Zootaxa 4571 (1): 001–027
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4571.1.1
http://zoobank.org/urn:lsid:zoobank.org:pub:D1268894-FADE-482B-83F8-FD6B1C2619C1

A revision of the genus *Calcigorgia* (Cnidaria, Octocorallia, Acanthogorgiidae) with the description of three new species

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Abstract

Octocorals of the Acanthogorgiid genus *Calcigorgia* have been examined, from Japan, Sea of Okhotsk, and Bering Sea. The four known species are re-described and scanning electron microscopy (SEM) images of sclerites presented. Three other species are described and depicted, bringing the total number of *Calcigorgia* species to seven. *Calcigorgia simushiri*, Dautova 2018 is synonymized with *C. spiculifera* Broch, 1935. A neotype for *C. spiculifera* has been designated.

Key words: Anthozoa, taxonomy, deep-water octocorals, Japan, Sea of Okhotsk, Bering Sea, new species, subarctic Pacific

Introduction

The genus *Calcigorgia* was established by Broch (1935) and it was known from only a single small specimen of *C. spiculifera* collected from a depth of 150–165 m in the Sea of Okhotsk by the Russian vessel "Ara". *Leptogorgia beringi* Nutting 1912, was transferred to the genus *Stenogorgia* by Kükenthal (1919). Later on the genus *Stenogorgia* was synonymized with *Swiftia* by Deichmann (1936). Finally, the species was transferred to the genus *Calcigorgia* by Bayer (USNM) in his unpublished manuscript we have at our disposal. Because of this manuscript, the database of the USNM (http://collections.nmnh.si.edu/search/iz/) mostly referred to specimens of this species as *Calcigorgia beringi*. *Calcigorgia* has been a Subarctic North Pacific gorgonian genus until Dautova (2007) described *C. japonica* from a fragment from the Sea of Japan and extended the distribution of this genus to the south. Dautova (2007, 2018) compared her new species with *Calcigorgia beringi* (Nutting, 1912) and *C. spiculifera* Broch, 1935 in her publication. The genus was never revised. In order to identify recently collected *Calcigorgia* specimens from Japan we re-examined material of the five known species of that genus, *Calcigorgia beringi* (Nutting, 1912), *C. spiculifera* Broch, 1935, *C. japonica* Dautova, 2007, *C. matua* Dautova, 2018, and *C. simushiri* Dautova, 2018. Dr. Stephen Cairns (USNM) provided us with SEM images of USNM 30044, the holotype of *C. beringi* and informed us about an unpublished manuscript of the late Dr. F.M. Bayer (USNM: National Museum of Natural History, Smithsonian Institution, Washington D.C., USA) in which he proposed a redescription of *Calcigorgia spiculifera* and *C. beringi*, and a new species, *C. gracilis*. On our request Dr. Cairns was so kind to also send us the SEM images of the material used by Bayer for *C. spiculifera* and "*C. gracilis"*, and his unpublished manuscript. ZIN (Museum of the Zoological Institute of the Russian Academy of Sciences St. Petersburg, Russia) *Calcigorgia* material provided us with specimens of *C. japonica* and *C. matua*. As one of the specimens of the recently collected material proved to be Bayers's "*C. gracilis",* we refrain from giving a new name for this new species. A second species, *C. pacifica* **sp. n.**, proved to be the most common *Calcigorgia* species in Japanese waters. A third new species was discovered by the first author during a re-examination of the collection of the USNM, *C. gigantea* **sp. n.** Finally, we synonymize *C. simushiri* Dautova, 2018 with *C. spiculifera* Broch, 1935. Assignment of *Calcigorgia* to the Acanthogorgiidae was considered questionable by Dr. Bayer in his unpublished manuscript but was never challenged (see discusion).

Accepted by L. Watling: 14 Jan. 2019; published: 25 Mar. 2019

Material and methods

Of each specimen a small piece of the distal part of a branch was dissolved in a solution of household bleach (4% hypochlorite) to isolate sclerites. The sclerites were washed with de-mineralised water, dried on a hot plate, mounted on SEM stubs, and coated with Pd/Au for SEM imaging. For this, either a JEOL JSM6490LV scanning electron microscope was operated at high vacuum at 10 kV, or a JEOL JSM6510LA scanning electron microscope with a Quick Carbon Coater SC-701C, SANYU ELECTRON was used. Some of the SEM photographs of *C. beringi*, *C. gracilis* **sp. n.** and *C. spiculifera* were taken by Bayer and his original negative film in USNM was photographed under lightbox (FAS Digi) and then made digitally positive. Terminology used follows Bayer *et al*. (1983). Maps were drawn using QGIS2.18.21(https://www.qgis.org/en/site/) with the data from SRTM30plus (http://topex.uusd.edu/WWW_html/srtm30_plus.html). The coordinate data were estimated by locality name on the label when there were no exact coordinate data.

Abbreviations

AKM	Asako K. Matsumoto collection, Planetary Exploration Research Cen-er (PERC), Chiba Institute of Technology (Chitech), Japan
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
NBC (RMNH)	Naturalis Biodiversity Center, formerly Rijksmuseum van Natuurlijke Historie, Vondellaan 55, P.O. Box 9517, 2300 RA Leiden, The Netherlands
NSMT	National Science Museum Tokyo, Japan
USNM	National Museum of Natural History, Smithsonian Institution, Washington D.C., USA
ZIN	Museum of the Zoological Institute of the Russian Academy of Sciences St. Petersburg, Russia

Key to the species of *Calcigorgia*

1	Polyps with very short clubs (< 0.10 mm)	*C. matua* Dautova, 2018.
-	Polyps with longer clubs (> 0.10 mm)	2
2	Polyp clubs spiny, no double heads.	*C. japonica* Dautova, 2007
-	Polyp clubs poorly developed	3
3	Polyp clubs with tuberculate handles	4
-	Polyp clubs with smooth handles also present	6
4	Coenenchyme with spindles only, no double heads	*C. gigantea* **sp. n.**
-	Coenenchyme with double heads	5
5	Sclerites mostly up to 0.15 mm long, sclerites overall slender and sparsely tuberculate	*C. beringi* (Nutting, 1912)
-	Larger sclerites mostly 0.30 mm long, if shorter then bulky and coarsely tubercu-late	*C. spiculifera* Broch, 1935
6	Both polyps and branches have clubs, those of the branches half the size of those of the polyps	*C. pacifica* **sp. n.**
-	Only polyps have clubs	*C. gracilis* **sp. n.**

Taxonomy

Class ANTHOZOA Ehrenberg, 1831

Subclass OCTOCORALLIA Haeckel, 1866

Order ALCYONACEA Lamouroux, 1812

Family Acanthogorgiidae Gray, 1859

Genus *Calcigorgia* Broch, 1935

Calcigorgia Broch 1935: 22; 1940: 11, 19; Bayer 1981: 920 (in key only).

Diagnosis. Acanthogorgiidae having non-retractile polyps without spine-like sclerites projecting around summit of

polyps; tentacular sclerites are scales or absent; polyp and coenenchymal sclerites in the form of stout tuberculate spindles, occasionally club like, those of polyps not en chevron.

Calcigorgia beringi (Nutting, 1912)

Figures 1a, 2a, 3

Leptogorgia beringi Nutting, 1912: 95 (Alaska, USA).
? *Leptogrgia beringi*; Bielschowsky 1918: 29 (Sagami Bay, Japan).
? *Stenogorgia beringi*; Kükenthal 1919: 918, 1924: 348 (Japan).

Material examined. Holotype USNM 30044, SE of Agattu Island, Aleutian Islands, East Bering Sea, 52°01'N, 174°39'E, 1046 fathoms (1914 m), USFC *Albatross* Northwestern Pacific Expedition sta. 4780, Trawl—Agassiz beam, 8 ft, 7 June 1906, one nearly complete colony; other material examined by Dr. Bayer: USNM 1006240, Great Sitkin Island, Andreanof Islands, Aleutian Islands, East Bering Sea, 52.00°N, 176.642°E, AB01-43, depth 298 m, coll. Slear, J., 13 November 2000, dry; other material: USNM8848, Chica Island, Akutan Pass, Fox Islands, Aleutian Islands, East Bering Sea, U.S. Coast Survey, coll. Dall, William Healey, dry; USNM 100806, Amatignak Island, Delarof Islands, Aleutian Islands, East Bering Sea, 51°N, 179°W (cf. 51°15'26.40"N, 179°06'18.60"W), *R/V* Pacific Knight, cruise 941, haul 161, 18 July 1994; USNM 1004602, Bering Sea, 52°N, 177°W, AB01-45, 26 February 2001, dry; USNM 1006249, Bering Sea, AB01-4, sample #AE114, coll. Slear, J., 4 December 2000, dry; USNM 1006324, SE of Rat Islands, Aleutian Islands, East Bering Sea, 52.231°N, 175.159°E, depth to 182 m, *R/V* Alaska Sea, AB00-38, coll. Palmer, D., 26 January 2000, dry.

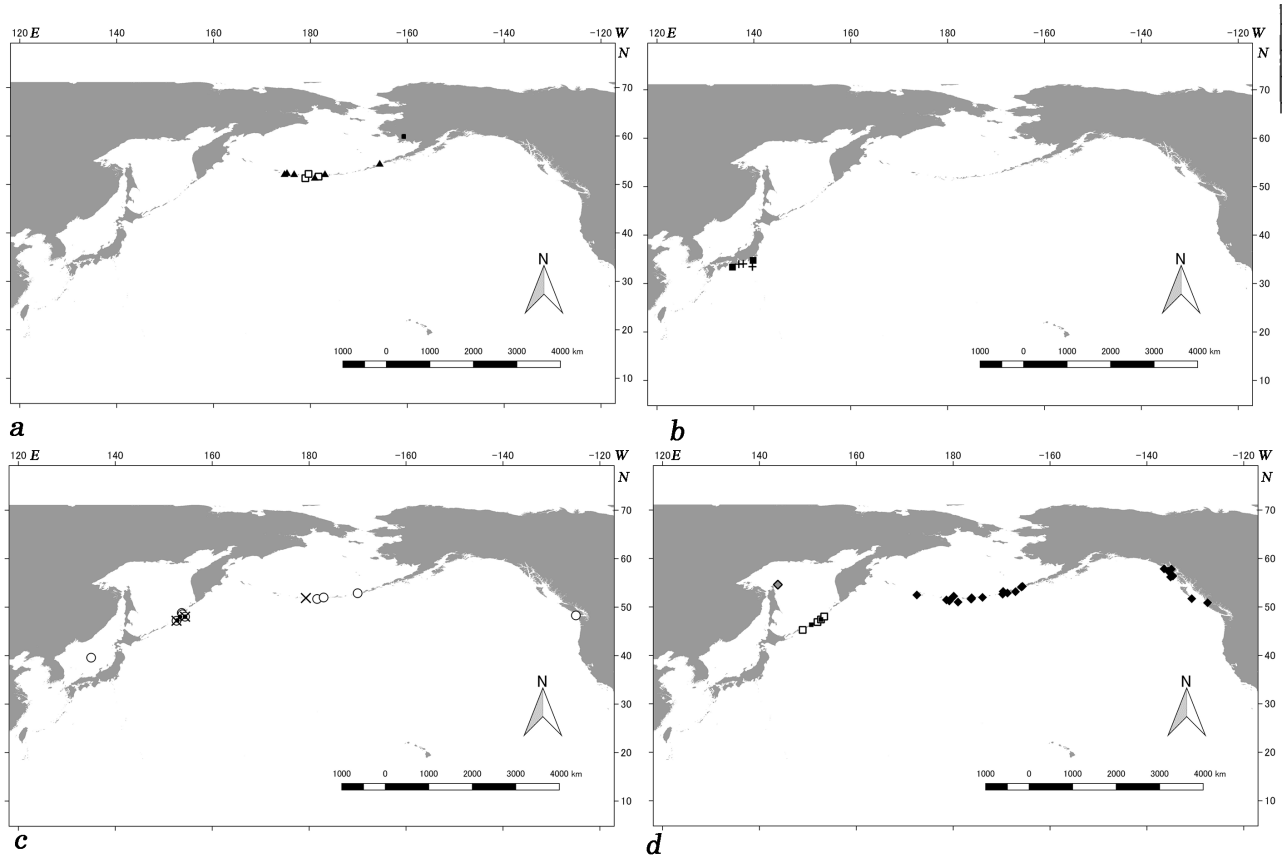

FIGURE 1. Distribution map of *Calcigorgia* species: a. *C. beringi* (▲) and *C. gigantea.* (☐) b. *C. gracilis* **sp. n.**(■) and *C. pacifica* **sp. n.** (+), c. *C. japonica* (○) (including the type locality data from Dautova 2007) and *C. matua* (×) and *C. matua* from Dautova 2018 (●), d. *C. spiculifera* (♦), type locality data from Broch 1935 (♦), *C. simushiri*(= *C. spiculifera*) from Dautova, 2018 (☐), ? *C. spiculifera* in Dautova, 2018 (■).

