

REMARKS. In the presence of the set of dermal spicules and fragile oxyoidal microscleres when such spicules easily split to primary and secondary rays the new subspecies is similar to two previously described subspecies: *A.* (*Acanthascus*) *alani alani* Ijima, 1898 and *A.* (*Acanthascus*) *alani profundus* Koltun, 1967. The differences are in the sizes of discoctasters, the presence of discomultiasters and in the similarity between dermal and atrial spicules in the new subspecies (in previously described subspecies atrialia are generally hexactins). Hypodermal pentactins with smooth and spiny tangential rays found in the new subspecies are considered to have allochthonous origin but meantime they point the close affinities between tree subgenera of *Acanthascus* which taxonomic status was downgraded by Tabachnick (2002b). It is very likely, that these subspecies should be raised to the species level but due to the historical tradition and comfort in identification of multispecific taxon *Acanthascus* its taxonomic position is preserved at the moment. A question of rising of the status of all the described subspecies to specific level requires futher investigations.

ETYMOLOGY. The subspecies name reflects the characteristically small size of discoctasters.

DISTRIBUTION. Currently found only at the Piip Volcano slope, Bering Sea, at 1420 m depth.

Acanthascus (*Acanthascus*) *alani profundus* Koltun, 1967. Figs 3, 4; Suppl. Tab. 2.

SYNONYMY. *Acanthascus alani profundum* Koltun, 1967: 93.

MATERIAL. IORAS 5/2/3830, 3831: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 9, spec. 2-3 and 2-4 correspondingly, 55.4282° N 167.2772° E, 986 m. IORAS 5/2/3835: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 9, spec. 1, 55.4282° N 167.2772° E, 984 m.

DESCRIPTION. BODY. The specimens are saccular: IORAS 5/2/3835 — 600 mm high, diameter of the osculum is approximately 250 mm (a fragment of this specimen was sampled, it measures 180 mm high, 100 mm in maximal diameter of the osculum,

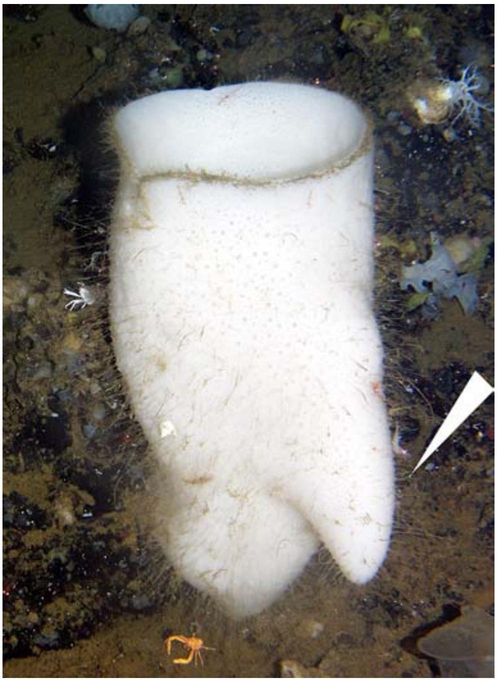

Fig. 3. *Acanthascus* (*Acanthascus*) *alani profundus*, a ROV 'Comanche' photo of the specimen IORAS/5/2/3826. The arrow shows sampled fragment.
Рис. 3. *Acanthascus* (*Acanthascus*) *alani profundus*, фотография выполненая подводным роботом "Comanche" образца IORAS/5/2/3826. Стрелка показывает на взятый фрагмент.

the walls are 10–15 mm in thickness); 5/2/3830 — 180 mm high, 100 mm in diameter, the walls are 8–10 mm in thickness; 5/2/3831 — 110 mm high, 40 mm in diameter, the walls are 5 mm in thickness. The latter two specimens are attached to each other by their basal parts; their atrial cavities are not common. Prostalia lateralia are diactins which protrude at 10–45 mm over the dermal surface.

REMARKS. Despite some notable differences in spicule sizes of dermal and atrial spicules and the presence of microdiscohexasters the newly found specimens are assigned to *Acanthascus* (*Acanthascus*) *alani profundus* Koltun, 1967 first of all owing to the presence of two size classes of discoctasters. Another type of spicules found in the new specimens is microdiscohexaster. Quite probably that the differences between our specimens and the original description of the subspecies is a result of that only a small fragment of a sponge was studied initially (Koltun, 1967). All other spicules show a similar type in the variations described earlier and in newly found specimens. It is very likely that *A.* (*Acanthascus*) *alani profundus* should be synonymized with *A.* (*Acanthascus*) *platei* Schulze, 1899, but it requires a significant revision since the largest discoctasters are dermal and the smallest are atrial (unlike *A.* (*Acanthascus*) *alani profundus*). Another species with a notable difference in dermal and atrial discoctasters is *A.* (*Acanthascus*) *cactus*, but unlike the specimens discussed above this species has generally dermal stauractins and atrial pentactins.

DISTRIBUTION. Bering Sea, at 984–2440 m depth.

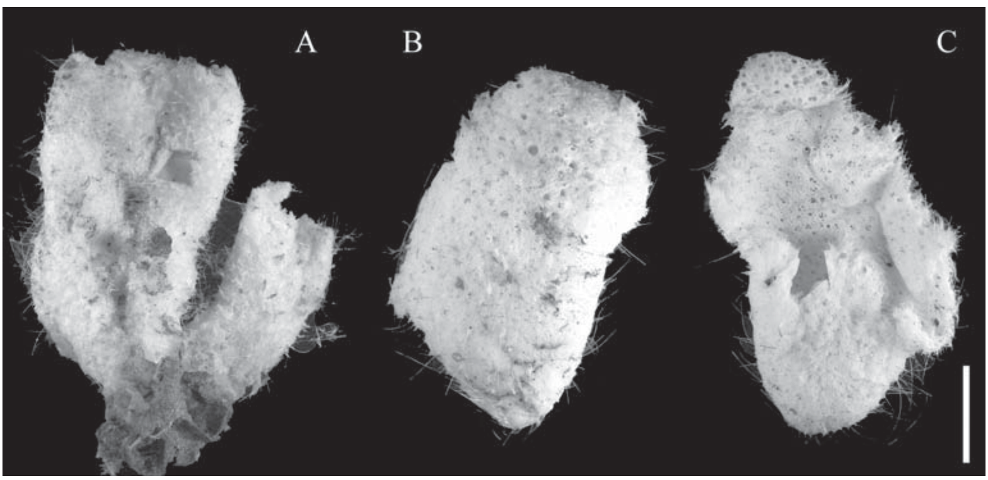

Fig. 4. *Acanthascus* (*Acanthascus*) *alani profundus*, external shape. Scale 50 mm. A — two specimens: large — IORAS/5/2/3830: small — IORAS/5/2/3831. B-C — view from different sides IORAS/5/2/3826.
Рис. 4. *Acanthascus* (*Acanthascus*) *alani profundus*, внешний вид. Масштаб 50 мм. A — два экземпляра: большой — IORAS/5/2/3830; маленький — IORAS/5/2/3831. B-C — вид с разных сторон IORAS/5/2/3826.

Fig. 5. *Acanthascus* (*Rhabdocalyptus*) *borealis*, external shape. Scale 50 mm. A — IORAS/5/2/3827. B — IORAS/5/2/3814. C — IORAS/5/2/3808.
Рис. 5. *Acanthascus* (*Rhabdocalyptus*) *borealis*, внешний вид. Масштаб 50 мм. A — IORAS/5/2/3827. B — IORAS/5/2/3814. C — IORAS/5/2/3808.

Acanthascus (*Rhabdocalyptus*) Schulze, 1886
Acanthascus (*Rhabdocalyptus*) *borealis* Okada, 1932
Fig. 5; Suppl. Tab. 3.

MATERIAL. IORAS 5/2/3827: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 18, spec. 3-1, 55.4382° N 167.2652° E, 1569 m. IORAS 5/2/3808; 3814: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 9, spec. 2-5 and 2-2 correspondingly, 55°28′58.8″ N 167°15′30.6″ E, 2849 m.

DESCRIPTION. BODY. The biggest specimen is IORAS 5/2/3827: 160 mm high, 60 mm in maximal diameter (close to the osculum); walls are 2–6 mm thick. Prostalia oscularia are diactins which protrude up to 20 mm over the osculum, prostalia lateralia are hypodermal pentactins which make a dense cover up to 15 mm above the dermal surface. Other specimens are smaller: IORAS 5/2/3814: 60 mm high, 20 mm in diameter in the middle and 15 mm in diameter of the osculum, the walls are 1–1.5 mm thick; IORAS 5/2/3808: 50 mm high, 25 mm in diameter in the middle and 20 mm in diameter of the osculum, the walls are 2–3 mm thick. Prostalia in the small specimens is smaller: oscularia diactins protrude up to 15–20 mm, prostalia lateralia of hypodermal pentactins (their tangential rays) are 10–15 mm over the dermal surface. The hypodermal pentactins are most parathropal with spiny tangential rays.

REMARKS. Differences between the new and previousely described specimens of *A*. (*Rhabdocalyptus*) *borealis* (Okada, 1932; Koltun, 1967) are given in the Suppl. Tab. 3. The most important of them: no microdiscohexasters in all investigated specimens were observed; smaller diameter of the oxyoidal microscleres; the ray of atrial hexactin may be notably smaller. Nevertheless these features are considered to be intraspecific, they are widening the species limits. Morever, the specimen described by Koltun (1967) has some additional intermediate parameters.

DISTRIBUTION. Bering Sea, Pacific side of Kuril Islands, at 440–2849 m depth.

Acanthascus (*Rhabdocalyptus*) *heteraster* Okada, 1932
Fig. 6; Suppl. Tab. 4.

MATERIAL. IORAS 5/2/3824: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 21, spec. 4, 55°28′58.8″ N 167°15′30.6″ E, 2849 m.

DESCRIPTION. BODY. The preserved specimen is tubular, about 90 mm high, 50 mm in maximal diameter; the walls are 1–3 mm thick. Prostalia lateralia are hypodermal orthotropal (rarely parath-

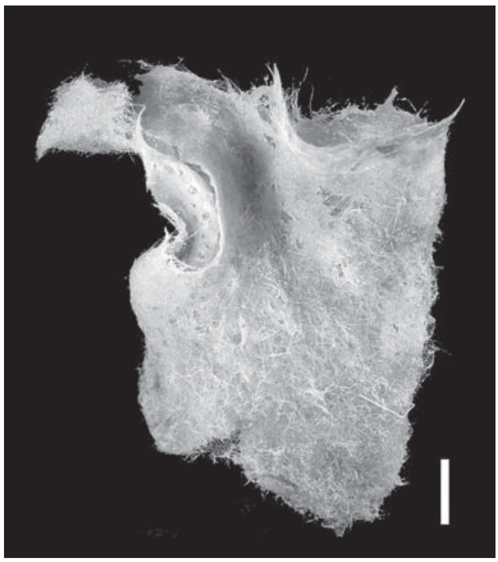

Fig. 6. *Acanthascus* (*Rhabdocalyptus*) *heteraster*, external shape. Scale 10 mm. A — view from dermal side. B — view from atrial side.
Рис. 6. *Acanthascus* (*Rhabdocalyptus*) *heteraster*, внешний вид. Шкала 10 мм. A — вид с дермальной стороны. B — вид с атриальной стороны.

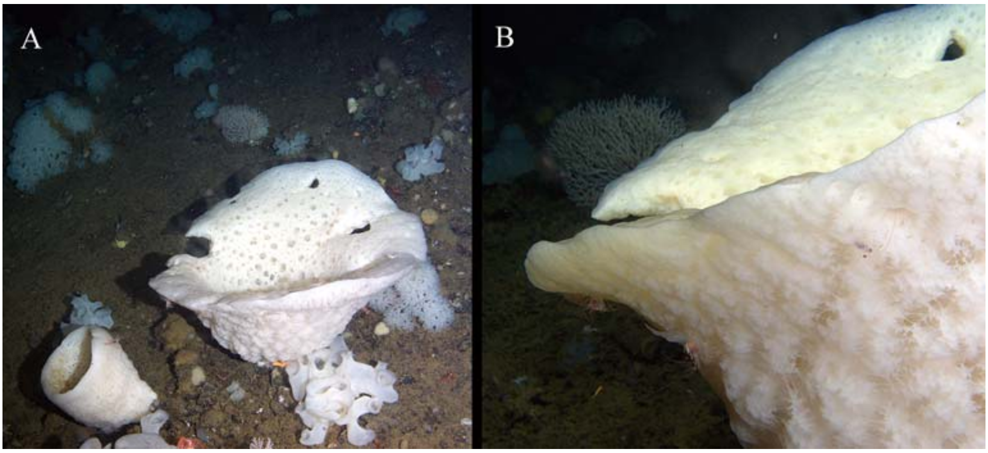

Fig. 7. *Acanthascus* (*Staurocalyptus*) *tylotus*, a ROV 'Comanche' photos. A — two specimens before capturing surrounded by numerous specimens of *Farrea* sp. A — IORAS 5/2/3832 – a smaller specimen, to the left; IORAS 5/2/3807 – a bigger specimen, to the right. B — magnified portion of the specimen IORAS 5/2/3807).

Рис. 7. *Acanthascus* (*Staurocalyptus*) *tylotus*, фотография подводного робота "Comanche". A — два экземпляра перед поимкой, окруженные многочисленными представителями *Farrea* sp. A — IORAS 5/2/3832 – маленький экземпляр, слева; IORAS 5/2/3807 – больший экземпляр, справа. B — увеличенный фрагмент образца IORAS 5/2/3807).

ropal) spiny pentactins irregularly distributed and protruding 1–4 mm over the dermal surface.

REMARKS. The newly found specimen has spicules size parameter different from those of the type specimen described by Okada (1932) (see the Suppl. Tab. 4). The long ray of atrial hexactins (directed into the atrial cavity) in the new specimen is notably longer then those in previouse descriptions; discoctasters are of a single type and their minimal size is less than that in the type specimen and larger than the minimal size of this type of microsclere in a specimen described by Koltun (1967). The discoctasters in the new specimen are notably larger than the same type of discoctasters in the initial description, microdiscohexasters are absent and oxyoidal microscleres reach larger sizes. Nevertheless most spicule parameters of this new specimen correspond to *A.* (*Rhabdocalyptus*) *heteraster* much more then to other species of the subgenus and it seem more reasonable to expand the spicule parameters in the previous species then to create a new one.

DISTRIBUTION. Bering Sea, off Pacific coast of Canada, 445–2849 m depth.

Acanthascus (*Rhabdocalyptus*) *mirabilis* Schulze, 1899
Suppl. Tab. 5.

MATERIAL. IORAS 5/2/3826: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 17, spec. 3, 55.4599° N 167.269° E, 2279 m.

DESCRIPTION. BODY. The specimen IORAS 5/2/3826 is a fragment of the 5–10 mm thick upper wall of the sponge. Prostalia oscularia and lateralia of large diactins protrude at 20–35 mm over the osculum margin. Prostalia of hypodermal pentactins protrude at about 10 mm over the dermal surface. The diameter of the osculum is about 80 mm in diameter (reconstructed). Hypodermal pentactins of both orthotropal and parathropal types have spiny or smooth tangential rays.

REMARKS. The new specimen agrees with the description of specimens of *Rhabdocalyptus mirabilis* (Reiswig *et al.*, 2013) except for the absence of microdiscohexasters. Both these specimens have floricoidal discoctasters that differ from those in the original description of this species (Schulze, 1899) while they have floricoidal discoctasters. The discs of floricoidal discoctasters are assymetrically attached to the secondary ray, while in the original description they are completely symmetrical. Spicules with assymetrical features are also known in: *A.* (*Rhabdocalyptus*) *unguiculatus* (Ijima, 1904) — a similar species with predomination of oxyhexasters and oxyhemihexasters over the oxyhexactins. This specimen also differs from *A.* (*Rhabdocalyptus*) *gomezei* (Tabachnick *et al.*, 2019), a species with notable amount of dermal stauractins, and *A.* (*Rhabdocalyptus*) *bidentatus* — stauractins predominate in this species and secondary rays of discoctasters have 2 teeth (Okada, 1932).

DISTRIBUTION. Off S of Alaska Peninsula, Bering Sea, 1143–2311 m depth.

Acanthascus (*Staurocalyptus*) Ijima, 1897
Acanthascus (*Staurocalyptus*) *tylotus* Reiswig et Stone, 2013
Figs 7, 8; Suppl. Tab. 6.

MATERIAL. IORAS 5/2/3807, 3832: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 9, spec. 3-1 and 3-2 correspondingly, 55.4253° N 167.2754° E, 783 m. IORAS 5/2/3834: RV 'Akademik M.A. Lavrentyev' – 75, ROV 'Comanche', sta. 9, spec. 1-1, 55.4282° N 167.2775° E, 984 m.

DESCRIPTION. BODY. All specimens have smooth but verrucose dermal surface (the bigger specimen has more verrucose surface). The specimen IORAS 5/2/3832 is saccular, it is about 200 mm high, 150 mm in diameter of the body and osculum, the walls are about 10–15 mm in thickness. From the specimen IORAS 5/2/3807 it was taken a fragment. It is also strongly destroyed being presented by fragments of the wall about 10–15 mm in thickness. The specimen IORAS 5/2/3834 is funnel-like and about 300 mm high, about 400 mm in diameter, the walls are 30–40 mm in diameter (a fragment of this specimen was sampled). The material in the collection was strongly destroyed during the fixation and transportation.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins with conically pointed, rough outer ends.

Dermalia and atrialia are similar to each other with the only exception — dermal spicules have a row of transitional forms to hypodermal pentactins and hexactins with orthotropal tangential rays, while the atrial spicules are restricted by forms with short rays. Typical dermal spicules as well as atrial ones have short rays with rounded outer ends and with rough shafts. Dermal spicules include pentactins, stauractins, paratetractins and diactins, however most of these spicules are hexactins with equal rays or rays of different length. The dermal hexactins have rays 0.044–0.407/0.008–0.022 mm. The dermal diactins with a widening in the middle or four rudimental tubercles have rays 0.067–0.407 mm long. Some dermal hexactins and pentactins have one extremely long ray, 3 times or more the length of the other rays, which is directed inside the body. This ray is equal in shape to the tangential ones when it is relatively small, or they are rough at base only. The biggest of such spicules, which could be called real hypodermal pentactins and hexactins, have rays smooth at base and rough, conically pointed or rounded outer ends. The rare hypodermal hexactins have rays directed outside the body 0.019–0.322 mm long, tangetial rays are 0.063–0.874 mm long, the ray directed inside the body is 0.33–2.59 mm long, the diameter of these rays is 0.03–0.06 mm. Atrial hexactins have rays 0.048–0.248/0.008–0.026 mm. Atrial stauractins have rays 0.141–0.178 mm long. Atrial tauactins have rays 0.081–0.344 mm long.

MICROSCLERES. Discoidal microscleres of two types: discoctasters and spherical discohexasters. The discoctasters have very short part of the common (fused) part of secondary ray, they seem to appear nearly immediately from the spherical central part, the secondary rays 2–16 in number (usually about 10) are distributed in widened, out curved tufts, their discs are not symmetrical (tendency to floricoidal type). The discohexasters are 0.040–0.097 mm in diameter; their 'primary' rosette is 0.007–0.022 mm in diameter. The spherical discohexasters are 0.015–0.032 mm in diameter; their "primary" rosette is 0.004–0.009 mm in diameter. Oxyoidal microscleres with smooth rays are generally presented by oxyhexactins, rare oxyhemihexasters with one primary ray branching in two units, and rare stauractins and tauactins. The diameter of oxyoidal microscleres is 0.036–0.191 mm.

REMARKS. Specific similarities between the described material of *A.* (*Staurocalyptus*) *tylotus* and the newly found specimens consist in the identity of the spicule construction and size of specific discoctasters, the domination of oxyhexactins among oxiodal microscleres and hexactins as dermal and atrial spicules which often have rays of different length and conically pointed outer ends of choanosomal diactins. The differences are also important: the presence of spherical discohexasters in both new specimens; numerous transitional forms between dermal spicules and hypodermal pentactins and hexactins. Our material might be distinguished as a separate subspecies but the similarities, especially those related to discoctasters, do not seem to allow distinguishing them at the specific level.

DISTRIBUTION. Bering Sea, 155–984 m depth.

Aulosaccus Ijima, 1896
Aulosaccus ijimai (Schulze, 1899)
Suppl. Tab. 7.

SYNONYMY: *Calycosaccus ijimai* Schulze, 1899: 30; *Aulosaccus pinnularis* Okada, 1932: 88; Koltun, 1967: 75.

MATERIAL. IORAS 5/2/2045. RV 'Akademik Mstislav Keldysh' – 22, sta. 2304, HOV 'Mir-2', Pacific side of the Bering Island, 55°02.6′ N 165°55.2′ E, 509 m.

DESCRIPTION. BODY. The specimen is 200 mm long, 80 mm in maximal diameter, with walls 10–15 mm thick.

REMARKS. The species is well–known and the precise description of spicules is omitted being presented in the Suppl. Table 7. As in the previously described materials the new specimen has no hypodermal pentactins. Most spicule measurements correspond to those published before (Schulze, 1899;

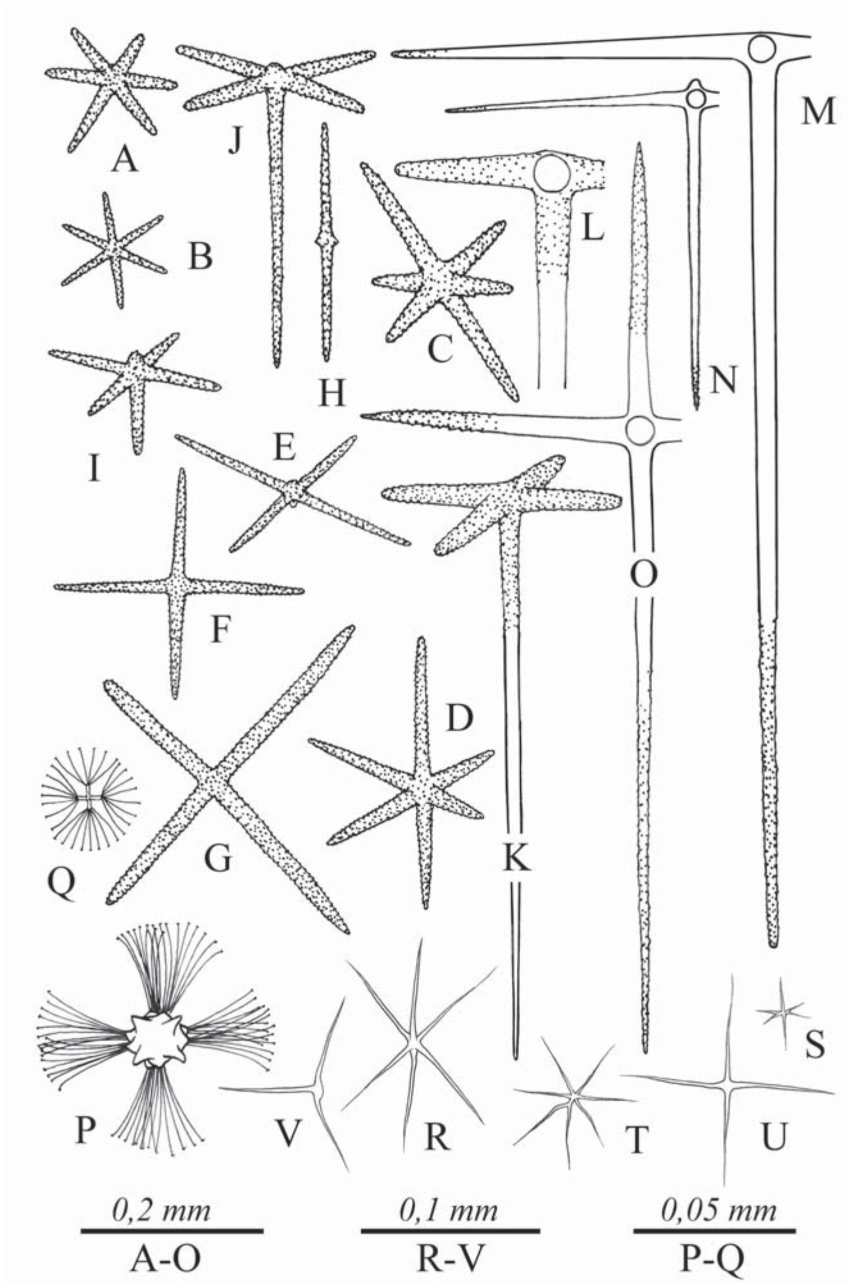

Fig. 8. Spicules of *Acanthascus* (*Staurocalyptus*) *tylotus*. A–D — dermal hexactins. E–G — dermal stauractins. H — dermal diactin. J — dermal pentactin. K–N — hypodermal pentactins. O —hypodermal hexactin. P — discoctaster. Q — microdiscohexaster. R–S — oxyhexactins. T — oxyhemihexaster. U — oxystauractin. V — oxytauactin. A–C; E–F; H–T — IORAS 5/2/3832. D; G; S; U–V — IORAS 5/2/3807.
Рис. 8. Спикулы *Acanthascus* (*Staurocalyptus*) *tylotus*. A–D — дермальные гексактины. E–G — дермальные ставрактины. H — дермальная диактина. J — дермальная пентактина. K–N — гиподермальные пентактины. O — гиподермальная гексактина. P — дискоктастер. Q — микродискогексастер. R–S — оксигексактины. T — оксигемигексастер. U — окситавурактина. V — окситауактина. A–C; E–F; H–T — IORAS 5/2/3832. D; G; S; U–V — IORAS 5/2/3807.

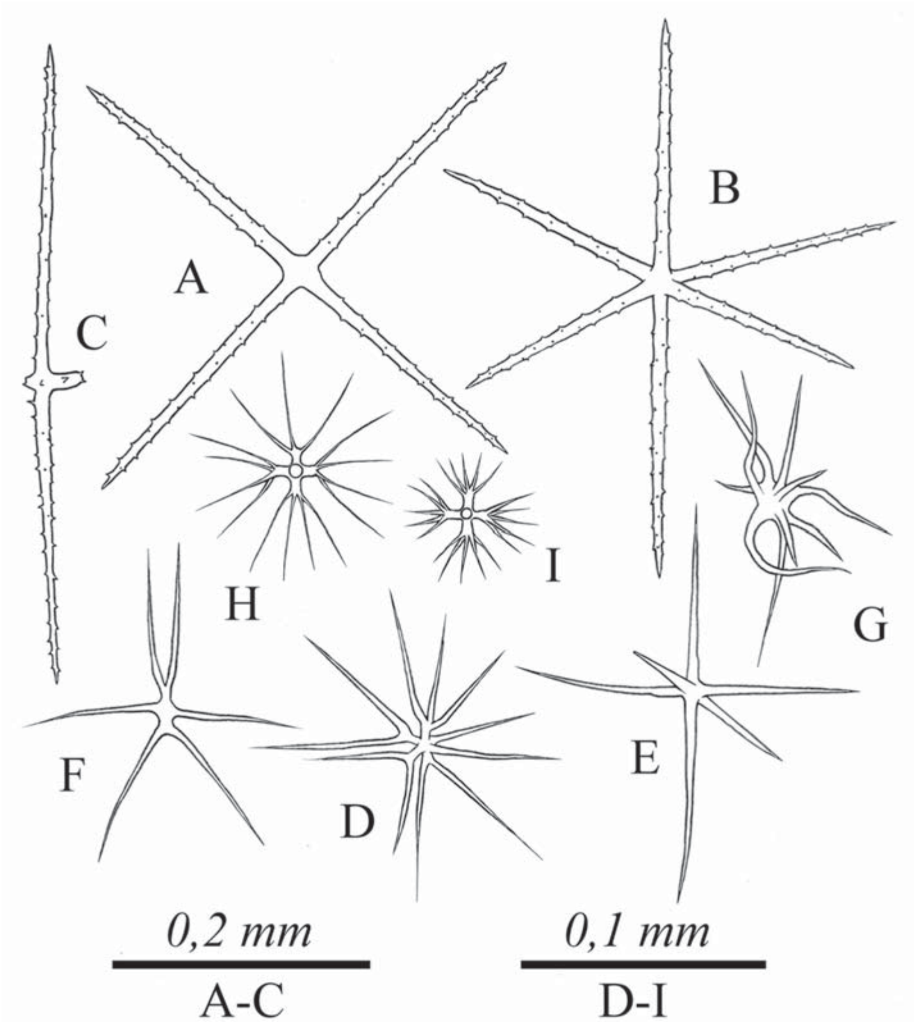

Fig. 9. Spicules of *Bathydorus laniger*, IORAS 5/2/2046. A — dermal or atrial stauractin. B — dermal or atrial hexactin. C — dermal or atrial diactin. D — oxyhemihexaster. E — oxyhexactin. F–G — abnormal oxyoidal microscleres. H–I — oxyhexasters.
Рис. 9. Спикулы *Bathydorus laniger*, IORAS 5/2/2046. A — дермальная или атриальная ставрактина. B — дермальная или атриальная гексактина. C — дермальная или атриальная диактина. D — оксигемигексастр. E — оксигексактина. F–G — анормальные оксиоидные микросклеры. H–I — оксигексастры.

Okada, 1932; Koltun, 1967). Nevertheless, the absence of the sufficient description of *C. ijimai* allows attributing it to the *A. pinnularis,* since newly collected specimens of *A. pinnularis* demonstrate wide variation of spicule sizes which are often intermediate between *A. ijimai* and typical *A. pinnularis* after finding of the new representative which spicule measurements are often intermediate between the previous two species: '*ijimai*' (Schulze, 1899) and '*pinularis*' (Okada, 1932).

DISTRIBUTION. North Pacific: off Aleutian, Kuril and Commander (Bering) Islands, 117–843 m depth.

Bathydorus Schulze, 1886
Bathydorus laniger Kahn, Geller, Reiswig et Smith, 2013
Fig. 9; Suppl. Tab. 8.

MATERIAL. IORAS 5/2/2046. RV 'Akademik Mstislav Keldysh' – 22, sta. 2295, HOV 'Mir-1', Pacific side of the Bering Island, 54 °57.65′ N 165°42.8′ E, 5975 m.

DESCRIPTION. BODY. The specimen was observed from the submersible as a conical sponge attached to a stone (unfortunately a photo of the live specimen was not taken before a sampling. Several flat wall fragments about 1–3 mm thick were collected.