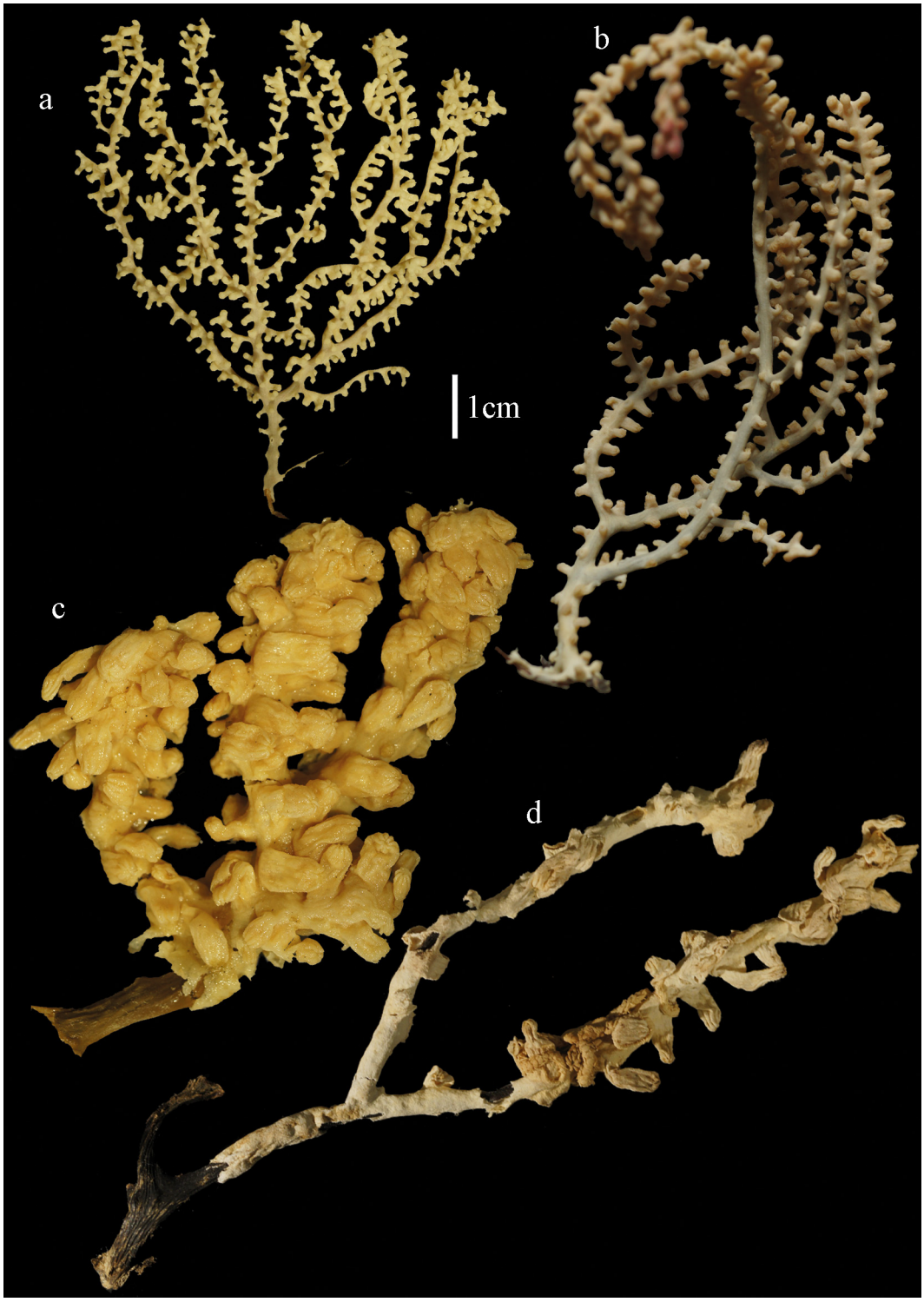

FIGURE 2. **a** *Calcigorgia beringi* (Nutting, 1912), holotype USNM 30044 **b** *C. matua* Dautova 2018, ZIN 11664 **c** *Calcigorgia gigantea* **sp. n.** holotype USNM 1013069 **d** paratype USNM 1004615.

Description (after Nutting and the manuscript of Bayer). The holotype is 7.9 cm long and 7 cm wide (Figure 2a), a holdfast is lacking. The cylindrical polyps are situated all around the branches and are up to 1.75 mm long and 1 mm wide. The infolded tentacles contain small, flattened scales, up to 0.10 mm long, sparsely ornamented with simple, rounded projections (Figure 3a). These extend along the tentacle bases and intergrade with longer, more closely sculptured capstans, belted spindles and cylinders densely filling the polyps and coenenchyme, 0.05–0.15 mm long (Figure 3b). A few poorly developed clubs (Figure 3b top) and crosses (Figure 3c) are also present, with similar size as the spindles and cylinders.

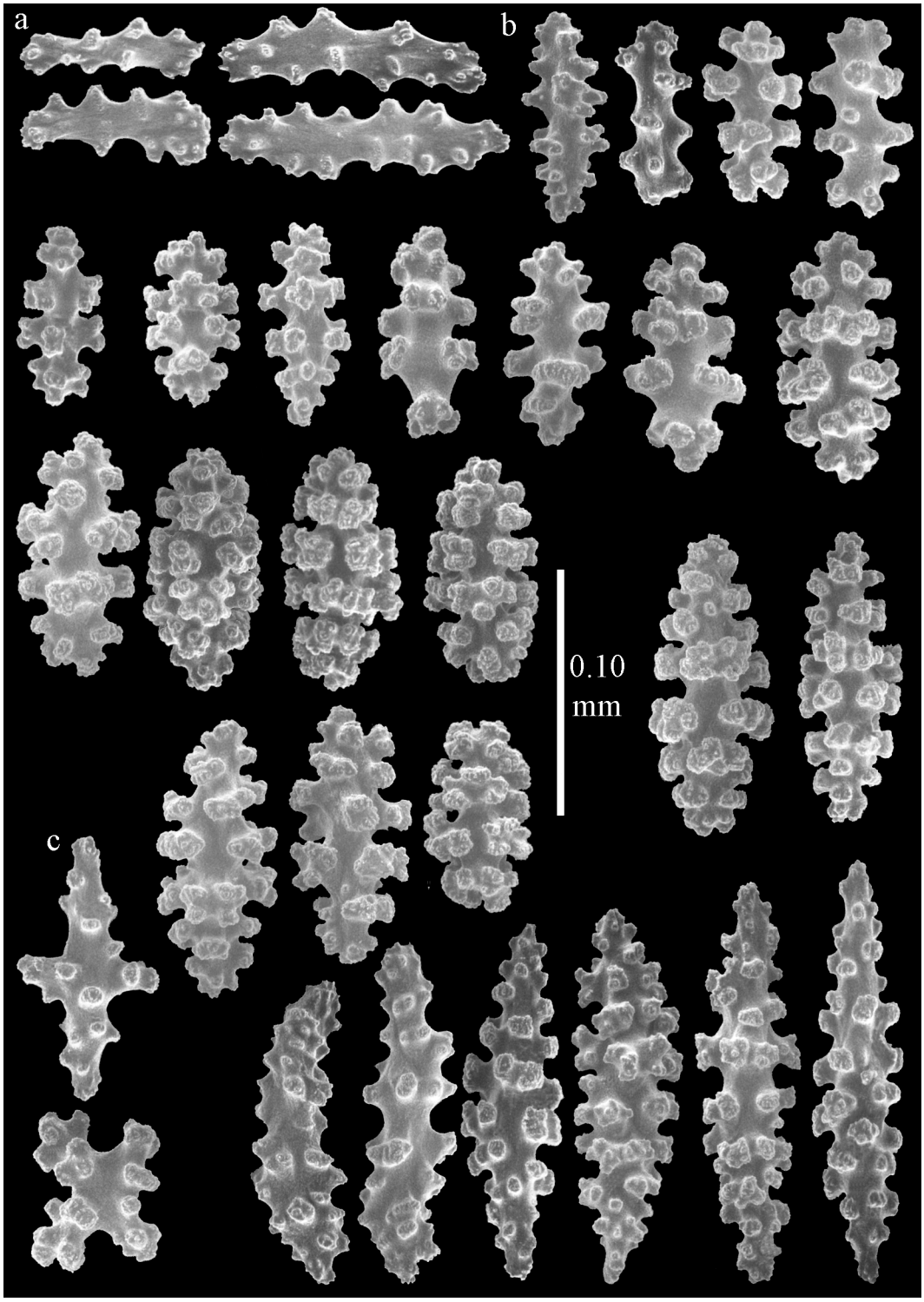

FIGURE 3. *Calcigorgia beringi* (Nutting, 1912), holotype USNM 30044 **a** tentacle scales **b** clubs, capstans, belted spindles and cylinders **c** crosses.

Distribution. Western Aleutian Islands, West Bering Sea. The type locality is actually SE of Agattu Island in the Near Island group of the western Aleutians, in the south edge of West Bering Sea, in 1914 m, rather than in the Bering Sea as stated by Nutting (Figure 1a). The only locality with western longitude, Amatignak Island is the southernmost point of Alaska, as well as the westernmost longitude of Alaska, located in the West Bering Sea.

Remarks (partly after the manuscript of Bayer). Nutting's original description and photograph of the colony adequately show the appearance of the preserved colony, but a new photograph is presented (Figure 2a) for

comparison with the other species considered here. Nutting's description and illustration of the sclerites do not adequately characterize the species, and apparently misled Kükenthal (1924: 348), who wrote that the tubercles of the sclerites "in unregelmäßigen Gürteln stehen" (placed in irregular whorls). Nutting was misled by the resemblance of its regularly belted spindles, which resemble the sclerites of many gorgonians. He observed (1912: 96) that it "has longer and more prominent calyces than any other species of the genus" but did not notice that the polyps are not retractile as always is the case in gorgoniids. It is not clear whether the material from Japan identified by Bielschowsky (1918) and Kükenthal (1919) really is this species; it was not examined by us. Although Kükenthal (1919, 1924) was correct in removing *Leptogorgia beringi* from the genus *Leptogorgia*, his assignment of the species to *Stenogorgia* (= *Swiftia*) is untenable because the polyps of that genus are more or less completely retractile within distinct calyces owing to the presence of a neck-zone nearly or completely devoid of sclerites.

The original description of Nutting (1912) and later re-description of Bayer did not mention the presence of clubs in the polyps, which are however present in the type material, though poorly developed and in low numbers (Figure 4d).

Calcigorgia gigantea sp. n.

Figures 1a, 2c–d, 4–5

http://zoobank.org/7050EC0C-7AE5-439C-AE76-3997997ABEFC

Material examined. Holotype, USNM 1013069, Tanaga Pass west of Tanaga Island, Andreanof Islands, Aleutian Islands, Bering Sea, 51°N 137.64'N 178°19.2'W, depth 375 m, bottom temp. 4 °C, F/V Pacific Knight, cruise 94-1, haul 121, 5 July, 1994 (Figure 2c); paratypes USNM 1004615 Amchitka Pass, Rat Islands, Aleutian Islands, 51.2885°N 178.947°E, depth 347–391 m, field number AB01-65, coll. McCluskey, P. (Figure 2d); USNM 1010177, Semisopochnoi Island, Rat Islands, Aleutian Islands, West Bering Sea, 52.1756°N 179.608°E, depth 128–135 m, R/V Dominator, st. 135, 24 June 2000.

Description. The holotype is 7 cm wide and 10 cm high (Figure 2c). The stem is 2 cm long and about 6 mm wide. The polyps are about 9–10 mm high and 5–6 mm wide. Tentacles without sclerites. Polyps with poorly developed clubs (Figure 4a), up to 0.60 mm long and spindles up to 0.90 mm long (Figure 4b–c); all with simple tubercles. The coenenchyme with smaller spindles, 0.20–0.50 mm long, with more developed tubercles (Figure 4c).

Etymology. From the Latin *gigantea*, giant or very large, referring to the large polyps and sclerites

Colour. The preserved holotype is white, all sclerites are colorless.

Distribution. Aleutian Islands, both East and West Bering Sea in 128–391 m (Figure 1a).

Remarks. The colony of USNM1004615 is rather slender and has smaller polyps than the holotype (Figure 2d) but its polyp sclerites (Figure 5a–b) are very much like those of the holotype. The coenenchyme has smaller spindles, up to 0.20 mm long, and some capstans (Figure 5c). *Calcigorgia gigantea* **sp. n.** is unique in the genus by its large polyps and sclerites.

Calcigorgia gracilis sp. n.

Figures 1b, 6a–c, 7–8

http://zoobank.org/0433555C-8C5E-40A8-8B5F-3C9306A86EC5

Acanthogorgiidae sp. Takahashi *et al*. 2016: 32 (Nojima Submarine Canyon, Japan).

Material examined. Holotype USNM 60280, Shio Misaki Light N75°E, 9.6 mi, Japan, 33°23'30"N, 135°34'E, 1188 m, *U.S.F.C. str. Albatross* sta. 4971, 27 August 1906, SEM 2537, 2538 of Bayer; other material: JAMSTEC No.1120034415, Nojima canyon branch, So-O Trough, Sagami Trough, off Boso, Japan, 34°46'42.60"N, 139°50'18.66"E, 1497m, dive HPD# 1426, B05, R/V *Natsushima*, NT12-22, coll. R. Mimori, 23 August 2012.

Description (modified after the manuscript of Bayer). The holotype is 4 cm wide and 5.2 cm high, 8 cm if the extremely flexible main branch is fully stretched out (Figure 6a). The stem is 1.5 cm long and about 1 mm wide. The colony is sparsely branched in an openly pinnate manner, not strictly in one plane. Six lateral branches arise from the primary axis in alternating sequence, the lowest three of these giving rise in turn to shorter twigs. The principal axis

extends about 5.5 cm beyond the uppermost lateral branch. Regular lateral branching forms the colony, with branches thread-like, less than a mm wide. The brown axis is visible through the thin coenenchyme. The denuded axis of the main trunk is about 0.6 mm in diameter roughly 5 mm above the base; the extremely slender branches taper little if at all distally, being about 0.35–0.4 mm in diameter throughout. The non-retractile polyps are arranged spirally around the branches, they form cylindrical polyps 1.75 mm high and 0.75–0.8 mm in diameter with tentacles folded in over the mouth; they are distantly spaced, sometimes alternate, sometime opposite or nearly so, in most cases two opposite polyps at the summit of each terminal twig. Tentacles with scales, up to 0.12 mm long, with a few simple tubercles (Figure 7a). These intergrade proximally with the sclerites of the body wall of the polyp, which include slender tuberculate spindles and club-like sclerites up to 0.3 mm long (Figure 7b). The clubs with less tuberculate to smooth handles. Coenenchyme with capstans, small spindles and cylinders, up to 0.12 mm long, with simple or complex tubercles (Figure 7c). A few crosses are also present (Figure 7d).