REMARKS. Due to the presence of the specific dermal and atrial spicules with rare short spines, generally stauractins, the similarity of microscleres, hypodermal pentactins, the identification of the new specimen is doubtless *Bathydorus laniger*. The external shape of the holotype colony was a simple flat disc (unusual for Hexactinellida) however this new specimen has the usual conical shape. The disc-like body of the holotype could be a result of destruction of the specimen to fragments during its life, or an early developing stage of growing of the base-bottom before the walls, or simply the result of life on the muddy silt. The observed differences are not sufficient, but they accomplish the primary description. Hypodermal pentactins may be rarely rough. Stauractins are dominating spicules of dermal and atrial surface but corresponding diactins, tauactins and pentactins may be rarely found. So-called hypoatrial hexactins, spicules which have rays equal to stauractins, are situated at both surfaces, they are not as common, as stauractins. A new type of microscleres — small oxyhexasters with numerous spiny secondary rays (6–8 in number) may be considered as a single specific variation between the type and newly collected specimen. ‘Weltner’s bodies’ are irregularly distributed on the dermal surface of this specimen.

DISTRIBUTION. N Pacific: off California coast and Pacific side of the Bering Island, at 3950–5975 m depth.

Bathydorus spinosissimus Lendenfeld, 1915
Fig. 10; Suppl. Tab. 9.

MATERIAL. IORAS 5/2/2084; IORAS 5/2/2223: RV ‘Akademik Mstislav Keldysh’ – 22, sta. 2309, trawl, N off the Bering Island, 55°13.24–12.02′ N 167°29.07–26.7′ E, 3957–3978 m. MIMB: lv-82-5 sp2: RV ‘Akademik M.A. Lavrentyev’ – 82, sta. 5, ROV ‘Comanche’, 55.2647° N 167.3013° E, 3879 – 3875 m.

DESCRIPTION. BODY. The specimen IORAS 5/2/2084 is one large fragment of the wall 50x150 mm and several smaller fragments. The specimen IORAS 5/2/2223 is a small fragment likely of the same specimen. The walls are 1.5–2 mm thick, from atrial side the walls are relatively smooth, from dermal side they have some sparse and small outgrowths about 1 mm high and same in diameter.

REMARKS. The species was originally described as a subspecies *Bathydorus laevis spinosissimus* Lendenfeld, 1915. Here it is considered as a separate species. Some differences between the holotype and the newly collected specimen are considered as an interspecific variation. Dermal and atrial spicules are very similar in shape. They have rays with dense covering of spines; atrial hexactins have a ray directed outside the body pinnular. Dermal spicules and microscleres are generally smaller in the newly found specimen. But in both specimens from distantly located areas, from the Bering Sea and off the N Peru, dermalia are generally stauractins and pentactins, and all transitional forms from diactins to hexactins may be rarely found. Both of them often have rudimental tubercles or short rays instead of those (distal and proximal) not completely developed. The new specimens have some rare dermal and atrial spicules with branching rays and some rare oxyoidal microscleres of abnormal forms with reduced number of primary and secondary rays and some of the rays notably curved. Some oxyhexasters in the new specimen have notable amount of secondary rays – up to 6, some rare oxyhexactins were observed there as well.

DISTRIBUTION. Pacific Ocean: off N Peru and N off the Bering Island, at 3957–4063 m depth.

Bathydorus spinosus Schulze, 1886
Figs 11, 12; Suppl. Tab. 10.

SYNONYMY. *Bathydorus spinosus* Schulze, 1886: 50; 1887: 153 and a number of followed publications. *B. levis spinosus* Wilson, 1904: 51; Ijima, 1927: 367; Koltun, 1967: 88; *B. levis neospinosus* ssp.n. (this publication, see the corresponding references).

MATERIAL. IORAS 5/2/3809: RV ‘Akademik M.A. Lavrentyev’ – 75, ROV ‘Comanche’, sta. 9, spec. 3-3, 55.4253° N 167.2754° E, depth 783 m. MIMB lv-82-7 sp1: RV ‘Akademik M.A. Lavrentyev’ – 82, sta. 7, ROV ‘Comanche’, 55.3689° N 167.2659° E, depth 984 m. MIMB lv-82-7 sp2. RV ‘Akademik M.A. Lavrentyev’ – 82, sta. 7, ROV ‘Comanche’, 55.3688° N 167.2662° E, depth 981 m.

DESCRIPTION. BODY. The specimen IORAS 5/2/3809 is 60 mm high and 30 mm in maximal diameter, at base about 15 mm in diameter, the walls are 1 mm thick. Other specimens are presented by fragments of the wall of corresponding thickness.

SPICULES. MEGASCLERES. Dermal and atrial spicules in the newly found specimens include hexactins and pentactins. The pentactins dominate among dermalia whereas hexactins dominate among atrialia.

MICROSCLERES. Oxyoidal microscleres are subdivided into two groups with thin 8–10 secondary rays and with thick with 1–4 secondary rays. The former are spherical oxyhexasters which are gener-

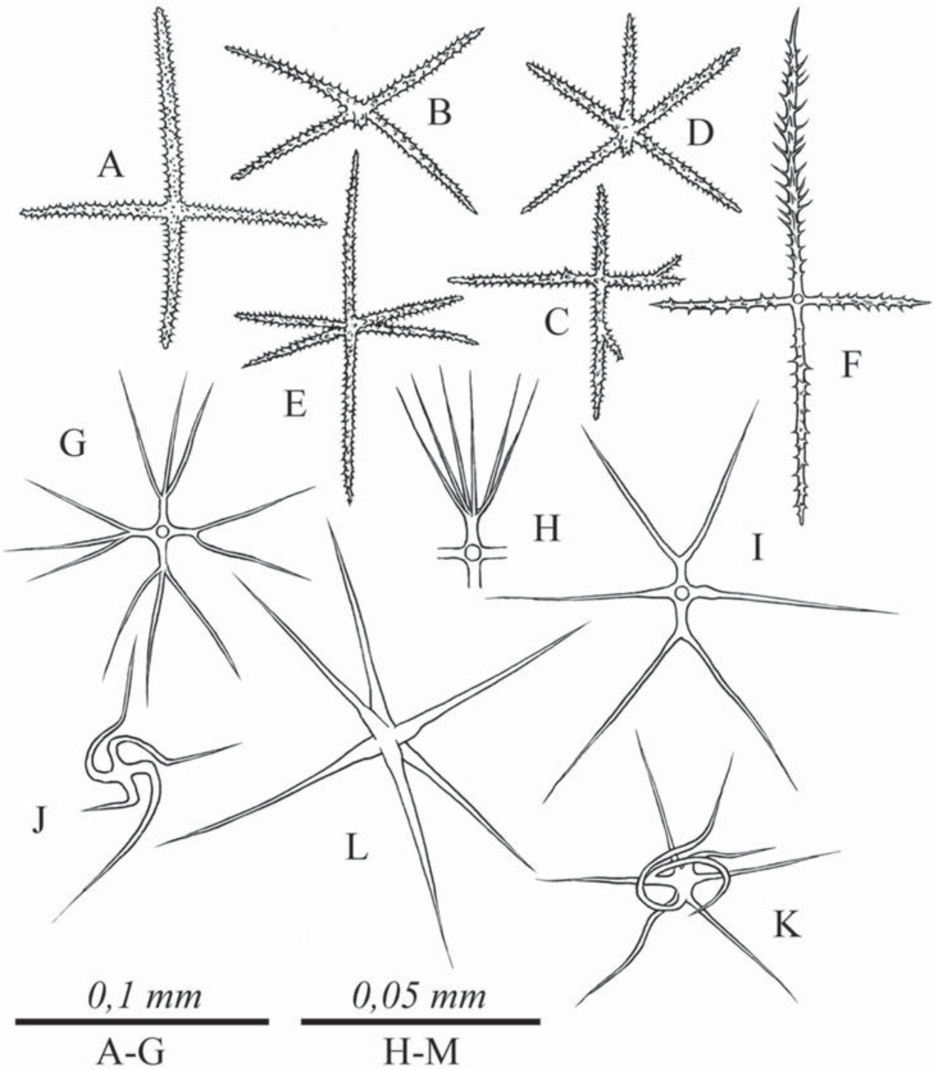

Fig. 10. Spicules of *Bathydorus spinosissimus*, IORAS 5/2/2084. A–C — dermal stauractins. C — dermal stauractin with branching rays. D — dermal pentactin. E — dermal hexactin. F — atrial pinular hexactin. G–H — oxyhexasters. I — oxyhemihexaster. J–K — abnormal oxyoidal microscleres. L — oxyhexactin.
Рис. 10. Спикулы *Bathydorus spinosissimus*, IORAS 5/2/2084. A–C — дермальные стауррактины. C — дермальная стауррактина с ветвящимися лучами. D — дермальная пентактина. E — дермальная гексактина. F — атриальная пинулярная гексактина. G–H — оксигексастры. I — оксигемигексастр. J–K — анормальные оксиоидные микросклеры. L — оксигексактина.

ally smaller than the latter type, which include oxyhemihexasters, oxyhemistaurasters, oxydiasters, oxyhexactins and other abnormal spicules.

REMARKS. The measurements of the spicules of this specimen are given in the Suppl. Tab. 10. The shape of dermal and atrial spicules entirely corresponds to those described and figured by Koltun (1967) for the specimens of the N Pacific (including the Bering Sea). While oxyoidal microscleres are different, the newly found specimens have notable amounts of abnormal oxyoidal microscleres: oxyhemistaurasters and oxydiasters.

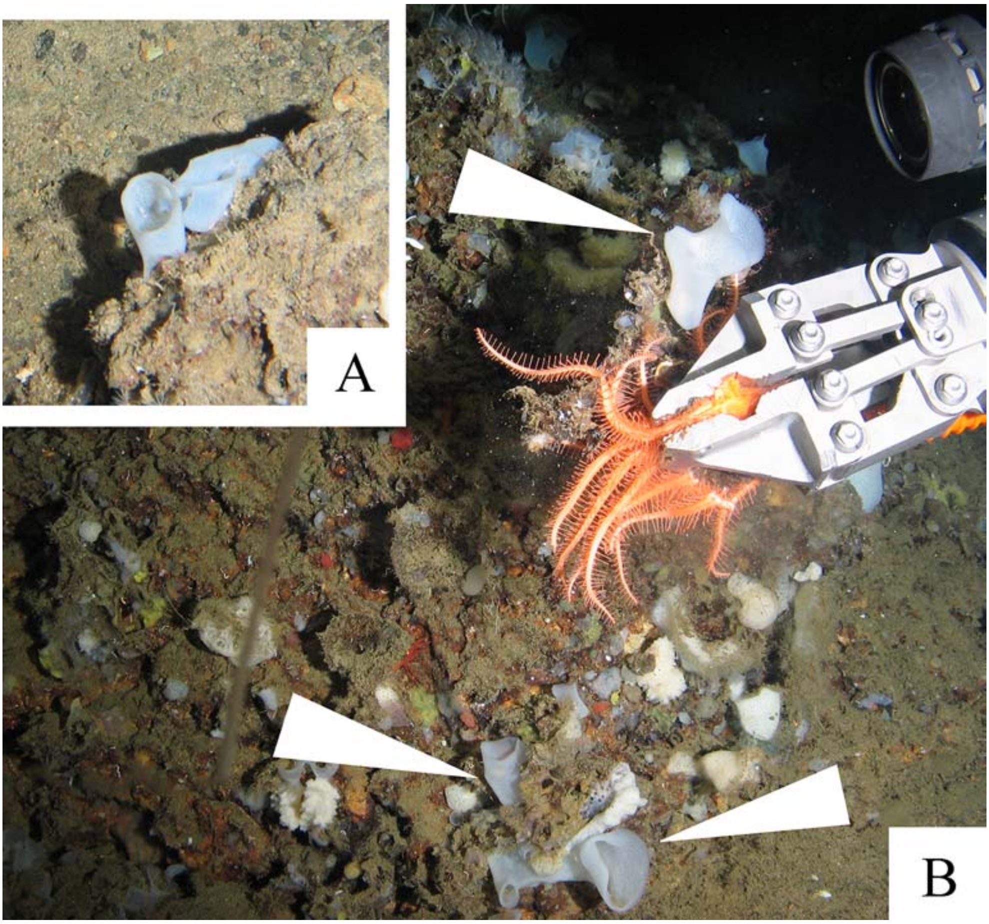

Fig. 11. *Bathydorus spinosus*, a ROV 'Comanche' photos. A — specimens before capturing. B — moment of sampling, specimens of *B. spinosus* are shown by arrows.
Рис. 11. *Bathydorus spinosus*, фотографии подводного робота "Comanche". A — экземпляры перед сбором. B — момент сбора образцов *B. spinosus* (показаны стрелками).

This species epithet '*spinosus*' was used as a subspecies epithet for a new subspecies of *B. laevis* — *B. levis spinosus* ssp.n. by Wilson (1904), that was also followed by Koltun (1967) (*levis* a mistake of *laevis*). Wilson (1904) did not provide any information on the preoccupied name '*spinosus*' used for *B. spinosus* by Schulze, 1886 (see also Schulze, 1887). It is unclear what Wilson intended to do: to describe a new taxon or to suggest the transfer of the species '*spinosus*' described earlier (1886) into another species '*levis* = *laevis*' (1895) as a subspecies. In the first case, his taxon requires a new name, in the second — appropriate synonymization. The curiosity of this case is complicated by the notable similarity between *B. levis spinosus* of Wilson and *B. spinosus* of Schulze. Thus the operation of synonymization appears to be correct. Thus, we suggest a new name *B. levis neospinosus* **ssp.n**. for *B. levis spinosus* of Wilson to avoid the homonymy and simultaneously we make it a lower synonym of *B. spinosus* Schulze.

DISTRIBUTION. Cosmopolitan (except the Arctic Ocean), at 783–4847 m depth.

aff. *Bathydorus* sp.
Fig. 13.

MATERIAL. IORAS 5/2/3838: RV 'Akademik M.A. Lavrentyev' – 75, sta. 18, specimen 3–3, ROV 'Comanche', 55.4382° N 167.2652° E, 1559 m.

DESCRIPTION. BODY. The specimen is represented by a small fragment attached to a dead skeleton of *Farrea*.

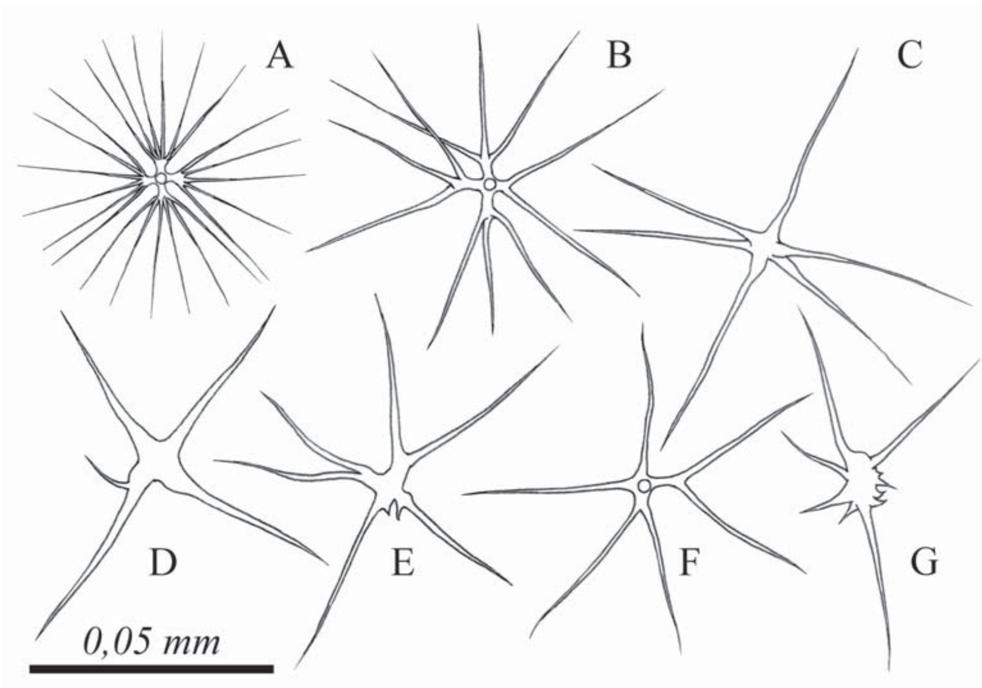

Fig. 12. Spicules of *Bathydorus spinosus*, IORAS 5/2/3809 (additional types to previous descriptions). A — small oxyhexaster. B — large oxyhexaster. C — oxyhexactin. D, E, G — abnormal oxyoidal microscleres. F — oxyhemihexaster.
Рис. 12. Спикулы *Bathydorus spinosus*, IORAS 5/2/3809 (в дополнение к предыдущим описаниям). A — маленикий оксигексастр. B — большой оксигексастр. C — оксигексактина. D, E, G — анормальные оксиоидные микросклеры. F — оксигемигексастр.

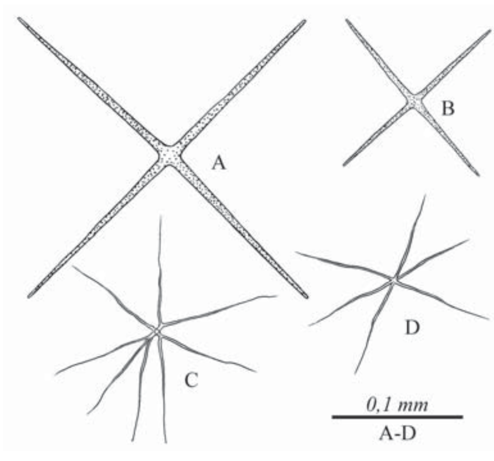

Fig. 13. Spicules of *Bathydorus* sp., IORAS 5/2/3838. A–B — dermal stauractins. C — oxyhemihexaster. D — oxyhexactin.
Рис. 13. Спикулы *Bathydorus* sp., IORAS 5/2/3838. A–B — дермальные ставрактины. C — оксигемигексастр. D — оксигексактина.

SPICULES. MEGASCLERES. Hypodermal (and hypoatrial pentactins as well), rarely stauractins with conically pointed, rough outer ends. The tangential rays of these pentactins are 0.3–1.0 mm long, the ray directed inside the body is 0.5–1.0 mm long, these rays are 0.009–0.034 mm in diameter. Choanosomal diactins 2.3–3.7/0.008–0.014 mm have stout shafts or with a widening in the middle with rounded, rough outer ends.

Dermalia and possibly atrialia are stauractins, rarely tauactins. They have slightly rough rays with conically pointed or rounded outer ends. The rays of these stauractins are 0.085–0.344 mm in diameter (n=27, avg: 0.192 mm, std: 0.065 mm), the diameter of these rays is 0.004–0.013 mm.

MICROSCLERES. Oxyoidal microscleres have very thin rays. They are usually oxyhexasters and oxyhemihexasters with 1–3 secondary rays, often curved or sometimes oxyhexactins. The diameter of oxyhexasters is 0.144–0.237 mm (n=25, avg: 0.170 mm, std: 0.020 mm), the diameter of their primary rosette is 0.007–0.015 mm (n=25, avg: 0.008 mm, std: 0.002 mm). The diameter of oxyhexactins is 0.148–0.215 mm (n=8, avg: 0.175 mm, std: 0.021 mm).

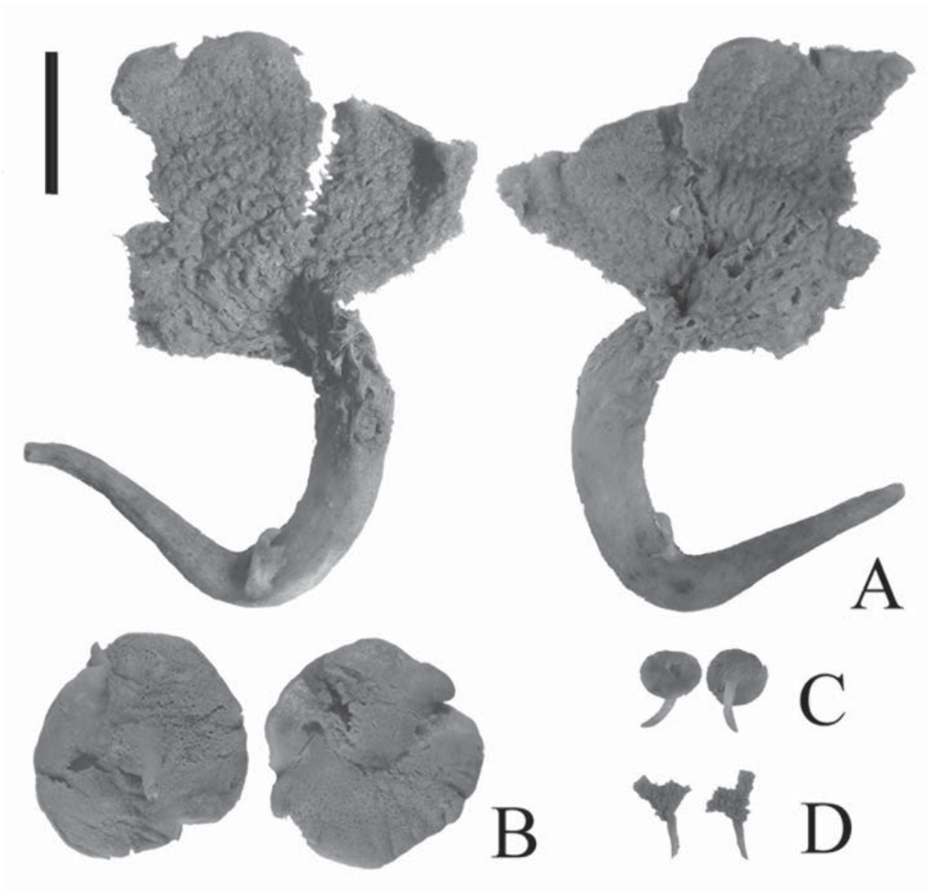

Fig. 14. *Caulophacus* (*Caulophacus*) *elegans*, external shape from different sizes. Scale 50 mm. A — IORAS 5/2/2152. B — IORAS 5/2/2147. C — IORAS 5/2/2216. D — IORAS 5/2/2187.
Рис. 14. *Caulophacus* (*Caulophacus*) *elegans*, внешний вид с разных сторон. Масштаб 50 мм. A — IORAS 5/2/2152. B — IORAS 5/2/2147. C — IORAS 5/2/2216. D — IORAS 5/2/2187.

REMARKS. Among the species of *Bathydorus* only *B. servatus* Topsent, 1927 (1928) has similar oxyoidal microscleres with such thin rays. But dermal stauractins are much smaller as well as oxyoidal microscleres are also smaller in the newly found material, besides dermal diactins are absent (unlike *B. servatus*). Based on a small fragment, description of a new species does not seem reasonable, moreover, the spicule content may be not complete and thus the generic identification is also not perfect. Spicules of other hexactinellids — *Farrea* and *Periphragella* were also found in investigated spicule preparations so the specimen is obviously contaminated by foreign spicules.

Caulophacus Schulze, 1886
Caulophacus (*Caulophacus*) Schulze, 1886

Caulophacus (*Caulophacus*) *elegans* Schulze, 1886
Figs 14, 15; Suppl. Tab. 11.

SYNONYMY: *Caulophacus elegans* Schulze, 1885: 438, fig. 159 — nomen nudum in the fig. footnote; 1886: 46; 1887: 126; Koltun, 1967: 118.

MATERIAL. IORAS 5/2/2147: RV 'Akademik Mstislav Keldysh' – 22, sta. 2309, trawl, N off the Bering Island, 55°13.24–12.02′ N 167°29.07–26.7′ E, depth 3957–3978 m. IORAS 5/2/2151; 2152; 2155; 2157; 2158.1; 2162; 2164; 2167; 2168; 2169; 2172; 2173; 2174; 2175; 2179; 2180; 2180.1; 2184; 2185; 2186; 2187; 2191; 2194; 2195; 2199; 2202; 2204; 2207; 2208; 2210; 2211; 2212; 2214; 2216; 2218; 2236; 2245; 2260; 2261; 2269; 2275; 2296; 2299; 2306; 2308: RV 'Akademik Mstislav Keldy-

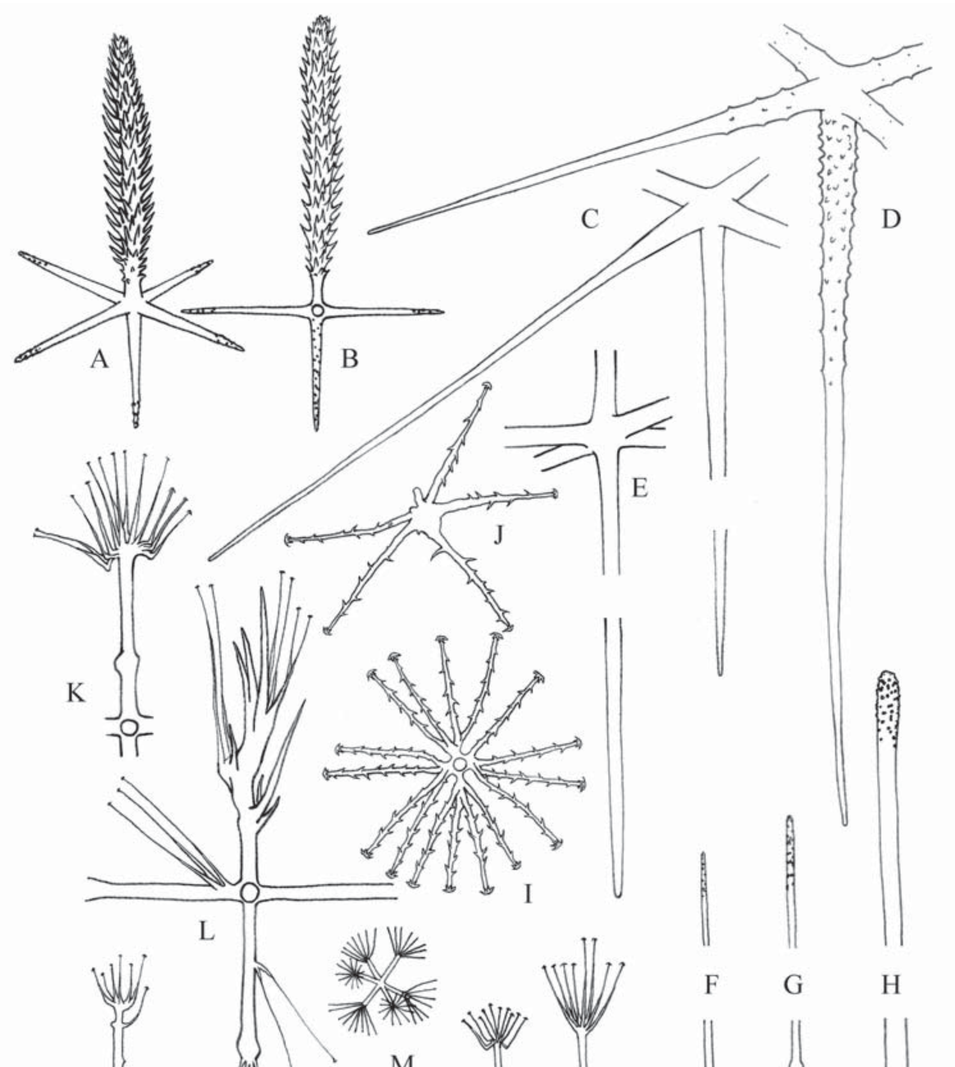

Fig. 15. Spicules of *Caulophacus* (*Caulophacus*) *elegans*. A — dermal hexactin. B — atrial hexactin. C–D — dermal or atrial pentactins: C — smooth; D — with spines on the rays close to the spicule center. E — choanosomal hexactin. F–H — choanosomal diactins. I — spiny spherical discohexaster. J — abnormal spiny discohexaster. K–O — lophodiscohexasters: O — anysolophodiscohexaster. P — lophodiscodiaster. A–J; L; N–O — IORAS 5/2/2152. K; M; P — IORAS 5/2/2147.

Рис. 15. Спикулы *Caulophacus* (*Caulophacus*) *elegans*. A — дермальная гексактина. B — атриальная гексактина. C–D — дермальные или атриальные пентактины: C — гладкая; D — с шипами на основаниях лучей. E — хоаносомальная гексактина. F–H — хоаносомальные диактины. I — шиповатый сферический дискогексастр. J — аномальный шиповатый дискогексастер. K–O — лофодискогексастеры. O — анизолофодискогексастер. P — лофодискодиастер. A–J; L; N–O — IORAS 5/2/2152. K; M; P — IORAS 5/2/2147.

sh' – 22, sta. 2316, trawl, N off the Bering Island, 55°36.08–35.00′ N 167°23.04–24.46′ E, depth 4200–4294 m.

DESCRIPTION. BODY. The specimens have a mushroom shaped body typical for *Caulophacus*. Some specimens however are just fragments. Discoidal bodies are from 33 to 200 mm in diameter, 1.5–10 mm in thickness, with undulating edges of discs. Peduncles are tubular 2.5–20 mm in diameter.

SPICULES. MEGASCLERES. Hypodermalia and hypoatrialia are pentactins with rays having smooth and rounded outer ends or they have tubercles or numerous tubercles on the shafts close to the spicular center. The tangential rays of hypodermal and hypoatrial pentactins are 0.3–0.6 mm long, the ray directed inside the body is 0.5–0.7 mm long, these rays are 0.017–0.038 mm in diameter. Choanosomal spicules are diactins and hexactins. Choanosomal diactins usually have a widening in the middle, sometimes four rudimental tubercles or they are stout, their outer ends are rounded and rough. Choanosomal diactins are 1.1–1.5/0.005–0.011 mm. The diactins of the peduncle are 0.019–0.022 mm in diameter; they are connected by numerous synapticular junctions. Choanosomal hexactins have smooth rays with rounded outer ends, that are 0.45–0.9/0.023–0.044 mm in length.

Dermalia and atrialia are similar to each other in shape and generally in size. They are hexactins which have rays directed outside the body. Rays are pinular and smooth or slightly covered by tubercles; other rays have rounded or conically pointed, rough outer ends. Rarely dermal and atrial spicules are pentactins with a rudimental tubercle situated in place of the ray directed inside the body. The pinular ray of dermal hexactins is 0.096–0.248 mm long, tangential rays are 0.067–0.141 mm long, the ray directed inside the body is 0.048–0.137 mm long, the diameter of these rays is 0.007–0.011 mm; the diameter of the pinular part is 0.037–0.044 mm. The pinular ray of atrial hexactins is 0.111–0.340 mm long, tangential rays are 0.067–0.144 mm long, the ray directed inside the body is 0.037–0.118 mm long, the diameter of these rays is 0.007–0.009 mm; the diameter of the pinular part is 0.026–0.037 mm.