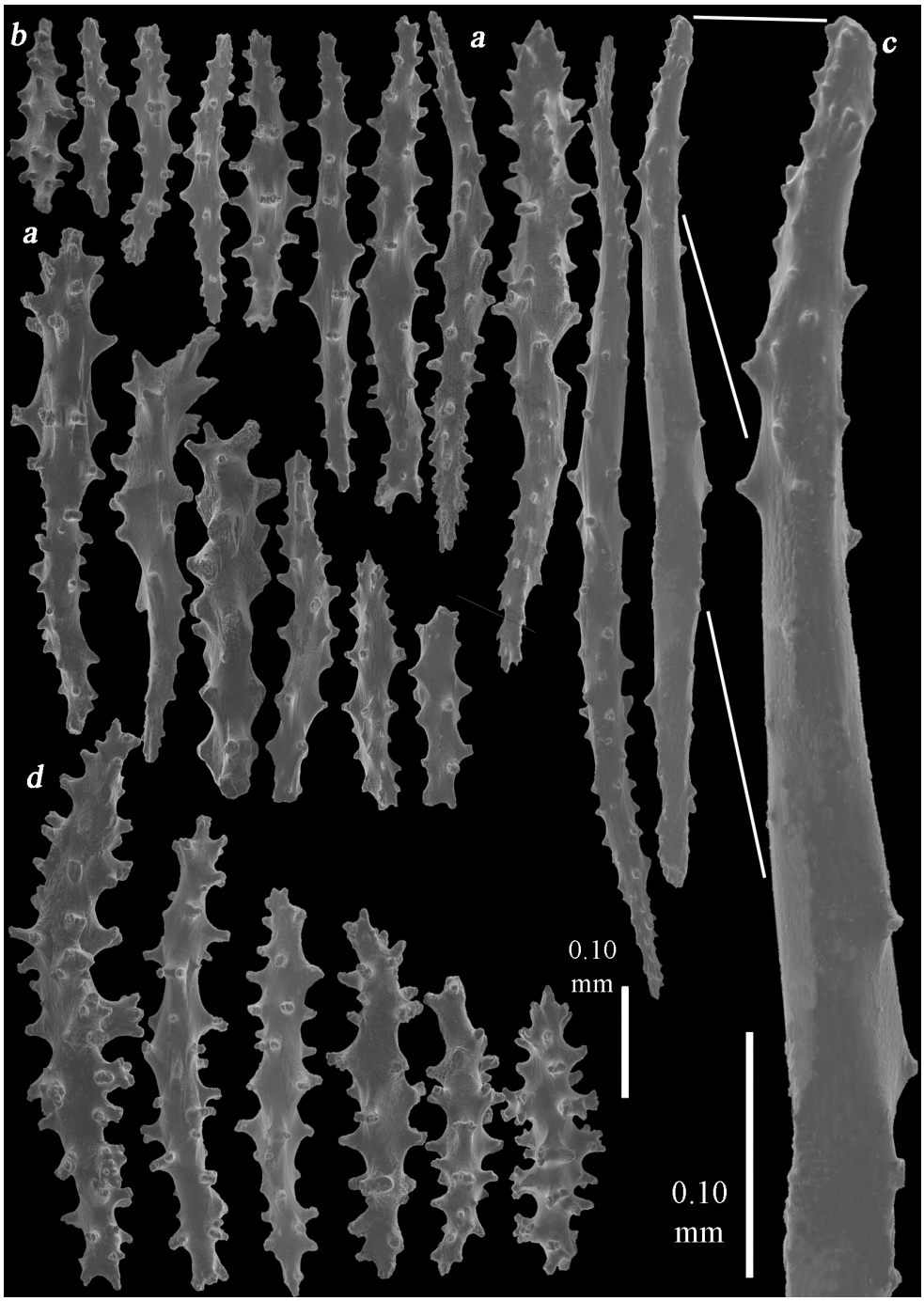

FIGURE 4. *Calcigorgia gigantea* **sp. n.** holotype USNM1013069 **a**, four club-like sclerites of polyps; **b–c** spindles of polyps; **d** spindles of coenenchyme.

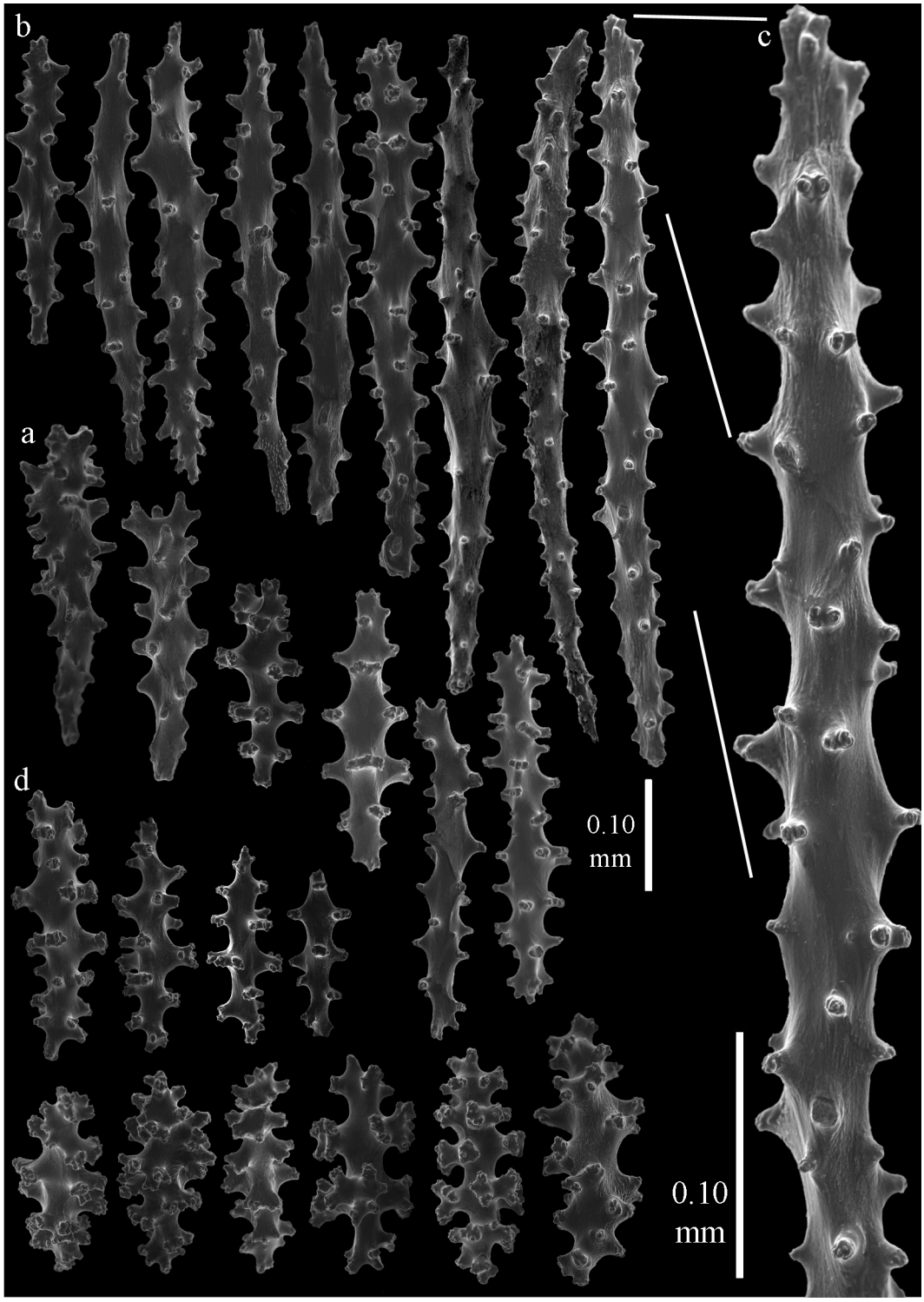

FIGURE 5. *Calcigorgia gigantea* **sp. n.** paratype USNM1004615 **a**, three club-like sclerites of polyps; **b–c** spindles of polyps; **d** spindles of coenenchyme.

Colour. The preserved holotype is white, and all sclerites are colorless. The colony in situ is pink (Figure 6c).

Etymology. From the Latin *gracilis*, slender, referring to the colony shape with its slender branches, following Bayer's manuscript.

Distribution. Pacific side of Japan mainland: off Boso peninsula, Shio Misaki in 1188–1497 m (Figure 1b).

Variability. The holotype has somewhat less developed sclerites than the other material (Figure 8), polyp spindles with two smooth ends and clubs with a smooth handle. It also shows some crosses (Figure 7d) not

observed in the other examined material. The size of polyps of the other material is larger, about 1.5 mm high and 1 mm wide.

Comparisons. When first examined superficially, this specimen was identified as *C. beringi* owing to its slender colonial form contrasting with the coarser aspect of *C. spiculifera*, and to its deep-water habitat. However, the growth form is even more delicate and the branches more slender and flexible than in *C. beringi*, which lacks the slender clubs of the polyp walls, so it clearly cannot be accommodated in that species as defined by its original type material, which is now fully illustrated by SEM for the first time.

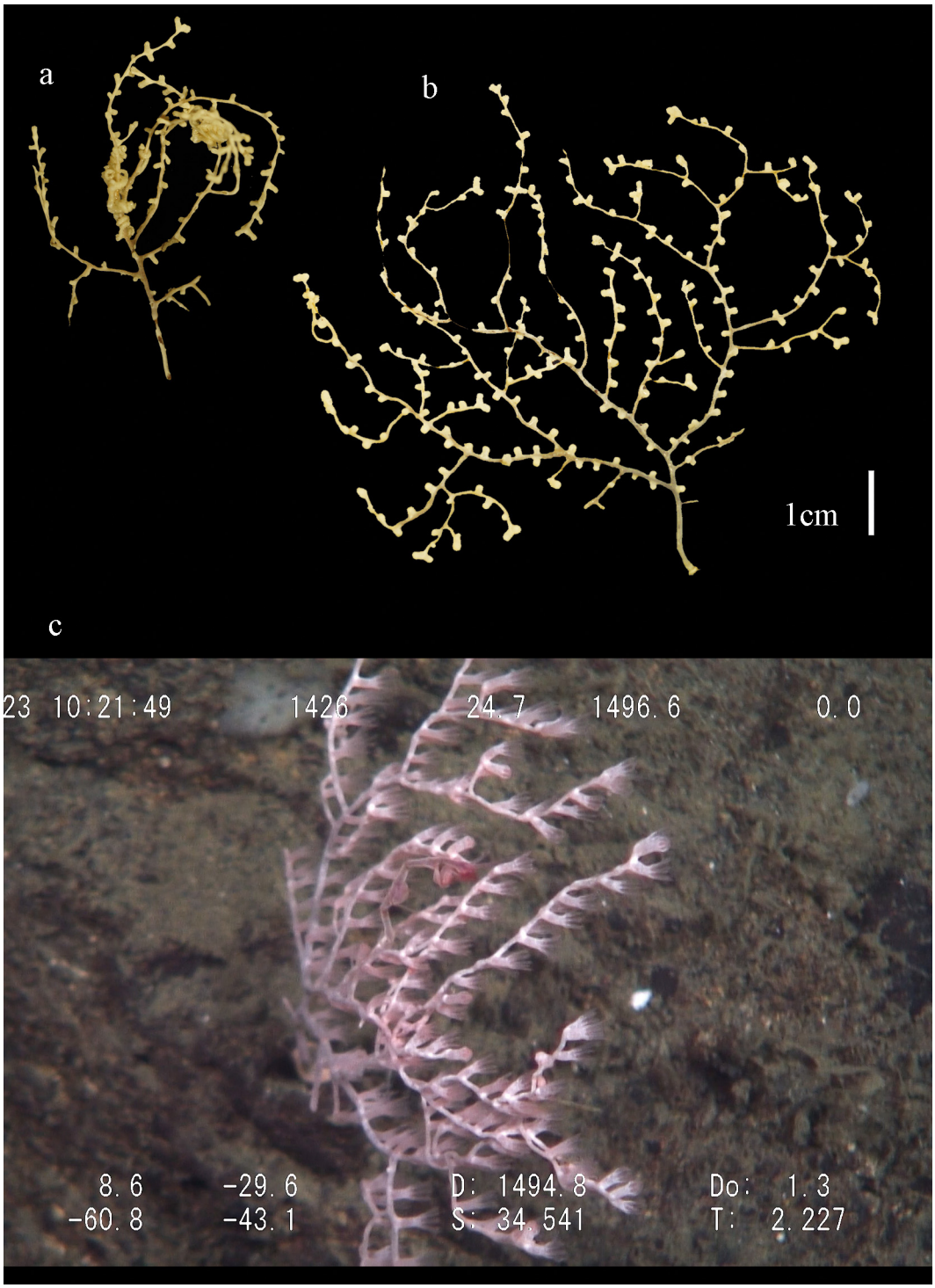

FIGURE 6. a. *Calcigorgia gracilis* **sp. n.**, holotype USNM 60280. **b.** *C. gracilis* **sp. n.** JAMSTEC No.1120034415 **c** *C. gracilis* **sp. n.** live images (JAMSTEC No.1120034415 , depth 1497 m, dive HPD# 1426)

The robust colonial form, crowded polyps, and larger polyps immediately distinguish *C. spiculifera* from *C. gracilis* as well as from *C. beringi*. Moreover, neither of those species has slender clubs of the type characteristic for *C. gracilis*.

Commensals. Two of the lateral branches of holotype each bear a small ophiuroid tightly entwined around it.

Remarks. The other examined material is the specimen mentioned by Takahashi *et al* as Acanthogorgiidae sp. When viewed with standerd illumination under the traditional stereomicroscope, the polyps of *C. gracilis* have a distinctly rough, even prickly aspect, owing to the spindles and slender clubs of the body wall.