MICROSCLERES. Obviously two types of discoidal microscleres are known in these specimens. Some oxyoidal microscleres but likely they belong to other hexactinellids from close locations. Discohexasters have short principal rays, the rays are spiny and usually they have 5–6 secondary rays, rarely 1. Abnormal discohexasters are rare. The discohexasters are 0.086–0.151 mm in diameter with primary rosette 0.011–0.036 mm in diameter. Lophodiscohexasters often have tubercles carrying some additional discoidal rays on the smooth shafts; sometimes the secondary rays are of different sizes (lophoanysodiscohexasters). The secondary rays of large lophodiscohexasters are short–spiny, in small spicules they look to be smooth and even sometimes tyloidal in shape (not completely developed). The number of secondary rays is from 4 to about 30. Rarely lophodiscodiasters were found. Lophodiscohexasters are referred to a single size class of spicules in spite the significant size variation. The gap of their size classes was observed in some specimens but in other the gap is different and in some completely absent. The diameter of lophodiscohexasters is 0.047–0.324 mm with primary rosette 0.022–0.144 mm in diameter. The largest lophodiscohexaster was found in the specimen 5/2/2168 — 0.324 mm in diameter with the primary rosette 0.108 mm in diameter what is close to that described by Koltun (1967) (0.330 mm in diameter) which he considered to have allochthonic origin.

REMARKS. As it was observed, the specimens of different sizes: small and big (Suppl. Tab. 11) have very similar sizes of spicules. Moreover, Table 11 shows that the smallest specimen 5/2/2187 has the most spicules of larger sizes than larger specimens.

Among numerous species of *Caulophacus* (*Caulophacus*) the newly found materials are most of all similar to *C.* (*Caulophacus*) *elegans* in the presence of discohexasters (unlike discohexactins), shape of most spicules, but unlike the previously known species it has dissimilar dermal and atrial pinular hexactins. The dermal hexactins are smaller than the atrial ones in *C.* (*Caulophacus*) *elegans* and generally equal in the new specimens from the Bering Sea.

DISTRIBUTION. Bering Sea, E of Japan, 3680–4220 m.

Caulophacus (*Caulophacus*) *hyperboreus* Koltun, 1967

Figs 16–18; Suppl. Tab. 12.

MATERIAL. IORAS 5/2/2084; IORAS 5/2/2153; 2154; 2161.1; 2228.1; 2229; 2231; 2232; 2233; 2234: RV 'Akademik Mstislav Keldysh' – 22, sta. 2309, trawl, N off the Bering Island, 55°13.24–12.02′ N 167°29.07–26.7′ E, 3957–3978 m. IORAS 5/2/2150; 2158; 2177; 2178; 2182; 2183; 2183.1; 2217: RV 'Akademik Mstislav Keldysh' – 22, sta. 2316, trawl, N off the Bering Island, 55°36.08–35.00′ N 167°23.04–24.46′ E, 4200–4294 m. IORAS 5/2/3811; 3811.2–3811.9; 3820, 3821: RV 'Akademik M.A. Lavrentyev' – 75, sta. 22, ROV 'Comanche', 55°30′36.1″ N 167°19′27.1″ E, 3879–3578 m.

DESCRIPTION. BODY. The specimens had mushroom-like bodies or fragments often attached to a peduncle branching into many separate bodies. It is not obvious if they represent a single specimen

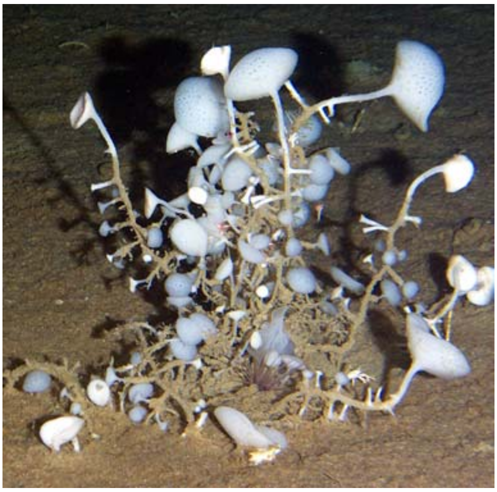

Fig. 16. Specimens of *Caulophacus* (*Caulophacus*) *hyperboreus* attached to a dead skeleton of *Periphragella* (not visible here). A ROV 'Comanche' photo. RV 'Akademik M.A. Lavrentyev' – 75, sta. 22, 55°30′36.1″ N 167°19′27.1″ E, depth 3879–3578 m.

Рис. 16. Экземпляры *Caulophacus* (*Caulophacus*) *hyperboreus* прикрепленные к мертвому скелету *Perifragella* (не виден). Фотография подводного робота "Comanche"; НИС "Академик М.А. Лаврентьев" – 75, станция 22, 55°30′36.1″ N 167° 19′27.1″ E, глубина 3879–3578 м.

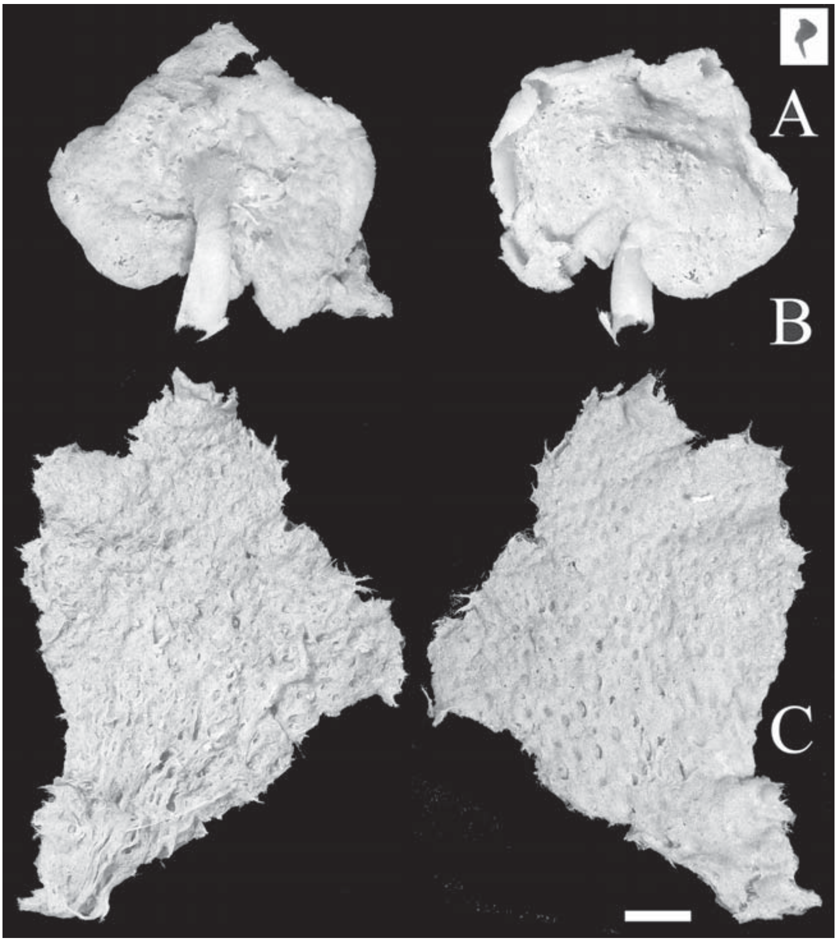

Fig. 17. Specimens of *Caulophacus* (*Caulophacus*) *hyperboreus*: A — IORAS 5/2/2232. B — IORAS 5/2/2250, view from different sides. C — IORAS 5/2/2661, view from different sides. Scale 10 mm.

Рис. 17. Экземпляры *Caulophacus* (*Caulophacus*) *hyperboreus*: A — IORAS 5/2/2232. B — IORAS 5/2/2250, вид с разных сторон. C — IORAS 5/2/2661, вид с разных сторон. Масштаб 10 мм.

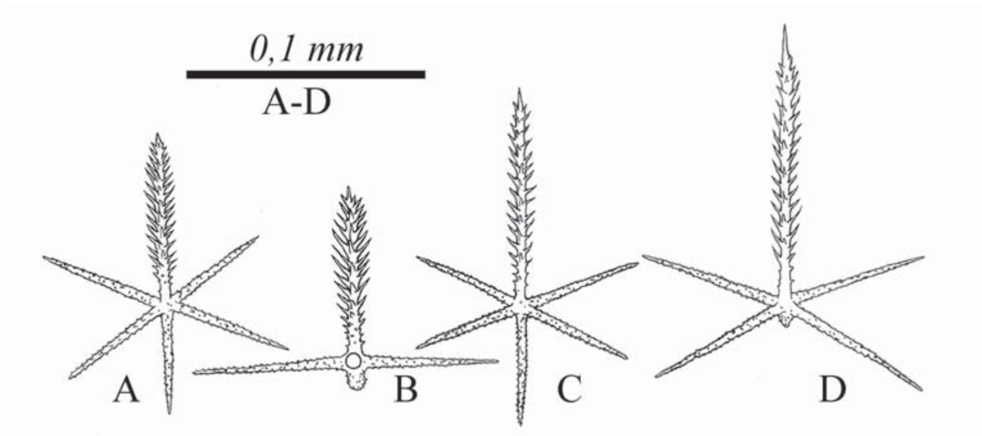

Fig. 18. Spicules of *Caulophacus* (*Caulophacus*) *hyperboreus*, IORAS 5/2/2229 (additional types to previous descriptions). A — dermal pinular hexactin. B — dermal pinular pentactin. C — atrial pinular hexactin. D — atrial pinular pentactin.
Рис. 18. Спикулы *Caulophacus* (*Caulophacus*) *hyperboreus*, IORAS 5/2/2229 (в дополнение к предыдущим описаниям). A — дермальная пинулярная гексактина. B — дермальная пинулярная пентактина. C — атриальная пинулярная гексактина. D — атриальная пинулярная пентактина.

with stolonial branching or multiple organisms of same species that settled on the peduncle of one colony. The specimen sizes ranged from those with the disc 3 mm in diameter and 1 mm in thickness with peduncle 1 mm in diameter to the biggest ones 55 mm in diameter, 3–4 mm in thickness and the peduncle about 5 mm in diameter. But some of them reach even larger sizes — a single lamellate fragment of the discoidal body 90x70 mm and 4–6 mm in thickness was found.

REMARKS. The species was originally described as a subspecies: *Caulophacus schulzei hyperboreus* Koltun, 1967. Both species from the North Pacific, *C.* (*Caulophacus*) *schulzei* and *C.* (*Caulophacus*) *elegans,* are completely different from the subspecies described by Koltun (1967).

Among the newly found specimens of *Caulophacus hyperboreus* many had pinular pentactins among both dermal and atrial hexactins sometimes in large amounts. As it is seen from the Suppl. Tab. 12, it can be assumed that spicule combination and their sizes are very similar between investigated specimens and dissimilarities are considered as an inerspecific variation. Unlike specimens described by Koltun, some specimens from the new series from the Bering Sea have dermal and atrial pinular pentactins with their rudimentary ray directed inside the body, in some specimens they are even more numerous then corresponding hexactins (for instance, IORAS5/2/2229; 2232 and some other specimens). Meantime, the other spicules correspond in shape and size to typical representatives and these specimens are undoubtedly belonging to the same species.

DISTRIBUTION. Bering and Okhotsk Seas, 3400–4294 m depth.

Caulophacus (*Caulophacus*) *miri* **sp.n.**
Figs 19, 20.

MATERIAL. HOLOTYPE. IORAS 5/2/2054. RV 'Akademik Mstislav Keldysh' – 22, sta. 2296, HOV 'Mir-1', Pacific side of Bering Island, 54°57.7′ N 165°42.85′ E, 5952 m.

DESCRIPTION. BODY. The specimen is fungus-like with a discoidal ovoid body 140x190 mm and 20 mm thick, the edge of the disc is everted down so that the atrial surface present also on the lateral edge of the discoidal body. The tubular peduncle was broken into several pieces during collection but was 180 mm long with walls 5 mm in thickness. The upper part of the peduncle is 20x25 mm in diameter while the lower part is about 20 mm in diameter.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins and hexactins. The diactins are sometimes thick but most were thin. The thick diactins have stout shafts and rounded outer ends, they are 2–2.7/0.032–0.110 mm. The thin diactins have stout shafts, sometimes with a widening in the middle or four tubercle rudiments, their outer ends are rounded, smooth or rough, they are 1.5–1.9/0.008–0.024 mm. Choanosomal hexactins have rays 0.4–1.6/0.015–0.1 mm with conically pointed outer ends. Hypodermalia and hypoatrialia are pentactins with conically pointed outer ends. Tangential rays of these pentactins are 0.2–1.4 mm long, the ray directed inside the body 0.1–0.8 mm long, their diameter

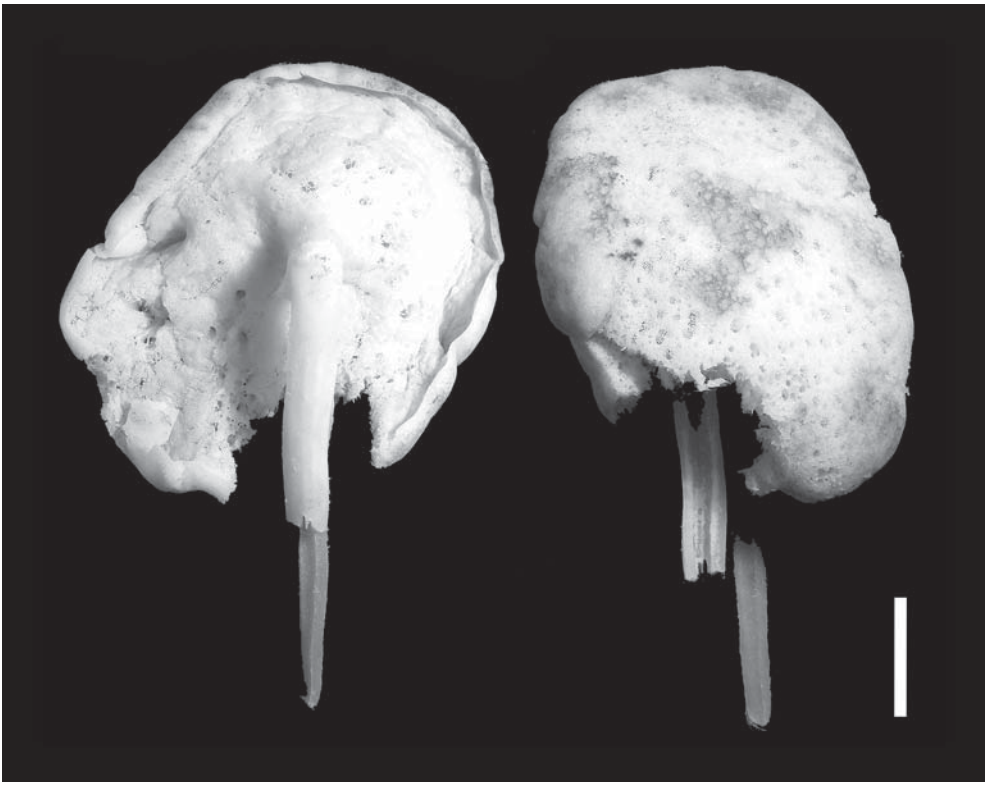

Fig. 19. *Caulophacus* (*Caulophacus*) *miri* sp.n., holotype, external shape from different sides. Scale 50 mm.
Рис. 19. *Caulophacus* (*Caulophacus*) *miri* sp.n., голотип, внешний вид сразных сторон. Масштаб 50 мм.

is 0.02–0.10 mm. Specific types of large hexactins are located beneath the atrial surface, each having a shortened ray directed outside the body with rough or short spiny rounded distal ends. Sometimes this ray is lanceolate in shape, and they do not protrude over the entire atrial surface. This outwardly protruding ray is about 0.6 mm long, whereas tangential rays are 1,3 mm long. The ray directed inside the body is about 0.8 mm long and the diameter of these rays is 0.04–0.05 mm. The diactins of the peduncle have a diameter of 0.015–0.053 mm and are connected to each other by numerous synapticular junctions.

Dermalia and atrialia are pinular hexactins, they have rounded or conically pointed outer ends, tangential rays and the ray directed inside the body are short-spiny. Some rare dermal pentactins have no pinular ray; the unpaired ray is equal in shape to other rays. Pinular ray of dermal hexacins is spherical, 0.067–0.107 mm in diameter (n=25, avg: 0.085 mm, std: 0.011 mm), tangential rays are 0.074–0.141 mm in diameter (n=25, avg: 0.104 mm, std: 0.016 mm), the ray directed inside the body is 0.056–0.111 mm in diameter (n=25, avg: 0.089 mm, std: 0.015 mm), the diameter of pinular ray is 0.019–0.033 mm at base and 0.041–0.063 mm in maximal mediate part, the diameter of other rays is 0.015–0.019 mm at base. The pinular ray in atrial hexactins may also be spherical but often they are elongate, often with irregular shaft having a widening some distance from the base. Pinular ray of atrial hexacins is 0.074–0.463 mm in diameter (n=30, avg: 0.226 mm, std: 0.135 mm), tangential rays are 0.078–0.152 mm in diameter (n=30, avg: 0.114 mm, std: 0.018 mm), the ray directed inside the body is 0.078–0.152 mm in diameter (n=30, avg: 0.105 mm, std: 0.014 mm), the diameter of pinular ray is 0.019–0.026 mm at base and 0.022–0.052 mm in maximal mediate part, the diameter of other rays is about 0.015 mm at base.

MICROSCLERES. Most microscleres are thick-rayed discohexactins, but there are rare discohemihexasters and sometimes discohexasters with 2–4 secondary rays. Lophodiscohexasters with 4–12 secondary rays are common close to the dermal and atrial surfaces. Some of these spicules have stout shafts, some have some secondary rays raised from the side of the primary rays, rarely lophodiscostau-

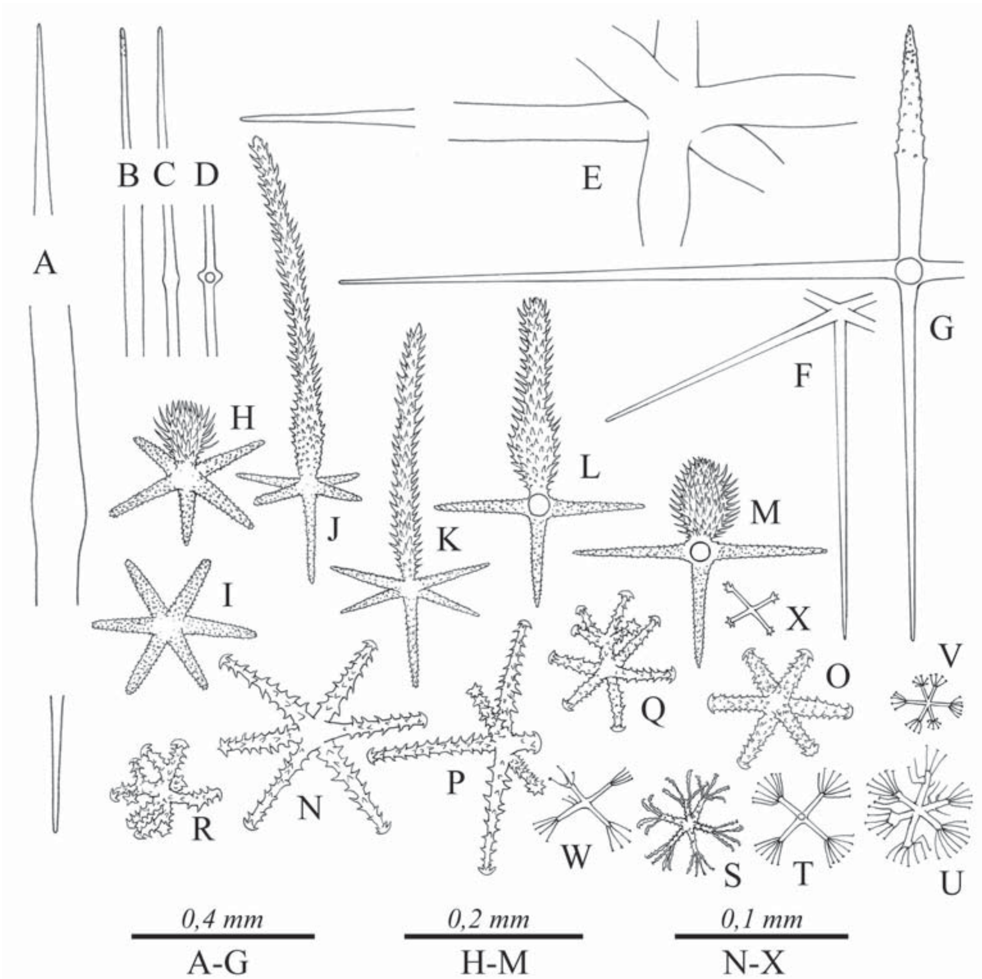

Fig. 20. Spicules of *Caulophacus* (*Caulophacus*) *miri* sp.n., holotype. A — thick choanosomal diactin. B–D — choanosomal diactins. E — choanosomal hexactin. F — hypodermal or hypoatrial pentactin. G — hypoatrial hexactin. H — dermal pinular hexatin. I — dermal hexactin. J–M — atrial pinular hexactins. N–O — discohexasters. P — abnormal discohexaster. Q–R — discohemihexasters. S — abnormal discohexaster. T–V — lophodiscohexasters. W — lophodiscostauraster. X — abnormal stauractin.

Рис. 20. Спикулы *Caulophacus* (*Caulophacus*) *miri* sp.n., голотип. A — толстая хоаносомальная диактина. B–D — хоаносомальные диактины. E — хоаносомальная гексактина. F — гиподермальная или гипоатриальная пентактина. G — гипоатриальная гексактина. H — дермальная пинулярная гексактина. I — дермальная гексактина. J–M — атриальные пинулярные гексактины. N–O — дискогексастры. P — аномальный дискогексастр. Q–R — дискогемигексастры. S — аномальный дискогексастр. T–V — лофодискогексастры. W — лофодискостаурастер. X — аномальная ставрактина.

rasters are found. The diameter of discohexactin is 0.089–0.185 mm (n=27, avg: 0.135 mm, std: 0.032 mm). The thick–rayed discohexasters are 0.059–0.104 mm in diameter (n=9, avg: 0.078 mm, std: 0.013 mm), the diameter of the primary rosette is 0.036–0.044 mm (n=9, avg: 0.039 mm, std: 0.003 mm). The lophodiscohexasters are 0.036–0.101 mm in diameter (n=25, avg: 0.067 mm, std: 0.016 mm), with the diameter of their primary rosette being 0.023–0.063 mm (n=25, avg: 0.037 mm, std: 0.010 mm).

REMARKS. In comparison to other species in this subgenus, the new species has a notable and significant difference in the sizes between dermal and atrial spicules. This feature is observed also in the type species — *Caulophacus* (*Caulophacus*) *latus* Schulze, 1886 (re-described later: Schulze, 1887; Tabachnick, 2002b). Unlike it, the new species has dermal hexactins with spherical shape of pinular heads; atrial hexactins with widened pinular rays and often they have irregular overall shape of the pinular ray when it is thickest at base, close to the center of the spicule. Microscleres sizes are also quite different between these species. *Caulophacus* (*Caulophacus*) *latus* has calycocomes or lophodiscohexasters which are extremely large. Other species of *Caulophacus* (*Caulophacus*) which also have larger pinular ray in atrial hexactins and pentactins carry short spines on this ray.

ETYMOLOGY. The species is named after the HOV 'Mir' which collected this specimen.

DISTRIBUTION. Currently found only off the Pacific side of Bering Island, at 5952 m depth.

Caulophacus (*Caulophacus*) *subarcticus* **sp.n.**
Figs 21, 22; Suppl. Tab. 13.

MATERIAL. HOLOTYPE: IORAS 5/2/2274: RV 'Akademik Mstislav Keldysh' – 22, sta. 2306, trawl, Pacific sine of the Bering Island, 54°57.1–57.7′ N 165°49.9–51.0′ E, 4401–3797 m.

DESCRIPTION. BODY. The specimen is fungus–like with a discoidal body 25 mm in diameter and 1–2 mm in thickness. The peduncle is about 1.5 mm in diameter and 35 mm long.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins and hexactins. The diactins are divided into two types: large and small. The former (about 1.5/0.02 mm) have stout shafts, conically pointed outer ends. Common diactins are thin with a widening in the middle, the outer ends are rough, rounded or clavate, these diactins are 0.9–2.4/0.006–0.009 mm. Choanosomal hexactins have conically pointed outer ends, their rays are 0.6–0.8/0.02–0.04 mm. Hypodermal and hypoatrial pentactins have smooth tangential rays or they are spiny at base, the ray directed inside the body may be spiny, the outer ends are smooth, conically pointed. The tangential rays of hypodermal and hypoatrial pentactins are 0.3–0.5 mm long, the ray directed inside the body is 0.6–1.0 mm, the diameter of these rays is 0.02–0.03 mm. Spicules of the peduncle are diactins about 8/0.006–0.023 mm with stout shafts, rounded or clavate outer ends. Unlike the penduncular diactins of other species, these do not fuse to each other.

Dermalia are hexactins as well as rare pentactins with a rudimental tubercle instead of a sixth ray directed inside the body. Dermal hexactins include those with clavate pinular rays and long tangential rays as well as those with a lanceolate pinular ray. The tangential rays and the ray directed inside the body are rough or short-spiny at their distal half with

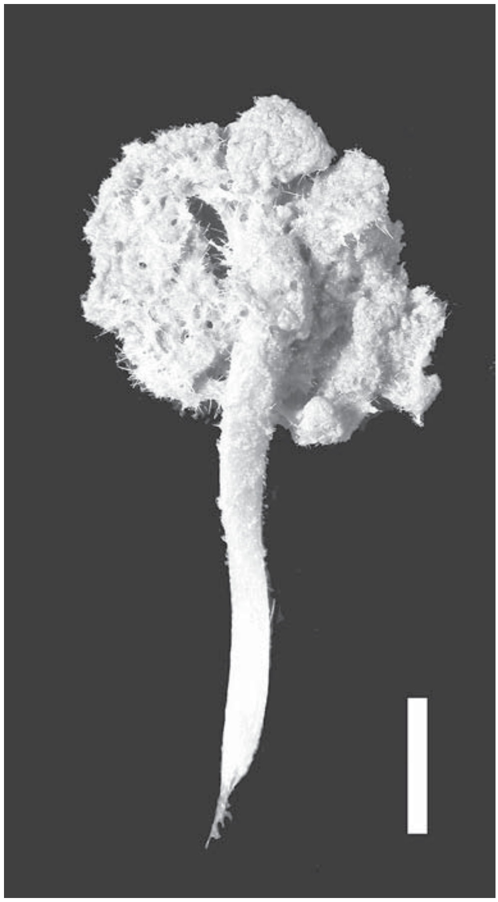

Fig. 21. *Caulophacus* (*Caulophacus*) *subarcticus* sp.n., holotype, external shape. Scale 10 mm.
Рис. 21. *Caulophacus* (*Caulophacus*) *subarcticus* sp.n., голотип, внешний вид. Масштаб 10 мм.

conically pointed outer ends. The clavate pinular ray of dermal hexactin is 0.037–0.141 mm long (n=25, avg: 0.079 mm, std: 0.023 mm), maximal diameter of this ray is 0.011 mm, tangential rays are 0.041–0.107 mm long (n=25, avg: 0.087 mm, std: 0.015 mm), the ray directed inside the body is 0.030–0.093 mm long (n=25, avg: 0.066 mm, std: 0.018 mm), the diameter of these rays is 0.006 mm. Lanceolate pinular ray of dermal hexactin is 0.070–0.159 mm long (n=25, avg: 0.123 mm, std: 0.020 mm), the maximal diameter of this ray is 0.004 mm, tangential rays of these spicules are 0.052–0.081 mm long (n=25, avg: 0.064 mm, std: 0.010 mm), the ray directed inside the body is 0.033–0.078 mm long (n=25, avg: 0.059 mm, std: 0.011 mm), the diameter of these rays is about 0.003 mm. Atrialia are pentactins with rudimental tuberculated ray directed inside the body or sometimes hexactins, these spicules have pinular ray elongate

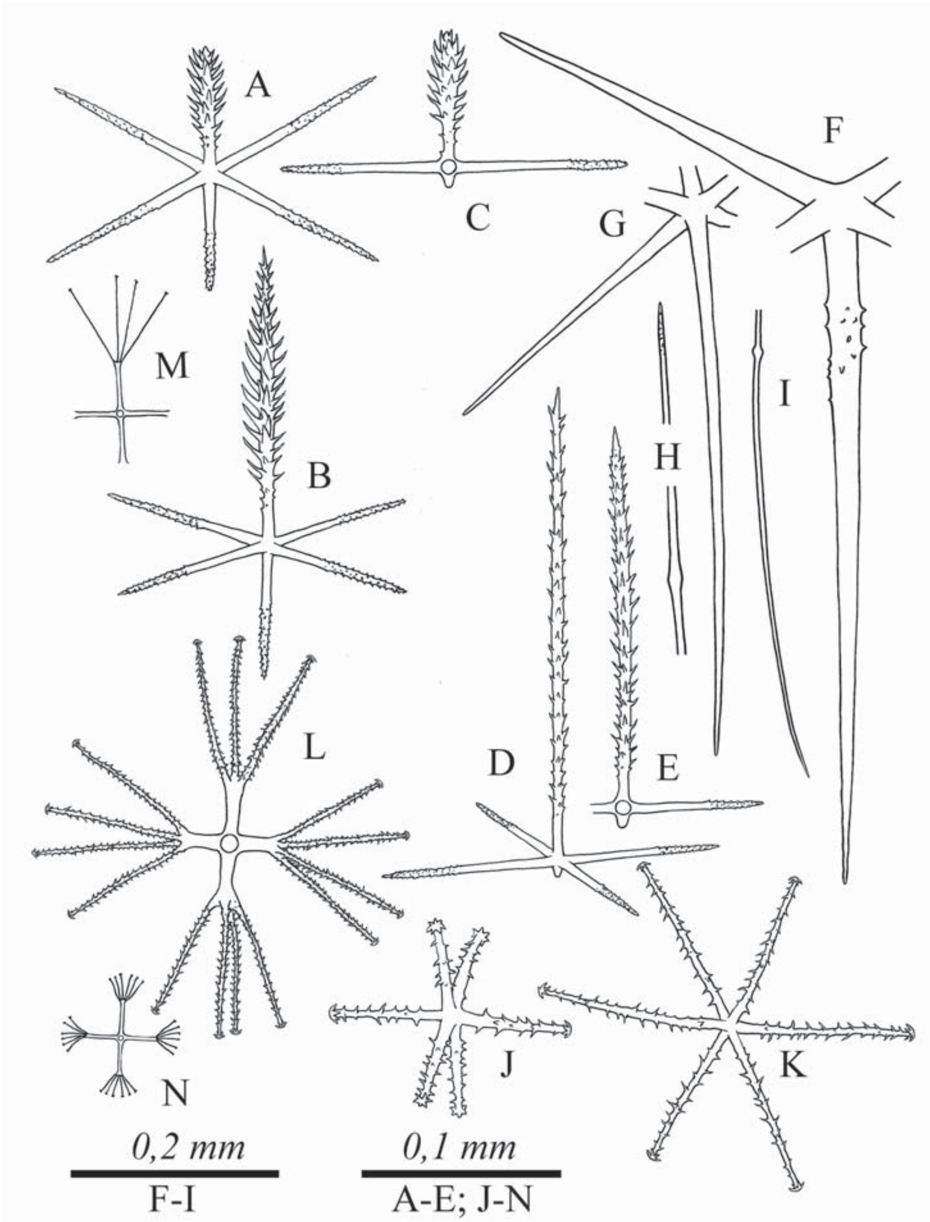

Fig. 22. Spicules of *Caulophacus* (*Caulophacus*) *subarcticus* sp.n., holotype. A–B — dermal pinular hexactins. C — dermal pinular pentactin. D–E — atrial pinular pentactins. F — hypodermal or hypoatrial pentactin. G — choanosomal hexactin. H–I — choanosomal diactins. J — thick-rayed discohexactin. K — thin–rayed discohexactin. L — discohexaster. M — intermedium spicule between discohexaster and lophodiscohexaster. N — lophodiscohexaster.