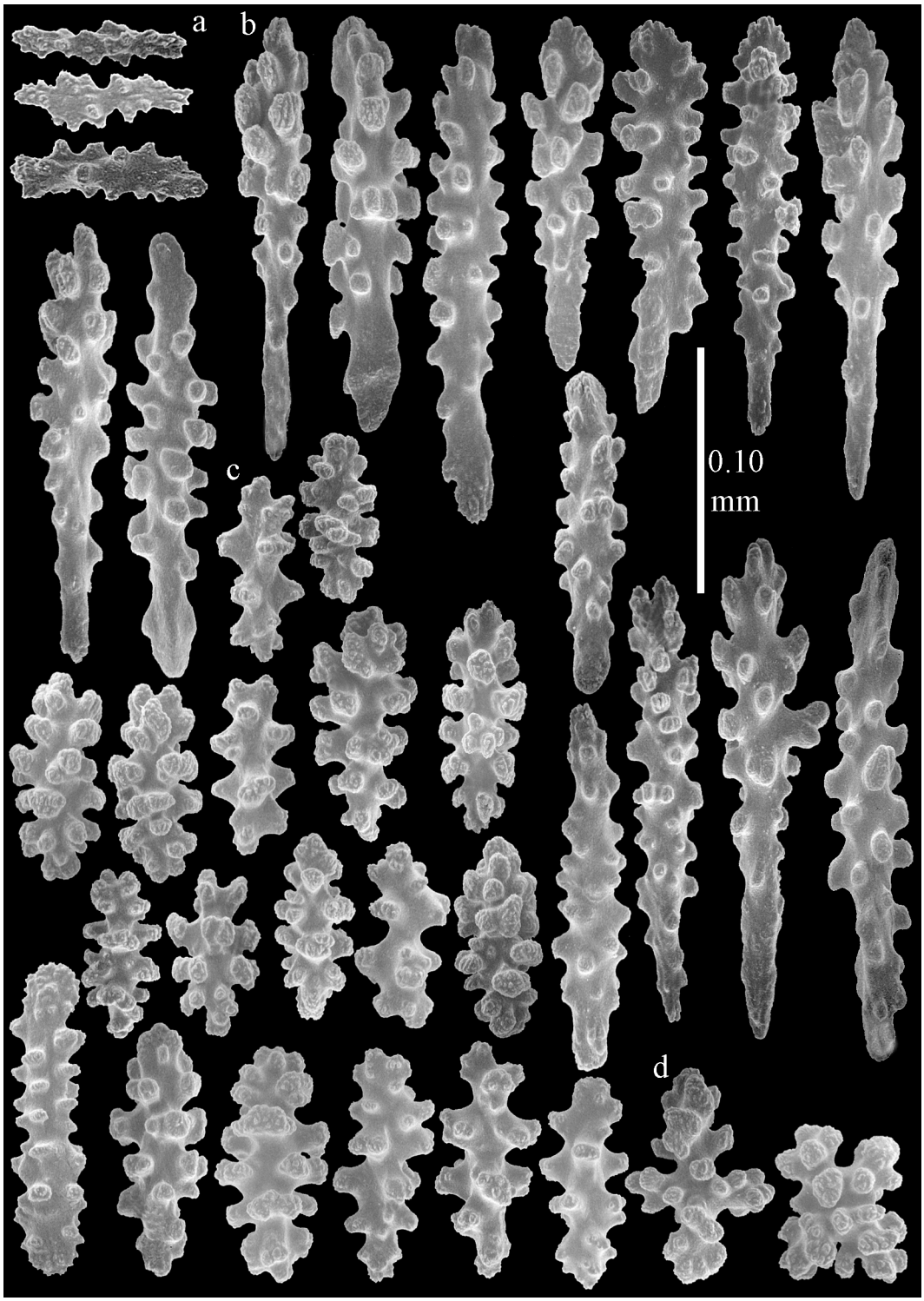

FIGURE 7. *Calcigorgia gracilis* **sp. n.**, holotype USNM 60280, **a** tentacle scales **b** clubs **c** capstans, spindles and cylinders **d** crosses.

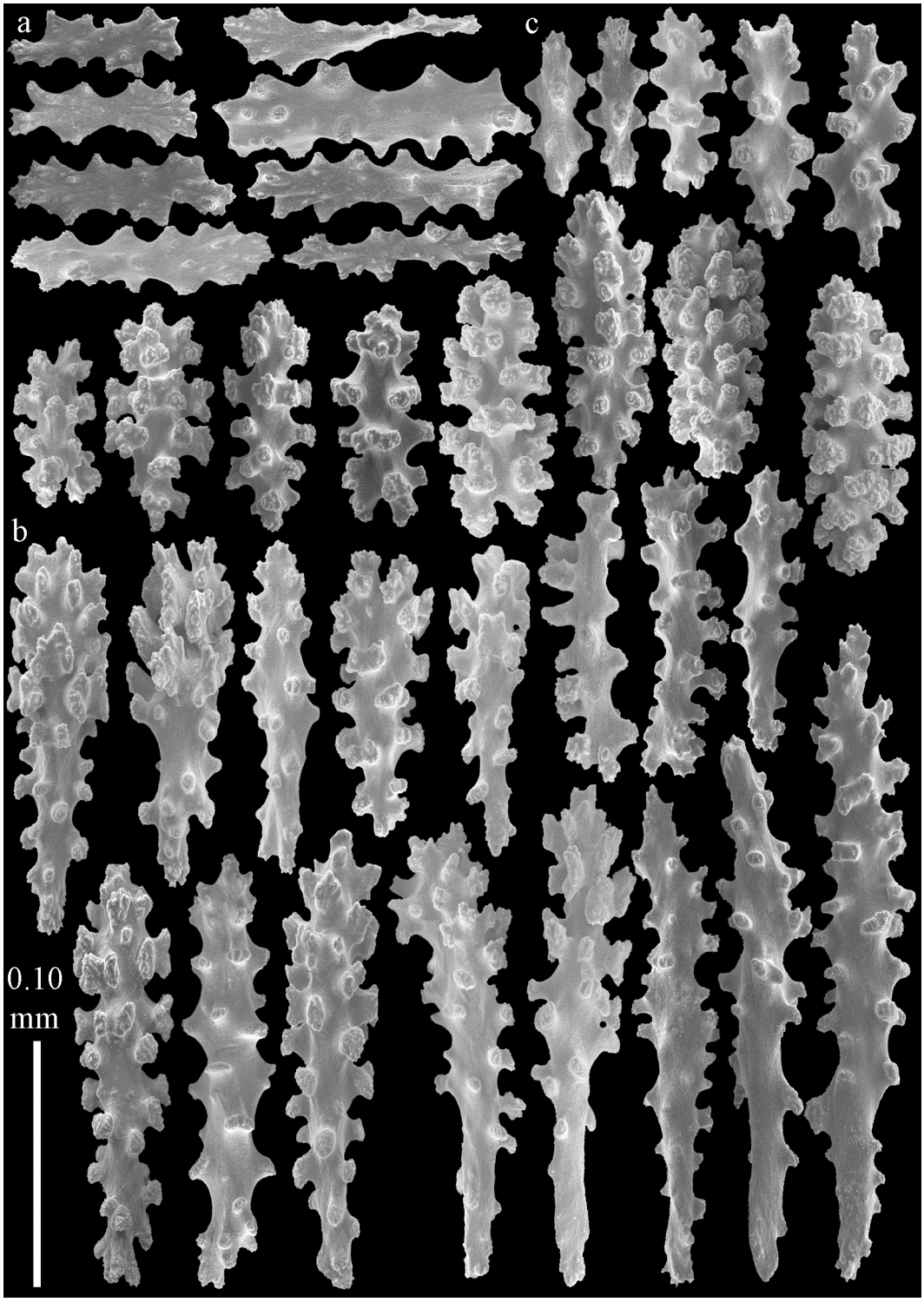

FIGURE 8. *Calcigorgia gracilis* **sp. n.**, JAMSTEC No.1120034415 **a** tentacle scales **b** clubs **c** capstans, spindles and cylinders.

Calcigorgia japonica **Dautova, 2007**

Figures 1c, 9ab, 10–12

Calcigorgia japonica Dautova, 2007: 302 (39°35'N, 135°01'E, Sea of Japan, 832–736 m deep, silted sand, 8 August 1933, coll. K.M. Deryugin); 2018: 11.

Material examined. ZIN 11678, Skaly Lovushki I., Sea of Okhotsk, "Novoulyanovsk", fishery bottom trawl №79 (maybe = Ottertrawl), bottom: unknown (trawl has been torn to pieces; all animals were collected from warps), coll. Alexander Ereskovsky, 4 October 1984; ZIN 11661, Ketoi I., Sea of Okhotsk, 47°12'8N 152°38'1E, depth 900 m, bottom: pebbles, Ship "Odissey" Cruise 34, St. 27, small dredge, coll. Mikhail Kolesnikov and Vyacheslav Bizikov, 10 January 1985; ZIN 11662, Skaly Lovushki I., Sea of Okhotsk, 48°02'17N 154°24'05 E, depth 580 m, bottom: stones, gravel, ship "Odissey" st. 18, small dredge, coll. Boris Sirenko and Mikhail Kolesnikov, 3 August 1984; ZIN 11675, Skaly Lovushki I., Sea of Okhotsk, 48°48'54N 153°43'00E, depth 800–1000 m, "Novoulyanovsk", fishery bottom trawl №79 (maybe = Ottertrawl), bottom: unknown (trawl has been torn to pieces; all animals were collected from warps), coll. Sergey Grebelnyi and Alexander Ereskovsky, 4 October 1984; USNM 100816 N of Four Mountains, Aleutian Islands, Bering Sea, 52°52.69'N 169°58.78'W, depth 62 m, bottom temp. 4.5 °C, R/V Vesteraalen cruise 94-1, haul 40, 11 June 1994, three nearly complete colonies; USNM 1004642 Bering Sea, 52°N 177°W, field number AB01-66; USNM 1006154 east of the Delray Islands, Aleutian Islands, Bering Sea, 51.6962°N 178.342°W, depth 280 m, R/V Spirit of the North, field number AB01-64, sample #16, coll. Renfro, K., 3 March 2000, one nearly complete colony; USNM1116869 British Colombia, Canada, North Pacific Ocean, 48.3007°N 124.935°W, depth 227.9 m, Deep Sea Coral and Sponge Habitat Expedition, cruise 958, st. 132, ROV Ropos, 1 June 2006.

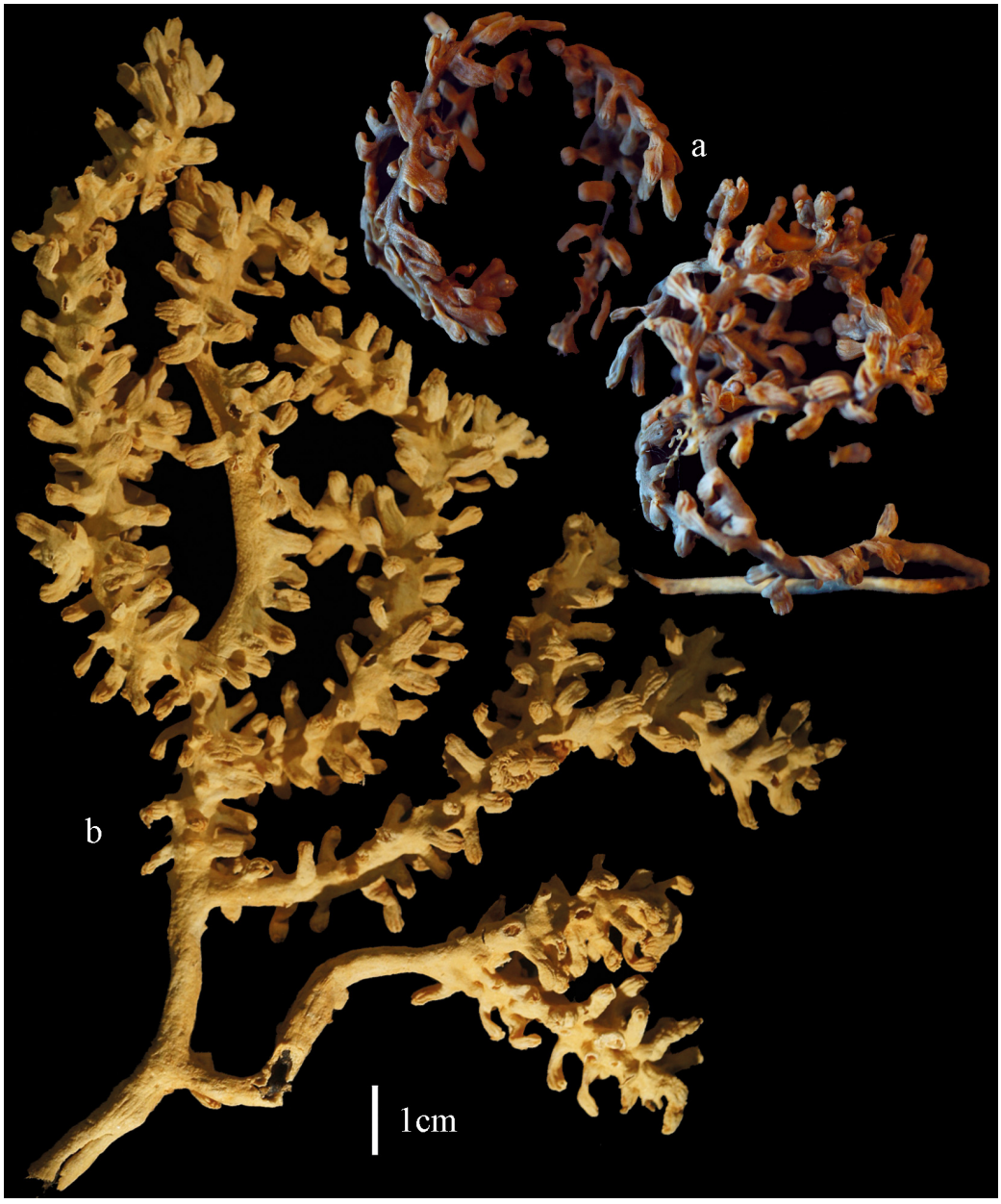

FIGURE 9. a *Calcigorgia japonica* Dautova, 2007, ZIN11678 **b** USNM1116869.

Description. ZIN 11678 are two fragments of a colony (Figure 9a). The polyps are arranged spirally around the branches, they are about 5 mm high and 2 mm wide. Tentacles without sclerites. Polyps with spindles and clubs, up to 0.35 mm long, with simple tubercles (Figure 10a). The clubs with very spiny heads. The coenenchyme with capstans, small spindles and crosses, up to 0.12 mm long, with simple tubercles (Figure 10b–c).

Colour. The fragments are brown and the sclerites are colorless.

Distribution. Sea of Japan in 832–736 m, Sea of Okhotsk in 580–1000 m, Bering Sea -280 m, West coast of North-American continent, NE Pacific in 227.9 m (Figure 1c).