Рис. 22. Спикулы *Caulophacus* (*Caulophacus*) *subarcticus* sp.n., голотип. A–B — дермальные пинулярные гексактины. C — дермальная пинулярная пентактина. D–E — атриальные пинулярные пентактины. F — гиподермальная или гипоатриальная пентактина. G — хоаносомальная гексактина. H–I — хоаносомальные диактины. J — дискогексактина с толстыми лучами. K — дискогексактина с тонкими лучами. L — дискогексастер. M — спикула промежуточная между дискогесастером и лофодискогексастером. N — лофодискогексастер.

and short–spiny, other rays are equal to those of dermal spicules. The pinular ray of atrial pentactin is 0.130–0.285 mm long (n=25, avg: 0.209 mm, std: 0.036 mm), about 0.007 mm in diameter, tangential rays are 0.041–0.111 mm long (n=25, avg: 0.079 mm, std: 0.016 mm), the rudimental ray is 0.007–0.022 mm long (n=25, avg: 0.012 mm, std: 0.003 mm), the diameter of these rays is 0.005–0.006 mm. Atrial hexactins have pinular rays 0.130–0.266 mm long (n=14, avg: 0.181 mm, std: 0.034 mm), tangential rays 0.044–0.104 mm long (n=14, avg: 0.083 mm, std: 0.016 mm), the ray directed inside the body is 0.048–0.081 mm long (n=14, avg: 0.065 mm, std: 0.008 mm).

MICROSCLERES. All microscleres have discoidal outer ends and include discohexasters, discohexactins and lophodiscohexasters. Discohexasters have 3–7 numerously spiny secondary rays are 0.111–0.289 mm in diameter (n=25, avg: 0.191 mm, std: 0.033 mm), the diameter of the primary rosette is 0.037–0.067 mm (n=26, avg: 0.054 mm, std: 0.010 mm). Discohexactins have thin (about 0,006 mm in diameter), long, spiny rays are 0.148–0.237 mm in diameter (n=26, avg: 0.194 mm, std: 0.025 mm). Discohexactins with thick (about 0.007 mm in diameter), short spiny rays are less numerous, they are 0.067–0.163 mm in diameter (n=15, avg: 0.130 mm, std: 0.026 mm). Discohexasters with thick, short, spiny rays are very rare, they are 0.133 mm in diameter (n=1), the diameter of the primary rosette is 0.022 mm (n=1). The lophodiscohexasters have 4–20 secondary rays are 0.036–0.112 mm in diameter (n=28, avg: 0.066 mm, std: 0.016 mm), the diameter of the primary ray is 0.025–0.054 mm (n=28, avg: 0.035 mm, std: 0.006 mm). Sometimes the shafts of lophodiscohexasters have some irregular spines of tubercles. Some intermediate in shape forms between lophodiscohexasters and discohexasters with spiny secondary rays may be found.

REMARKS. Among more than 20 species of *Caulophacus,* the new species, *C. subarcticus*, distinguishes by numerous types of microscleres, as well as variable dermal and atrial spicules, especially by their form of the pinular ray. It is very difficult to consider some of them to have allochthonic origin since they were the only representative of *Caulophacus* in the trawl sample. Some similarities may be found between the new species and *Caulophacus arcticus* Hansen (see one of the latest description of Koltun, 1967), known from the N Atlantic and Arctic Oceans; however the differences between these species are well-seen from the corresponding Suppl. Tab. 13.

ETYMOLOGY. The species name is originated from the name of the closest species *Caulophacus arcticus*.

DISTRIBUTION. Currently found only off the Pacific side of Bering Island, at 4401–3797 m depth.

Caulophacus (*Caulophacus*) sp.

MATERIAL. IORAS 5/2/2266: RV ‘Akademik Mstislav Keldysh’ – 22, sta. 2306, trawl, Pacific sine of the Bering Island, 54°57.1–57.7′ N 165°49.9–51.0′ E, 4401–3797 m. IORAS 5/2/2159; 2160: RV ‘Akademik Mstislav Keldysh’ – 22, sta. 2309, trawl, N off the Bering Island, 55°25.00′ N 167°16.32′ E, 410 m. IORAS 5/2/2268: RV ‘Akademik Mstislav Keldysh’ – 22, sta. 2311, trawl, N off the Bering Island, 55°36.08–35.00′ N 167°23.04–24.46′ E, 4200–4294 m. IORAS 5/2/2150; 2227: RV ‘Akademik Mstislav Keldysh’ – 22, sta. 2316, HOV ‘Mir-2’, Piip underwater volcano, 55°36.08–35.00′ N 167°23.04–24.46′ E, 4200–4294 m.

REMARKS. These materials are presented by peduncles which have sizes corresponding to *Caulophacus* (*Caulophacus*). Some of them were collected together with identified above specimens in trawl samples, some were identified by dead or broken peduncles only.

Hyalascus Ijima, 1896
Hyalascus giganteus Ijima, 1898
Figs 23, 24.

MATERIAL. IORAS 5/2/3833: RV ‘Akademik M.A. Lavrentyev’ – 75, ROV ‘Comanche’, sta. 18, spec. 5-1, 55.4353° N 167.2668° E, 1420 m.

DESCRIPTION. BODY. The sponge is funnel-like about 400 mm high and 200 mm in maximal diameter (off the oscular margin) and about 100 mm in the diameter at base. Only fragment of the upper part of this sponge was sampled. The collected specimen is presented by damaged thin lamellate wall fragment 2–5 mm in thickness with no prostalia.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins with rough, conically pointed or rounded outer ends, stout shafts or sometimes with a widening in the middle. Large choanosomal diactins are about 17/0.06 mm. Small choanosomal diactins are 1–5/0.004–0.022 mm. Hypodermal pentactins have rough or smooth, rounded or conically pointed outer ends. Tangential rays of hypodermal pentactins are 2–3 mm long, proximal ray is 1.6–3.3 mm long, the diameter of these rays is 0.04 mm.

Dermalia are spicules with rough rays and conically pointed outer ends, mostly they are pentactins with a rudimental tubercle at place of the distal ray. Sometimes dermal spicules are hexactins and stauractins, the latter may have 1 or 2 tubercles in place of reduced rays. Dermal pentactins have tangential rays 0.081–0.137 mm long (n=25, avg: 0.118 mm, std: 0.013 mm), proximal rays are 0.067–0.141 mm long (n=25, avg: 0.103 mm, std: 0.020 mm). The diameter of these rays is 0.007–0.009 mm. Dermal stauractins have rays 0.096–0.192 mm long (n=8,

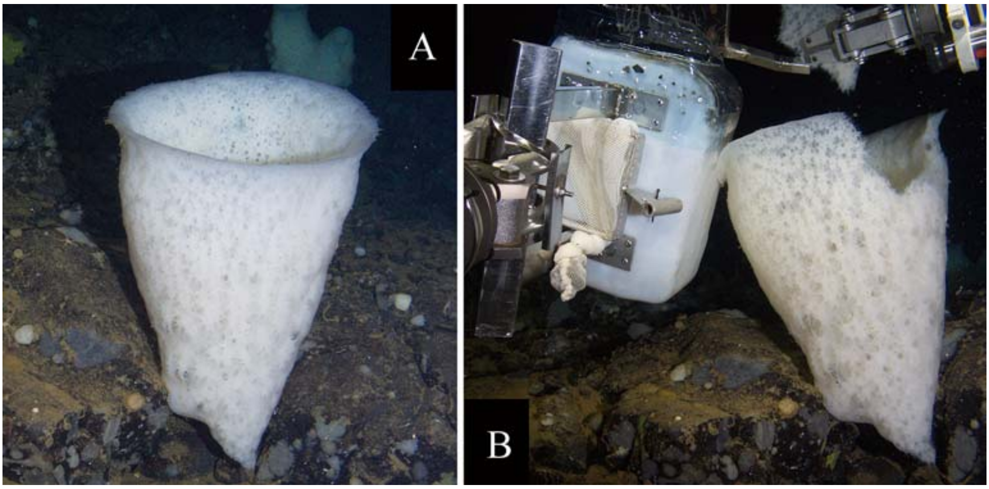

Fig. 23. *Hyalascus giganteus*, a ROV 'Comanche' photos. A — specimen before capturing. B — moment of sampling.
Рис. 23. *Hyalascus giganteus*, фотографии подводного робота "Comanche". A — экземпляр до поимки. B — момент взятия образца.

avg: 0.130 mm, std: 0.039 mm). Dermal hexactins have rays usually of equal length 0.081–0.137 mm long (n=12, avg: 0.116 mm, std: 0.017 mm). Atrial pentactins have tangential rays 0.081–0.241 mm long (n=25, avg: 0.120 mm, std: 0.029 mm), rays directed inside the body are 0.056–0.141 mm long (n=25, avg: 0.107 mm, std: 0.018 mm). Atrial stauractins have rays 0.107–0.185 mm long (n=6, avg: 0.130 mm, std: 0.029 mm). Small atrial hexactins have rays usually of equal length 0.089–0.118 mm long (n=3, avg: 0.100 mm, std: 0.016 mm).

MICROSCLERES. Various oxyoidal microscleres (i.e., oxyhexasters, oxyhemihexasters, abnormal oxyoidal-asterous forms (oxystarasters, oxyhemistaurasters); oxyhexactins, stauractins; tauactins, diactins and even monactins) and one type of microdiscohexaster were found. Oxyoidal microscleres have secondary rays with short spines directed towards the center of the spicule. The oxyhexasters and oxyhemihexasters with 1–3 secondary rays are 0.068–0.144 mm in diameter (n=25, avg: 0.100 mm, std: 0.018 mm), the diameter of their primary rosette is 0.005–0.014 mm (n=25, avg: 0.008 mm, std: 0.022 mm). The oxyhexactins are 0.076–0.130 mm in diameter (n=25, avg: 0.102 mm, std: 0.013 mm). The microdiscohexasters have 5–10 secondary rays, their diameter is 0.020–0.036 mm (n=25, avg: 0.028 mm, std: 0.004 mm), the diameter of their primary rosette is 0.004–0.010 mm (n=25, avg: 0.028 mm, std: 0.004 mm).

REMARKS. Some differences between *H. giganteus* (Ijima, 1904) and the newly found specimen are not considered to be important. Dermal spicules are a little smaller in the new specimen, atrial spicules larger, the size parameters of the microscleres generally are a little wider than those described. Variation of oxyoidal microscleres types is larger in the specimen from the Bering Sea. Nevertheless, all of these differences are considered to be an intraspecific variation.

DISTRIBUTION. Pacific side off Japan (Sagami Sea) and Bering Sea — Piip Volcano, at 1420 m depth (depth in the Sagami Sea — unknown).

Hyalascus keldyshi **sp.n.**
Figs 25, 26.

MATERIAL. HOLOTYPE: IORAS 5/2/2043. RV 'Akademik Mstislav Keldysh' – 22, sta. 2296, submersible 'Mir-2', Pacific side of the Bering Island, 55°00.8′ N 165°51.0′ E, 2200 m.

DESCRIPTION. BODY. The specimen is conical-tubular, 450 mm high, with the diameter at base being 30 mm and 120 mm off the osculum. The walls are 1–5 mm thick.

SPICULES. MEGASCLERES. Choanosomal spicules are diactins with conically pointed, rough or rarely clavate, smooth outer ends, with a widening in the middle or sometimes four rudimental tubercles.

Dermalia are spicules with micro–spine rays, mostly pentactins and stauractins, rarely hexactins. Some stauractins have a rudimental tubercle instead of the fifth ray. Tangental rays of dermal stauractins are 0. 067–0.093 mm long (n= 25, avg: 0.080 mm,

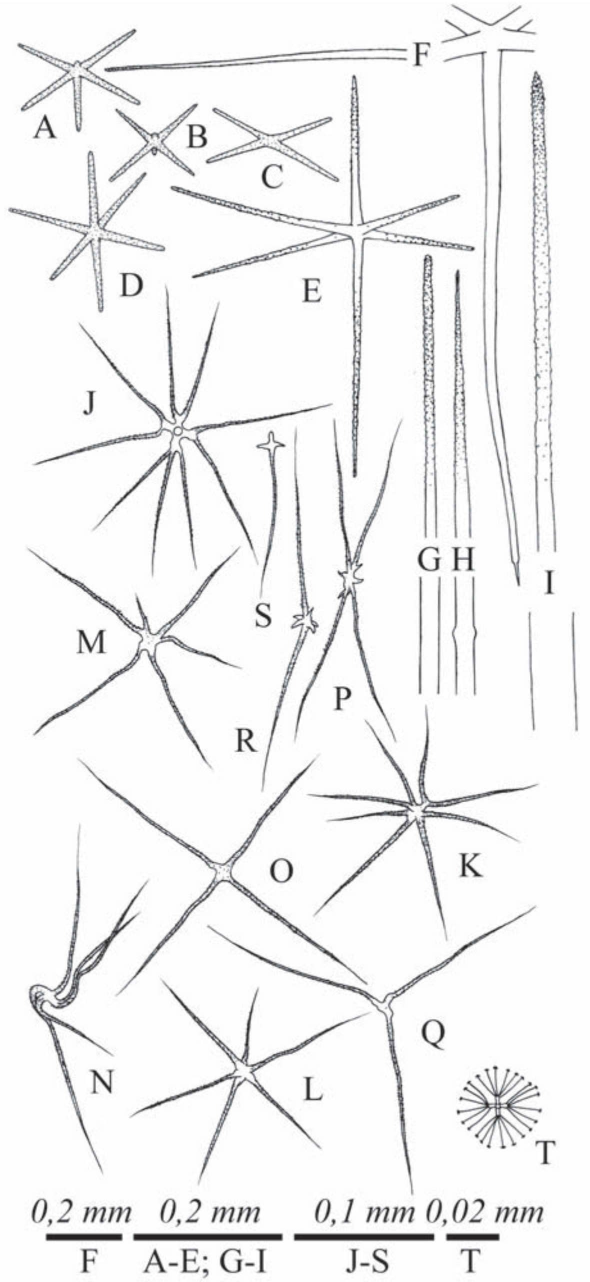

Fig. 24. Spicules of *Hyalascus giganteus*. A — dermal pentactin. B–C — dermal stauractins. D — dermal hexactin. E — atrial hexactin. F — hypodermal pentactin. G–I — choanosomal diactins. J — oxyhexaster. K — oxyhemihexaster. L — oxyhexactin. M–N — abnormal oxyoidal microscleres. O–P — oxystauractins. Q — oxyparatetractin. R–S — oxydiactins. T — microdiscohexaster.
Рис. 24. Спикулы *Hyalascus giganteus*. A — дермальная пентактина. B–C — дермальные ставрактины. D — дермальная гексактина. E — атриальная гексактина. F — гиподермальная пентактина. G–I — хоаносомальные диактины. J — оксигексастер. K — оксигемигексастер. L — оксигексактина. M–N — аномальные оксиоидальные микросклеры. O–P — окситавурактины. Q — оксипаратетрактина. R–S — оксидиактины. T — микродискогексастер.

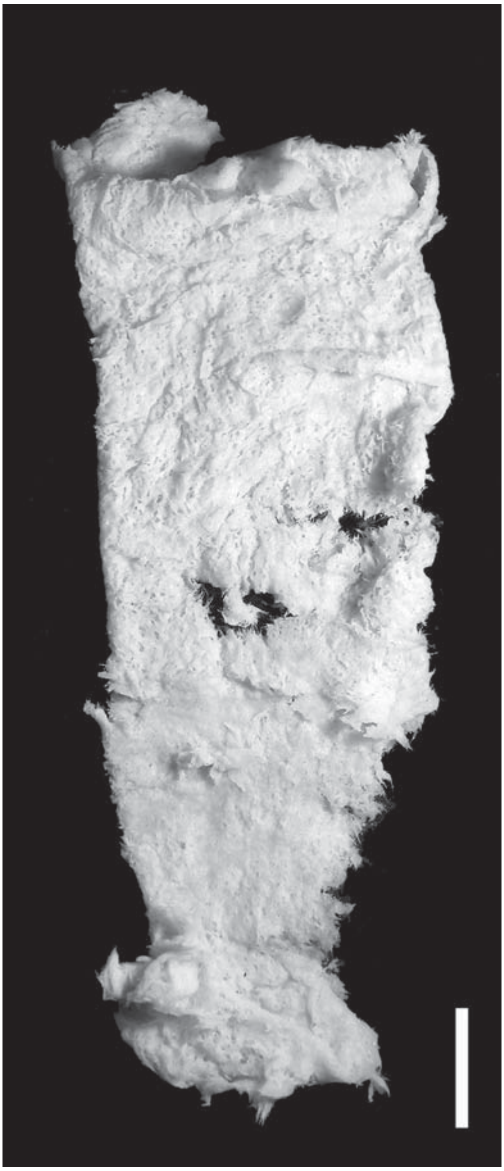

Fig. 25. *Hyalascus keldishi* sp.n., holotype, external shape. Scale 50 mm.
Рис. 25. *Hyalascus keldishi* sp.n., голотип, внешний вид. Масштаб 50 мм.

std: 0.006 mm). Tangential rays of dermal pentactins are 0. 052–0.085 mm long (n= 25, avg: 0.071 mm, std: 0.009 mm), the ray directed inside the body is 0.033–0.093 mm long (n=25, avg: 0.069 mm, std: 0.015 mm), the diameter of the rays of dermal spicules is about 0.007 mm. Atrialia are hexactins with micro-spined rays, the ray directed outside the body is the longest and most spiny, the spines themselves are longer than those on the other rays of the spicule. The ray directed outside the body of atrial hexactins is 0.118–0.233 mm long (n=27, avg: 0.158 mm, std: 0.035 mm), tangential rays are 0.070–0.122 mm long (n=26, avg: 0.091 mm, std: 0.015 mm), the ray directed outside the body is 0.056–0.122 mm long (n=27, avg: 0.098 mm, std: 0.015 mm), the diameter of these rays is 0.004–0.007 mm.

MICROSCLERES. One type of microdiscohexaster and several types of oxyoidal microscleres are present in this species. The oxyoidal microscleres have micro–spined rays, usually they are oxyhexactins and oxyhemihexasters with 1–2 secondary rays, sometimes abnormal forms of these spicules and rarely oxyhexasters (the latter could be also not finally developed microdiscohexasters). The oxyhexactins are 0.067–0.096 mm in diameter (n=25, avg: 0.081 mm, std: 0.009 mm). The oxyhemihexasters are 0.052–0.096 mm in diameter (n=25, avg: 0.073 mm, std: 0.012 mm), the primary rosette is 0.006–0.011 mm in diameter (n=25, avg: 0.008 mm, std: 0.021 mm). The rare oxyhexasters are 0.074–0.081 mm in diameter (n=3, avg: 0.076 mm, std: 0.004 mm), the primary rosette is 0.011–0.015 mm in diameter (n=3, avg: 0.014 mm, std: 0.002 mm). The microdiscohexasters are spherical; they have anchorate outer ends of the secondary rays represented usually by 6 units on each primary ray. The microdiscohexasters are 0.047–0.094 mm in diameter (n=25, avg: 0.062 mm, std: 0.011 mm), the primary rosette is 0.007–0.014 mm in diameter (n=25, avg: 0.009 mm, std: 0.002 mm).

REMARKS. Among the species of *Hyalascus* the new representative is characterized by spiny dermal spicules which are a combination of pentactins and stauractins. It is worth comparing it with similar species with the same spicule combinations: *H. giganteus* Ijima, 1898 (Ijima, 1904) and *H. farallonensis* Reiswig, 2018. Both species have dermal stauractins and pentactins. *H. attenatus* Okada, 1932 with dermal stauractins has however a close location. The new species has smaller rays of dermal spicules and larger size of microdiscohexasters then *H. giganteus* and *H. farallonensis*. The microdiscohexasters and oxyoidal microscleres in the new species are larger than those in *H. attenatus*, while the sizes of the dermal spicules rays are more or less equal to that of the new species. Hypodermal pentactins are entirely absent in this new species.

ETYMOLOGY. The species is named after RV ‘Akademik Mstislav Keldysh’ and simultaneously in memory of M.V. Keldysh.

DISTRIBUTION. Currently found only off the Pacific side of the Bering Island, at 2200 m depth.

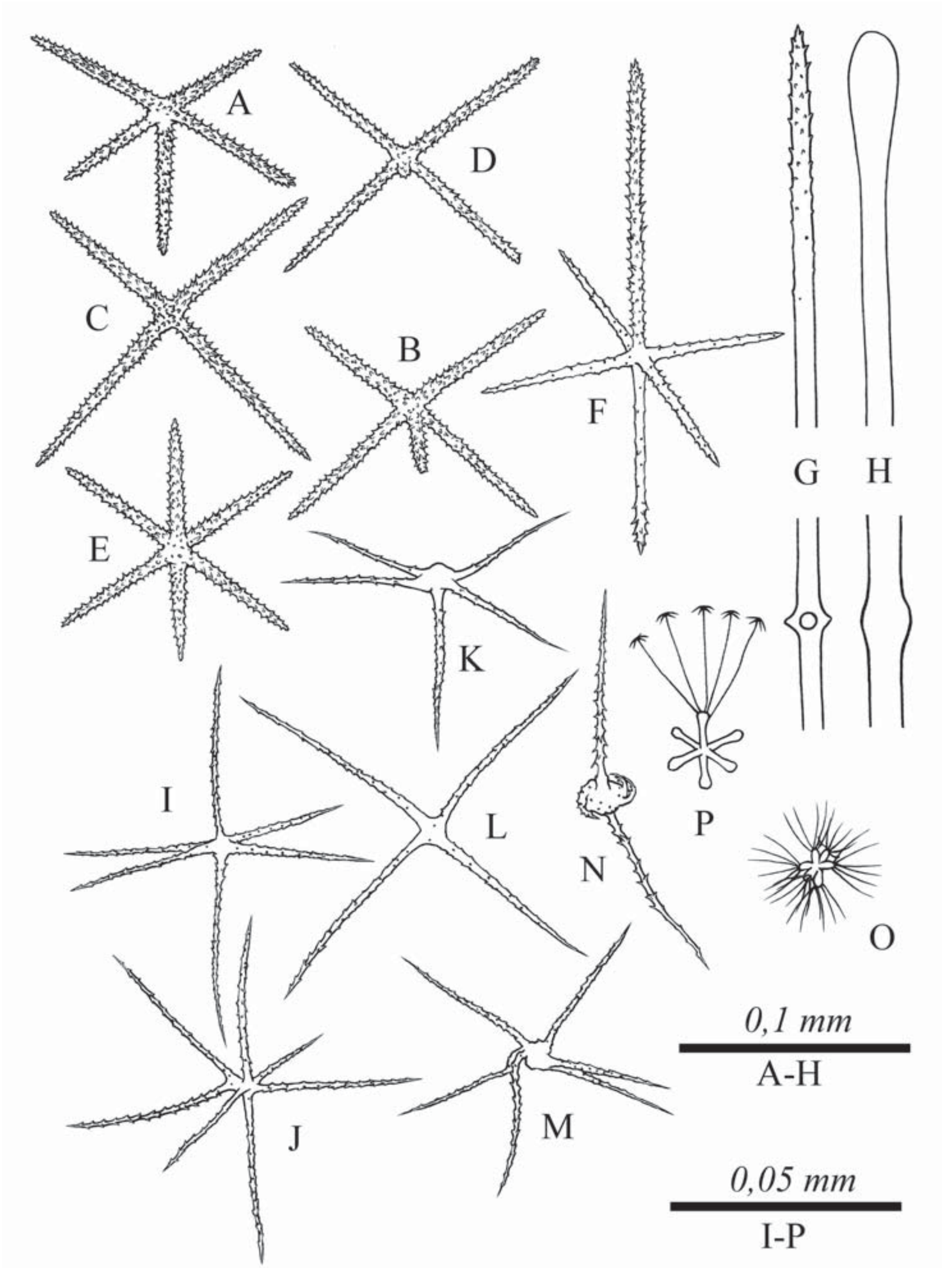

Fig. 26. Spicules of *Hyalascus keldishi* sp.n., holotype. A–E — dermalia. A–B — dermal pentactins. C–D — dermal stauractins. E — dermal hexactin. F — atrial hexactin. G–H — choanosomal diactins. I–O — oxyoidal microscleres. I — oxyhexactin. J — oxyhemihexaster. K — oxypentactin. L — oxystauractin. M — abnormal oxyhemihexaster. N — oxydiactin. O — oxyhexaster. P — microdiscohexaster.

Рис. 26. Спикулы *Hyalascus keldishi* sp.n., голотип. A–E — дермальные спикулы. A–B — дермальные пентактины. C–D — дермальные ставрактины. E — дермальная гексактина. F — атриальная гексактина. G–H — хоаносомальные диактины. I–O — оксиоидальные микросклеры. I — оксигексактина. J — оксигемигексастер. K — оксипентактина. L — оксиставрактина. M — аномальные оксигемигексастры. N — оксидиактина. O — оксигексастер. P — микродискогексастер.

Conclusion

Considerable efforts to investigate the family Rossellidae and others Hexactinellida in the Bering Sea were made by Koltun (1967) and Reiswig and Stone (2013). Koltun described a total of 24 species and subspecies of Hexactinellida from the Bering Sea, 9 of which were endemics. Fourteen of these were species or subspecies of Rossellidae, 5 of which were known only from the Bering Sea. Reiswig and Stone (2013) described 13 species of newly collected hexactinellids from the Bering Sea of which 8 were new. Among these were 8 rossellids, 4 of which were new. Our present research confirmed the results obtained by the previous authors and increased knowledge on taxonomy and distribution of hexactinellids from the North Pacific in general and the Bering Sea in clouse proportion of appearance of new taxa.

Representatives of the family Rossellidae constitute an important component of macrobenthic fauna of the continental, island and seamount slopes in the Bering Sea and adjacent area (Pacific side of the Aleutian and Kommandor Islands) (Suppl. Tab. 14). Our collection includes 5 genera and 16 species and subspecies of Rossellidae from this area. Besides a new species and a new subspecies from the Bering Sea, we describe three new species from the Pacific slope of Bering Island. It is highly likely that these species are also present on the opposite slope (Bering side) which is poorly investigated.

According to our and other published data, 19 Rossellidae species/subspecies are now known from the Bering Sea (likely, two more species were registered in this area) of which 7 species/ subspecies have so far only been found in the Bering Sea. Other species have different distribution patterns, but mainly their geographic ranges are limited by the northern Pacific and only one species is known to have a cosmopolitan distribution.

The recent discovery of new species of hexactinellids in the Bering Sea is indicative of our lack of knowledge about the taxon in this area and gives hope for appearance of new findings and new taxa in future.

Compliance with ethical standards

CONFLICTS OF INTEREST: The authors declare that they have no conflicts of interest.

Supplementary data. The following Tables are available online.

Table 1. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Acanthascus*) *alani* (original and literature data).

Table 2. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Acanthascus*) *profundus* (original and literature data).

Table 3. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Rhabdocalyptus*) *borealis* (original and literature data).

Table 4. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Rhabdocalyptus*) *heteraster* (original and literature data).

Table 5. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Rhabdocalyptus*) *mirabilis* (original and literature data).

Table 6. Measurements (in mm) of corresponding spicules of different types of *Acanthascus* (*Staurocalyptus*) *tylotus* (original and literature data).

Table 7. Measurements (in mm) of corresponding spicules of different types of *Aulosaccus ijimai* (original and literature data).

Table 8. Measurements (in mm) of corresponding spicules of different types of *Bathydorus laniger* (original and literature data).

Table 9. Measurements (in mm) of corresponding spicules of different types of *Bathydorus spinosissimus* (original and literature data).

Table 10. Measurements (in mm) of corresponding spicules of different types of *Bathydorus spinosus* (original and literature data).

Table 11. Measurements (in mm) of corresponding spicules of different types of *Caulophacus* (*Caulophacus*) *elegans*.

Table 12. Measurements (in mm) of corresponding spicules of different types of *C.* (*Caulophacus*) *hyperboreus* (original and literature data).

Table 13. Measurements (in mm) of spicules of different types of *Caulophacus* (*Caulophacus*) *subarcticus* and *C.* (*Caulophacus*) *arcticus* (from Koltun, 1967).

Table 14. Rossellidae from the Bering Sea and adjacent area (Commander and Aleutian Islands), which could be expected in the Bering Sea with high probability.

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