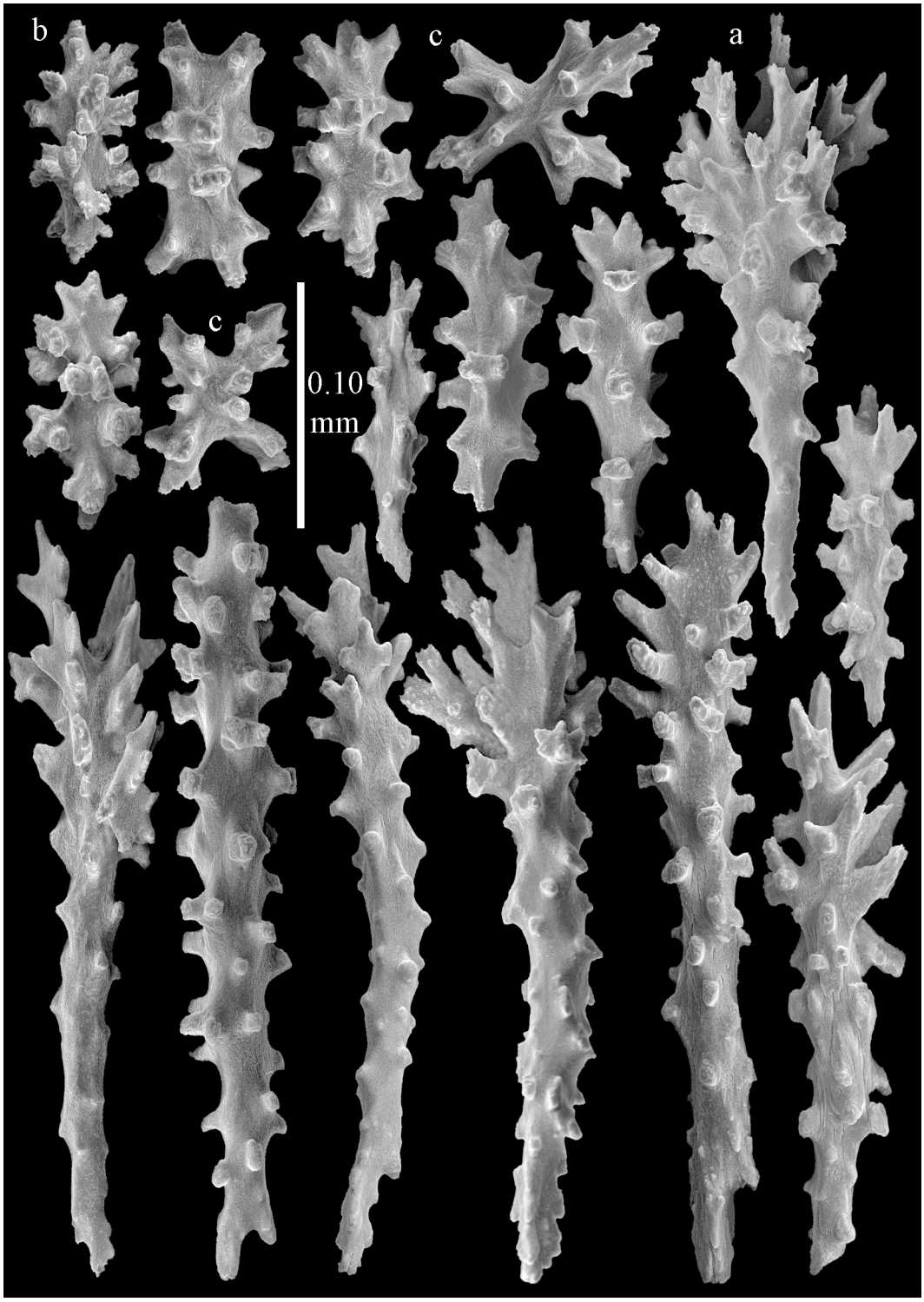

FIGURE 10. *Calcigorgia japonica* Dautova, 2007, ZIN 11678 **a** clubs **b** capstans and spindles **c** crosses.

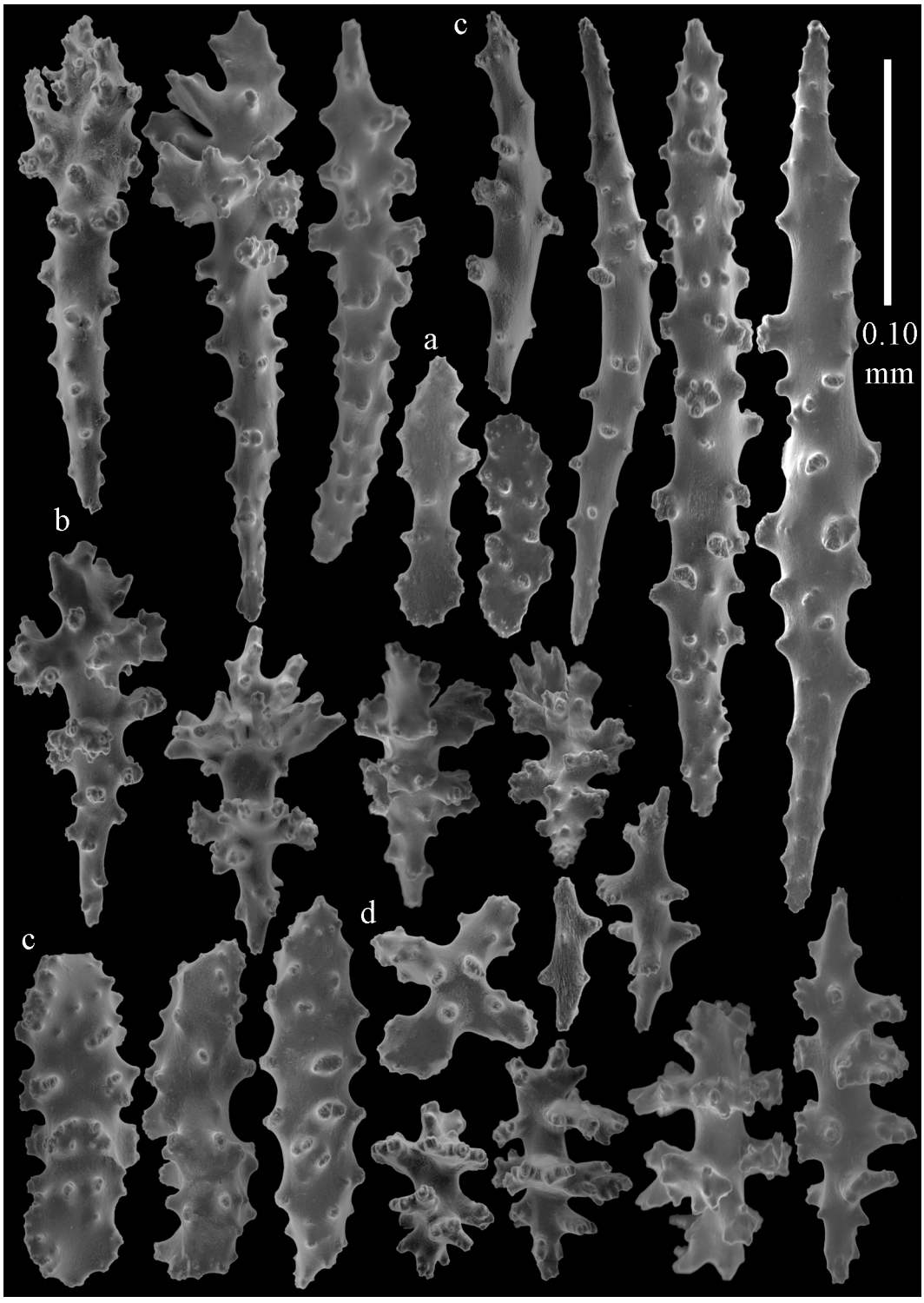

FIGURE 11 *Calcigorgia japonica* Dautova, 2007, USNM 1116869 **a** flattened rods **b** clubs of polyps **c** spindles and flattened spindles of polyps and coenenchyme **d** cross.

Remarks. The long spiny clubs of the polyps of this species are unique in the genus *Calcigorgia*. USNM 1116869, the only examined material from the NE Pacific, has well developed more foliate clubs (Figure 11b), the other sclerites are typical *C. japonica* except for some flattened rods and spindles (Figure 11a, c). USNM 100816 has immature clubs (Figure 12a) and most of the sclerites are larger than in the other specimens (Figure 12).

Specimens of *C. japonica*, previously known from only a single fragment, from the Sea of Japan (Dautova, 2007), from four localities of Sea of Okhotsk, with depth range 580–1000 m, two localities in Bering Sea, up to 280 m deep, and one locality on the west coast of the North-American continent, in 227.9 m, extend the distribution range of the species.

We here present the nearly complete colony of USNM1006154 from the West Bering Sea (Figure 9b).

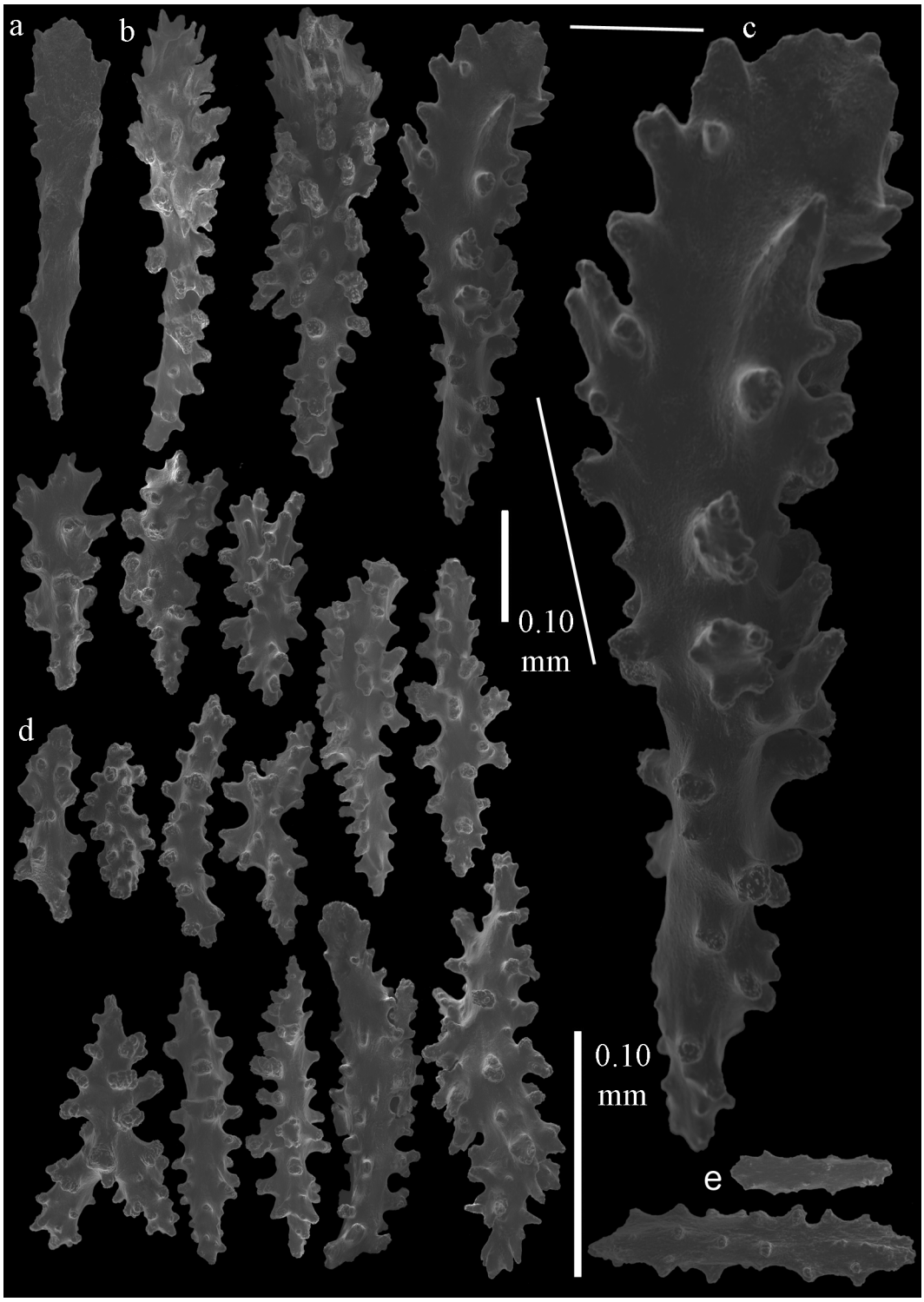

FIGURE 12. *Calcigorgia japonica* Dautova, 2007, USNM 100816 **a** immature club of polyps **b** clubs of polyps **c** club of polyp **d** spindles and tripoids of polyps and coenenchyme **e** immature spindles of coenenchyme; **c**, **e** same scale.

***Calcigorgia matua* Dautova, 2018**
Figures 1c, 2b, 13

Calcigorgia matua Dautova, 2018: 3(48°01'N, 153°22.03'E, east of Matua Is., 300 m dredged, 20 August 1987, coll. S. Grebelnyi leg.).

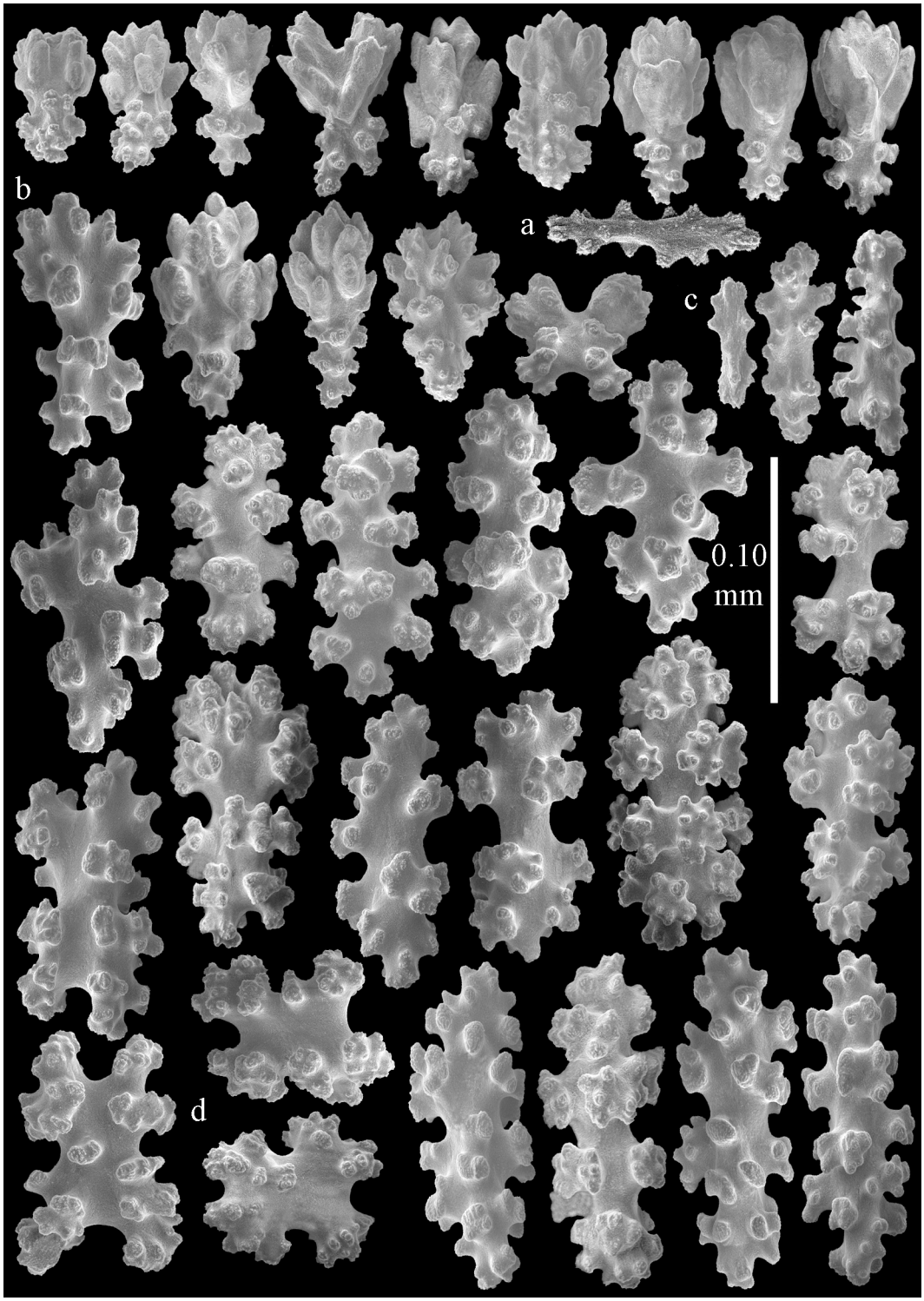

FIGURE 13. *Calcigorgia matua* Dautova, 2018 ZIN11664 **a** tentacle scale **b** five clubs **c** capstans, spindles and cylinders **d** crosses.

Material examined. ZIN 11664, Skaly Lovushki I., Sea of Okhotsk, 48°02'17N 154°24'05E, depth 580 m, bottom: sand with gravel, ship "*Odissey*" Cruise, small dredge, coll. Boris Sirenko, 3 August 1984; ZIN 11659, Ketoi I.,

Sea of Okhotsk, 47°12'8N 152°38'1E, depth 900 m, bottom: pebbles, ship "*Odissey*" Cruise 34, St. 27, small dredge, coll. Mikhail Kolesnikov and Vyacheslav Bizikov, 10 January 1985; ZIN 11665, Skaly Lovushki I., Sea of Okhotsk, 48°02'17N 154°24'05E, depth 580 m, bottom: stones, gravel, ship "*Odissey*" st. 18, small dredge, coll. Boris Sirenko and Mikhail Kokesnikov, 3 August1984; ZIN11670, same data as ZIN 11665; USNM 1006226, Semisopochnoi Island, Rat Islands, Aleutian Islands, West Bering Sea, 51.8925°N 179.336°E, coll. Slear, J., 21 November 2000.

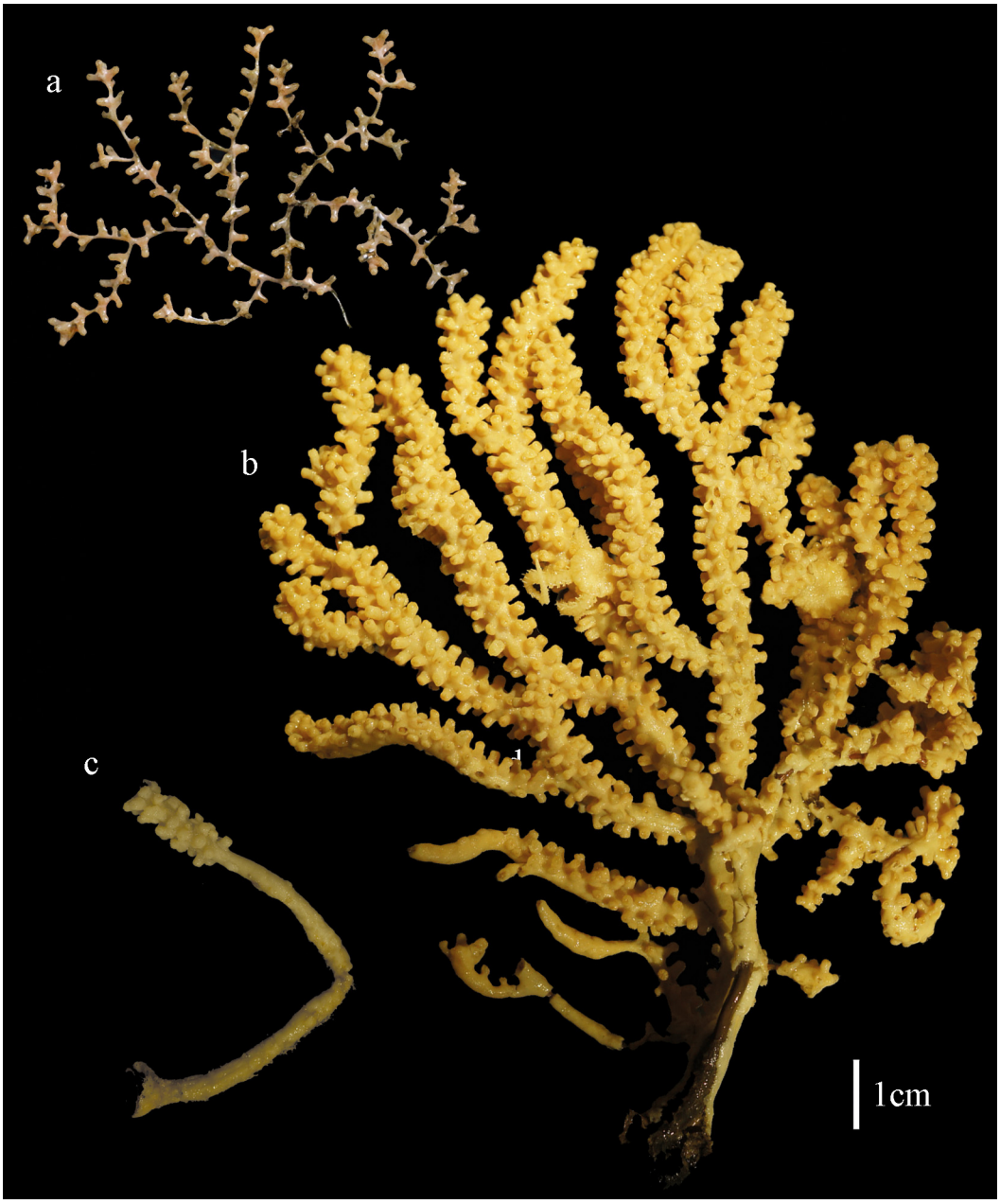

FIGURE 14. *Calcigorgia pacifica* **sp. n.**, **a.** holotype RMNH Coel. 42108 **b.** *Calcigorgia spiculifera* Broch, 1935, neotype USNM 1012500 **c**. *C. spiculifera* small colony, USNM133587.

Description. ZIN 11664 is 10 cm high and 5 cm wide (Figure 2b). The stem is 1.5 cm long and about 3 mm wide. Regular lateral branching forms the colony, with branches 2 mm wide. The cylindrical polyps are arranged spirally around the branches, they are about 2–3 mm high and 1 mm wide. Tentacles with scales, up to 0.12 mm long, with a few simple tubercles (Figure 13a). Polyps with small clubs, up to 0.10 mm long, with simple tubercles (Figure 13b). Coenenchyme with capstans, small spindles and cylinders, up to 0.12 mm long, with simple or complex tubercles (Figure 13c). A few crosses are also present (Figure 13d).

Distribution. Sea of Okhotsk in 300 (Dautova 2018)—900 m; West of Bering Sea (western Aleutian Islands) (Figure 1c).

Remarks. *Calcigorgia matua* mostly resembles *C. beringi* **sp. n.** but has very short distinct clubs in the polyps which are lacking in *C. beringi.* Their distribution overlap in the West Bering Sea, but *C. matua* also occurs in the Sea of Okhotsk while *C. beringi* is only recorded from the western Aleutian Islands.

Calcigorgia pacifica sp. n.

Figures 1b, 14a, 15

http://zoobank.org/BF134333-A7B7-497A-8740-5B82E34AFB89

Material examined. Holotype RMNH Coel. 42108 (AKM959-1), Shima Spur, 34°00.72'N, 136°53.28'E, depth 789–781 m, R/V Tansei-maru, KT08-3 cruise, 4 March 2008; paratypes: RMNH Coel. 42109 (AKM959-2), same data as holotype; RMNH Coel. 42143 (AKM310), Sagami Bay, 33°28.6N–33°28.9N, 139°41.6E–139°41.4E, depth 445–547 m, R/V Shinyo-maru, KS03, St. 22, coll. A.K. Matsumoto, 21 October, 2003. RMNH Coel. 42144 (AKM319), Sagami Bay, 33°28.8N–33°29.5N, 139°42.7E–139°42.6E, depth 512–600m, R/V Shinyo-maru, KS03, St. 25, coll. A.K. Matsumoto, 21 October, 2003; other material: NSMT-Co1431, 2nd Tenryu Sea Knoll, 34°03.819'N, 137°47.789'E, depth 692 m, dive 2K#1377, 8 August 2002 (fragment of JAMSTEC No. 52548).

Description. The holotype is 6.5 cm wide and 4.5 cm high (Figure 14a). The stem is 1 cm long and about 1 mm wide; the holdfast is missing. Regular, lateral branching forms the colony, with branches thread-like, less than a mm wide. The brown axis is visible through the thin coenenchyme. The polyps are arranged spirally around the branches, they are about two mm high and one mm wide. Tentacles with a few scales, up to 0.05 mm long, with a few simple tubercles (Figure 15a). Polyps with spindles (Figure 15b) and clubs (Figure 15c), up to 0.20 mm long, with simple tubercles. Coenenchyme with capstans, small spindles (Figure 15d) and small clubs (Figure 15e), 0.05–0.10 mm long, with simple tubercles.

Colour. Brownish. Live colour of polyps and tissue pink.

Etymology. Named after the Pacific Ocean because all specimens were found along the Pacific coast of Japan.

Distribution. Pacific side of Japan: Shima Spur, Tenryu Sea Knoll in 445–789 m (Figure 1b).

Remarks. The species mostly resembles *Calcigorgia gracilis* **sp. n.** but the latter species lacks smaller clubs in the coenenchyme of the branches.

Calcigorgia spiculifera Broch, 1935

Figures 1d, 14b–c, 16–20

Calcigorgia spiculifera Broch, 1935: 22; 1940: 11.(54°36'N, 143°48'E, Sea of Okhotsk, 165 m deep, «Ara» Trawl 27-1, Silty sand, Otter trawl, 8–9 Sep.1932, collector: P. Yu. Shmidt)

Calcigorgia spiculifera; Sanchez and Cairns 2004: 270.

Calcigorgia simushiri, Dautova 2018: 9. (46°46'41"N, 151°55'23"E, East of Simushir I., Sea of Okhotsk, 200 m deep, "Tikhookeansky", deredged, 16 Aug. 1987, S. Grebelnyi leg.)

? *Calcigorgia spiculifera*, Dautova 2018: 11. (47°25'N, 152°42'E, Rikord Strait, Sea of Okhotsk, 440 m deep, RV"Oparin", trawled, 1 Jul.1988, coll. Gruzov)

Material examined. Identified as *C. spiculifera* by Bayer: USNM 1012500; neotype, NE of Islands of Four Mountains, Aleutian Islands, Bering Sea: 53°11.67'N 169°41.07'W, depth 431 m, bottom temp, 3.6°C, F/N Vesteraalen cruise 94-1, haul 44, 11 June 1994, one nearly complete colony, (USNM-SEM Stub 2539); USNM 8849, Gull Island, Akutan Pass, Fox Islands, Aleutian Islands, East Bering Sea, U.S. Coast Survey, coll. Dall, William Healey, dry; USNM 75091, Queen Charlotte Strait, Near N End Of Vancouver Island, British Columbia, 50.87°N, 127.47°W, depth 30 to 50 m, scuba, coll. McDaniel, N. 1983; USNM 82124, South of Umnak Island, Fox Islands, Aleutian Islands, Bering Sea, 52.8761°N, 168.795°W, depth 86 m, *R/V* Miller Freeman cruise802,VH-80-30, 5 August 1980; USNM 100735, Tanaga Pass, between Ulak and Ilak I, Andreanof Islands, Aleutian Islands, Bering Sea, 51°26.98'N, 178°36.6'E, depth 393 m, bottom temp. 3.7°C, *R/V* Pacific Knight, cruise 94-1, haul 161, 18 July 1994; USNM 100805, Aleutian Islands, Near Islands, SW of Attu I., Bering Sea, 52.28°N, 172.30°W, depth 234 m, *R/V* Starlight, 84-1, haul 36, 13 July 1984, Two colonies, 1 large in alc (USNM-SEM Stub 2534);

USNM100807, Amatignak Island, Delarof Islands, Aleutian Islands, Bering Sea, 51°N, 179°W, *R/V* Pacific Knight, cruise 941, haul 161, 18 July 1994; USNM 1006141, Umnak Island, Fox Islands, Aleutian Islands, Bering Sea, 52.6326°N, 169.788°W, depth 79 to 80 m, *R/V* Vesteraalen, NOAA Expedition 2001, haul 3 #6, snail bag, coll. Lindner, A. 21 May 2001; USNM 1011013, Kirilof Point, near tip of point, Amchitka Island, Rat Islands, Aleutian Islands, Bering Sea, 51.42°N, 179.3°E, depth to 24 m, AB80-26, Scuba, vertical bedrock wall, coll. Barr, L.& Mercier, J., 2 June 1974; USNM 1011026, Alex's Grotto, gorgonian growth study site, Little Port Walter Light, Southeast Alaska, 56.39°N, 134.64°W, depth 290 m, John N. Cobb R/V, AB99-15, Scuba, coll. Stone, R. 2 June 1999; USNM 1011027, East Point, gorgonian growth study site, Tenakee Inlet, Southeast Alaska), 57.81°N, 134.95°W, depth 21 m, John N. Cobb R/V, AB99-14, Scuba, coll. Stone, R. 1 June 1999; USNM 1011029, Peril Strait, Liesnoi Island, Southeast Alaska, 57.42°N, 135.61°W depth 15 m, AB70-99, Scuba, coll. Ellis, Williamson, Hoopes, & Barr, 1 July 1970; USNM 1011030, Little Port Walter, Baranof Island, Alexander Archipelago, Southeast Alaska, 56.39°N, 134.64°W, depth 11 m, AB62-172, Scuba, coll. Guost, J. G. 8 May 1962; USNM1011091, Semisopochnoi Island, Petrel Bank, Rat Islands, Aleutian Islands, Bering Sea, 52.2243°N, 179.888°W, depth to 40 m, Delta DSR/V, Submersible Dive 5604, AB02-121, sample #27 & 28; coll. Malecha, P. 16 July 2002; USNM1011092, Adak Island, Rat Islands, Aleutian Islands, Bering Sea, 51.8864°N, 176.189°W, depth to 54 m, Delta DSR/V, Submersible Dive 5515, AB02-136, sample #57, coll. Stone, R. 22 July 2002; other material: USNM 60278, no data; USNM 80949, Off N Coast, Akun Island, Fox Islands, Aleutian Islands, Bering Sea, 54.2458°N, 165.689°W, depth 40 m, coll. Viada, S. T., 1 August 1985; USNM 100777, Amchitka Island, Rat Islands, Aleutian Islands, Bering Sea, 51.23°N, 179.2°E, cruise 861, Trawl—Noreast, haul 52, 17 August 1986; USNM 100809, SE of Kagalaska I., Andreanof Islands, Aleutian Islands, Bering Sea, 51°39.28'N, 176°13.2W, depth 216 m, bottom temp. 4.4 °C, *F/V* Pacific Knight cruise 94-1, haul 153, 12 July 1994; USNM 1006139, Unalaska Island, Fox Islands, Aleutian Islands, 53.1439°N, 167.14°W, depth to 107 m, *R/V* Vesteraalen, NOAA Expedition 2001, snail bag, haul 7 #1, coll. Lindner, A. 22 May 2001; USNM 1136483, Queen Charolette Sound, British Columbia, 51.7064°N, 130.752°W, depth to 284 m, coll. Driscoll, John, 11 June 2009; USNM 1011072, Lisianski Strait, 50 yards from shore, Gulf of Alaska, 57.86°N, 136.46°W, depth 10 m, AB77-72, Scuba, coll. Carlson, H. R. 17 July 1977; USNM 1011273, Adak Island, Beyer Bay, Andreanof Islands, Aleutian Islands, Bering Sea, 51.6427°N, 176.328°W, depth to 24 m, *R/V* Velero IV, AB02-133, sample #52, 53, Scuba, coll. Stone, R., Malecha, P., Courtney, D. 21 July 2002, dry; USNM 1011275, Little Tanaga Pass, Andreanof Islands, Aleutian Islands, Bering Sea, 51.8845°N, 176.189°W, depth to 52 m, Delta DSR/V, Submersible Dive 5515, AB02-139, sample #59, coll. Stone, R. 22 July 2002; USNM 1092786, Baranof Island, Cape Ommaney, Alexander Archipelago, Gulf of Alaska, 56.1781°N, 135.121°W, depth 244 m, *R/V* Velero IV, St.Ommaney 4, submersible, coll. Stone, R., 19 August 2005; USNM 1133587, South of Amilia Island, Andreanof Islands, Aleutian Islands, Bering Sea, 51.9716°N, 173.946°W, depth to 96 m, Delta DSR/V, st. 6224, submersible, 6 July 2004.

Description (after the manuscript of Bayer). Branching is a mixture of openly lateral and irregularly dichotomous. There is a strong tendency to branch in one plane so the colonies are more or less flabellate, but in some cases major branches conspicuously diverge, probably in response to local environmental conditions, and colonies then have a more or less compressed, bushy aspect. The cylindrical polyps are up to 3 mm tall and 1.6 mm wide.

The sclerites conform with those of the type as far as illustrated by Broch (1935), differing somewhat in size as can be expected. The polyps are armed with tuberculate spindles that may be more or less club-like, the smaller ones up to about 0.18 mm in length, the longer about 0.3 mm (Figure 16a) but intergrading with the spindles of the polyp body (Figure 16b), which reach a length of 0.36 mm, sometimes slightly longer. The coenenchyme contains small capstans, double heads, and cylinders 0.07–0.11 mm in length, with indistinct waist intergrading with belted spindles reaching lengths of 0.12–0.15 mm (Figure 17a), together with a few crosses and irregular forms (Figure 16c, 17b).

Colour. All sclerites are colorless.

Distribution. Okhotsk Sea in 150–165 m, eastward through the Aleutian Islands, 4–435 m, NE Pacific (Figure 1d).

Remarks. The type described by Broch (1935) seems to be missing in the University of Oslo, Norway or ZIN, St. Petersburg, Russia, but the USNM has a large number of specimens identified as *C. spiculifera* with characters matching the description of Broch.

Bayer's USNM-SEM 2539 stub used for showing complete polyps was taken from USNM 1012500 (Figures 14b, 18), and Bayer's USNM-SEM 2534 stub was taken from USNM100805 (Figures 16–17) . USNM 1012500 has been chosen as the neotype. The materials examined by Bayer were collected during NOAA Fishers bottom

trawl surveys in the Aleutioan Islands of Alaska and sent by Dr.Wing to Bayer in the 1990s (personal comm. Dr. Robert Stone, NOAA Fisheries 2018.2.21).

Bayer mentioned that Broch's original specimen obviously was a small colony dichotomously branched, but with only a single bifurcation that did not provide any idea of the branching of fully developed colonies. The specimens that Bayer examined agree so closely with Broch's description of the holotype in regard to morphological details that there can be no doubt about their conspecificity. He mentioned all are fully developed colonies that show the mature branching pattern lacking in the type. The colony of USNM1133587 is unbranched and the shape looks similar to Broch's description (Figure 14c). This also could be an small colony but it has developed sclerites (Figure 19).

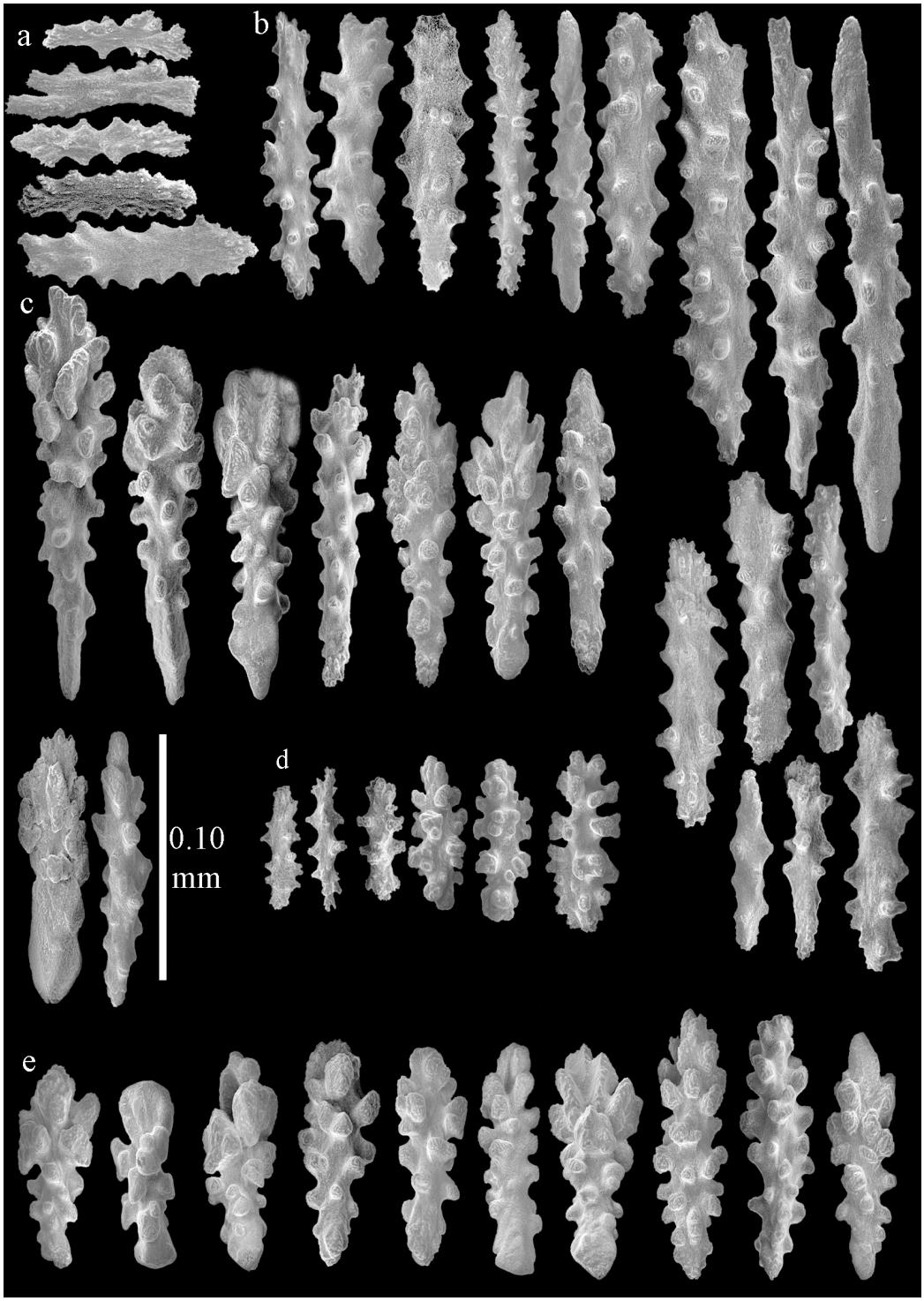

FIGURE 15. *Calcigorgia pacifica* **sp. n.**, holotype RMNH Coel. 42108 **a** undeveloped spindles **b** spindles of polyps **c** clubs of polyps **d** capstans and small spindles of coenenchyme **e** clubs of coenenchyme.

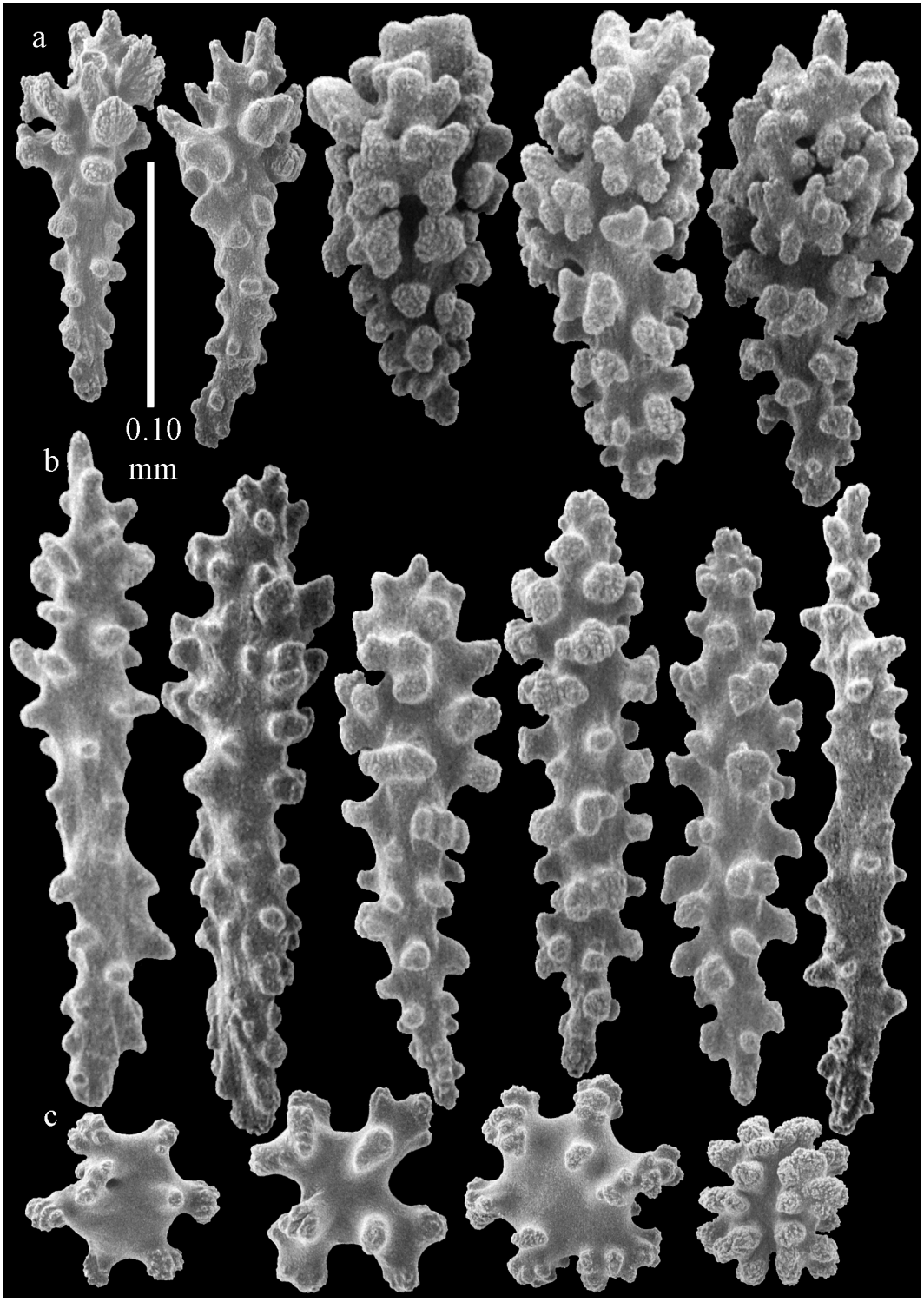

FIGURE 16. *Calcigorgia spiculifera* Broch, 1935 USNM100805, SEM2534 **a** clubs of polyps **b** spindles of polyps **c** crosses of coenenchyme.

The clubs are not always as long as mentioned above, USNM 1011030 has typical sclerites such as SEM 2534 (Figure 16–17) though it has rather smaller clubs up to only 0.15 mm long (Figure 20) obscuring the difference with *C. beringi*.

The species differs from all others in having polyp spindles and club-like sclerites instead of real clubs. Bayer mentioned that *C. beringi* has a more slender colonial form than *C. spiculifera*. *C. beringi* and *C. spiculifera* have been collected at the same locality in the Bering Sea showing that they share a similar habitat (Figure 1a, d). The

sclerites shown by Dautova (2018: Figure 7–13) for *C. simushiri* hardly differ from *C*. *spiculifera* (see discussion). Therefore we here synonymize *C. simushiri* with *C. spiculifera*. The information about the specimen identified as *C. spiculifera* in Dautova (2018) is not adequate to make a decision about what species that actually was. The locality of *C. Simushiri* in Dautova (2018) are mostly the same as *C.spiculifera* in Dautova (2018) (Figure 1d).

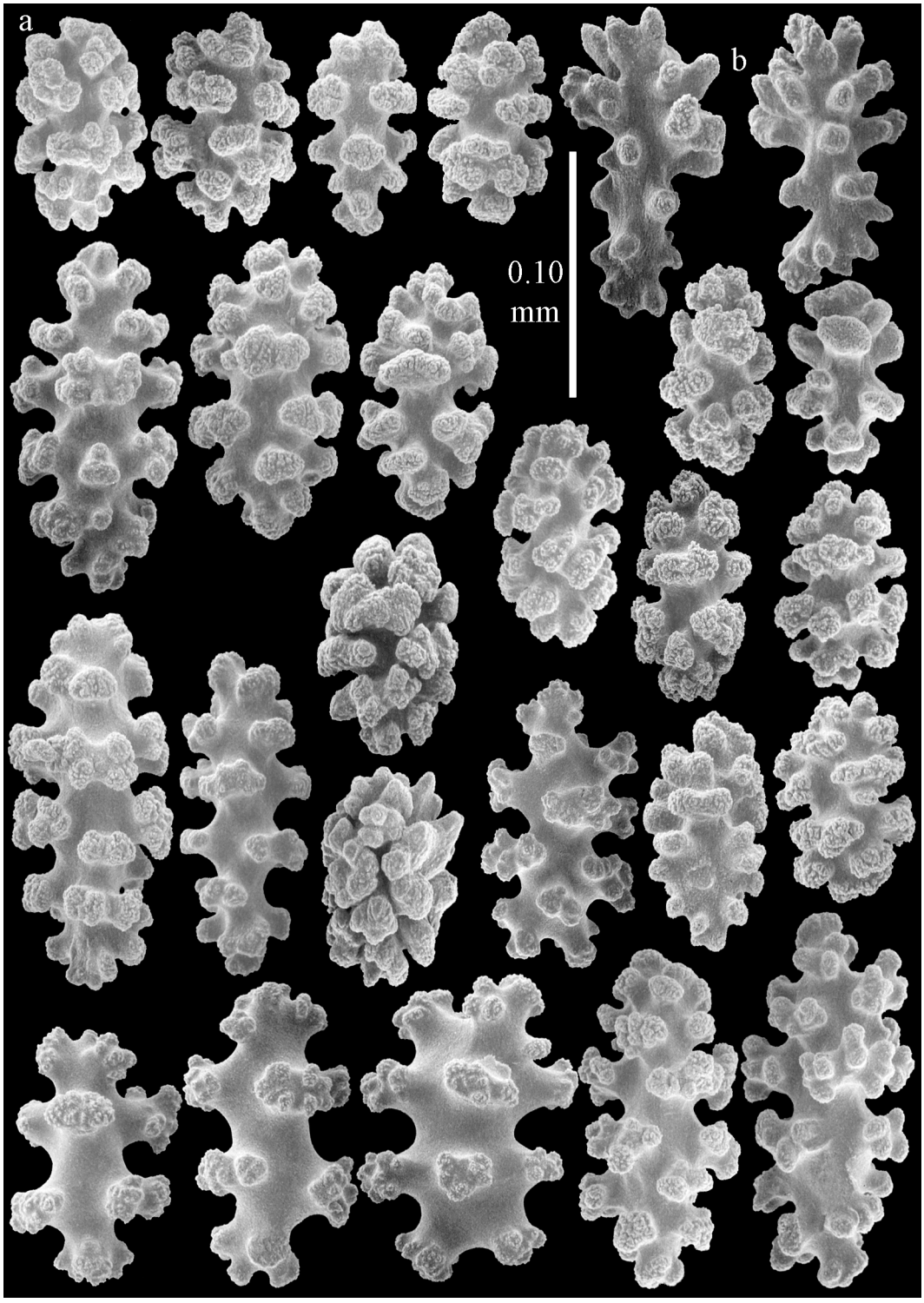

FIGURE 17. *Calcigorgia spiculifera* Broch 1935 USNM100805, SEM2534 **a** double heads and spindles of coenenchyme **b** two irregular forms of coenenchyme.

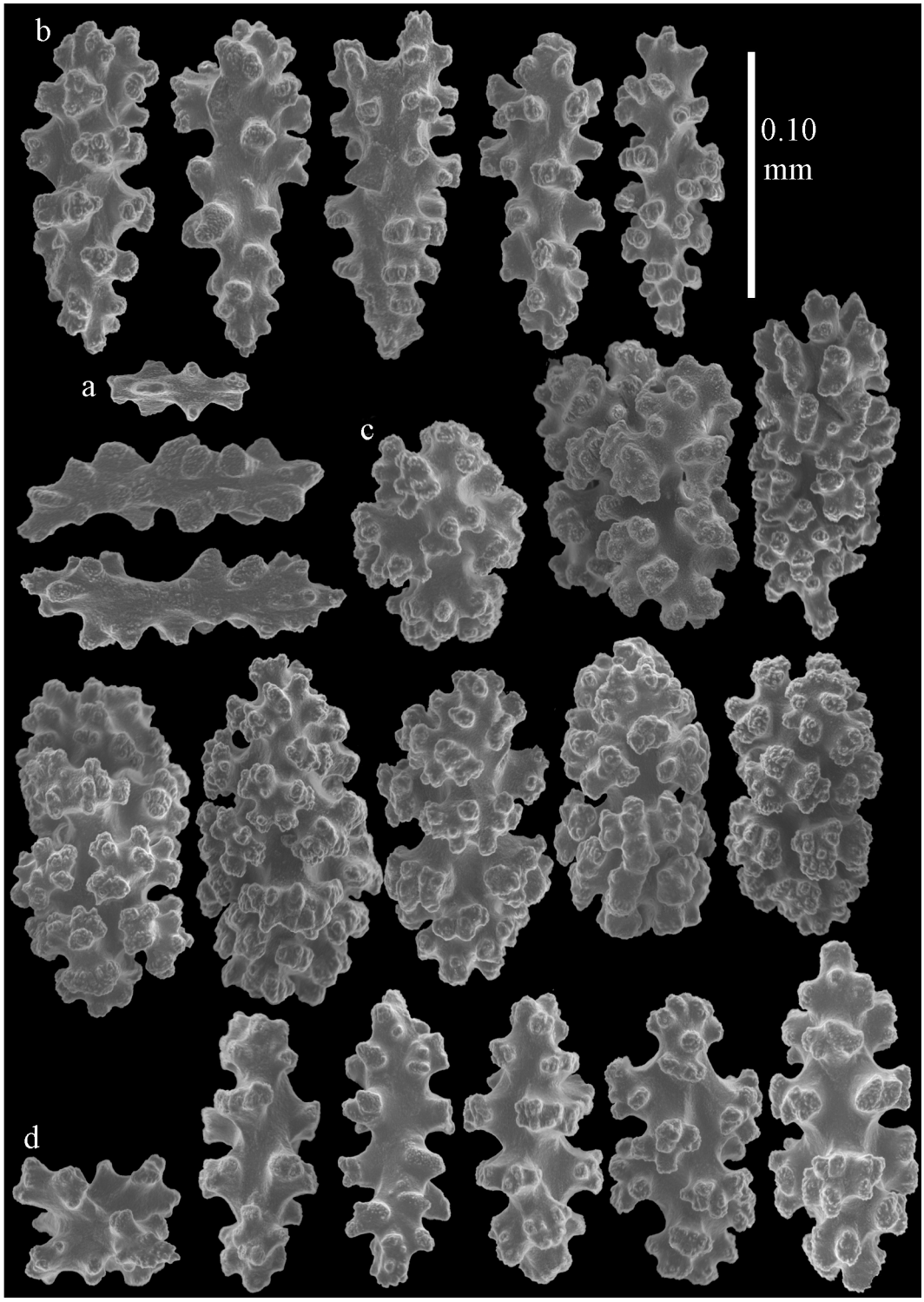

FIGURE 18. *Calcigorgia spiculifera* Broch, 1935, neotype USNM 1012500 **a** undeveloped spindles **b** clubs **c** capstans, belted spindles and cylinders **d** cross.

Discussion

According to Dr. Bayer's unpublished manuscript, assignment of the genus *Calcigorgia* to the family Acanthogorgiidae rests solely on its non-retractile polyps and uncalcified horny axis with a wide, chambered core. The characteristic tuberculate spindles (evidently derived from octoradiate capstans) are unlike the sclerites of any

other acanthogorgiid; in the body wall of polyps they are not placed *en chevron* in regular longitudinal rows, and they do not project around the tentacle base as a thorny crown of spines (as in *Acanthogorgia*). Although the assignment of *Calcigorgia* to the family Acanthogorgiidae is open to question, the only alternative would be the establishment of a new family-group taxon for it, a solution that would further complicate the classification of the Gorgonacea and clearly is undesirable at this time; it awaits evidence from molecular genetic analyses. Other genera in the family Acanthogorgiidae also have non-retractile polyps but do not have a thorny crown of spines as in *Acanthogorgia*. *C*. *pacifica* is the only species with clubs in polyps and coenenchyme of branches.

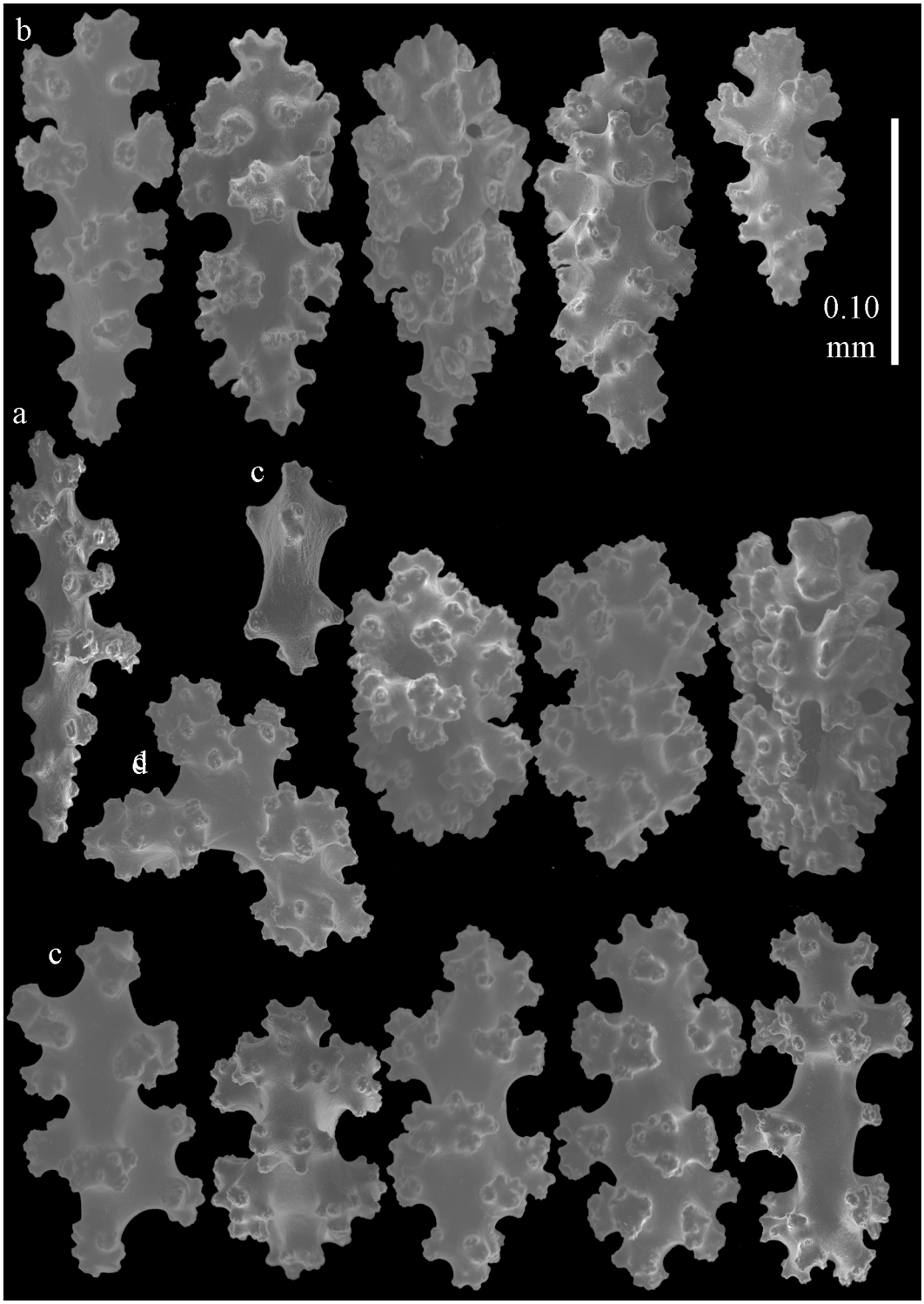

FIGURE 19. *Calcigorgia spiculifera* Broch, 1935, small colony, USNM 1133587 **a** spindle of polyps **b** clubs of polyps **c** capstans, double heads and spindles of coenenchyme **d** cross of coenenchyme.

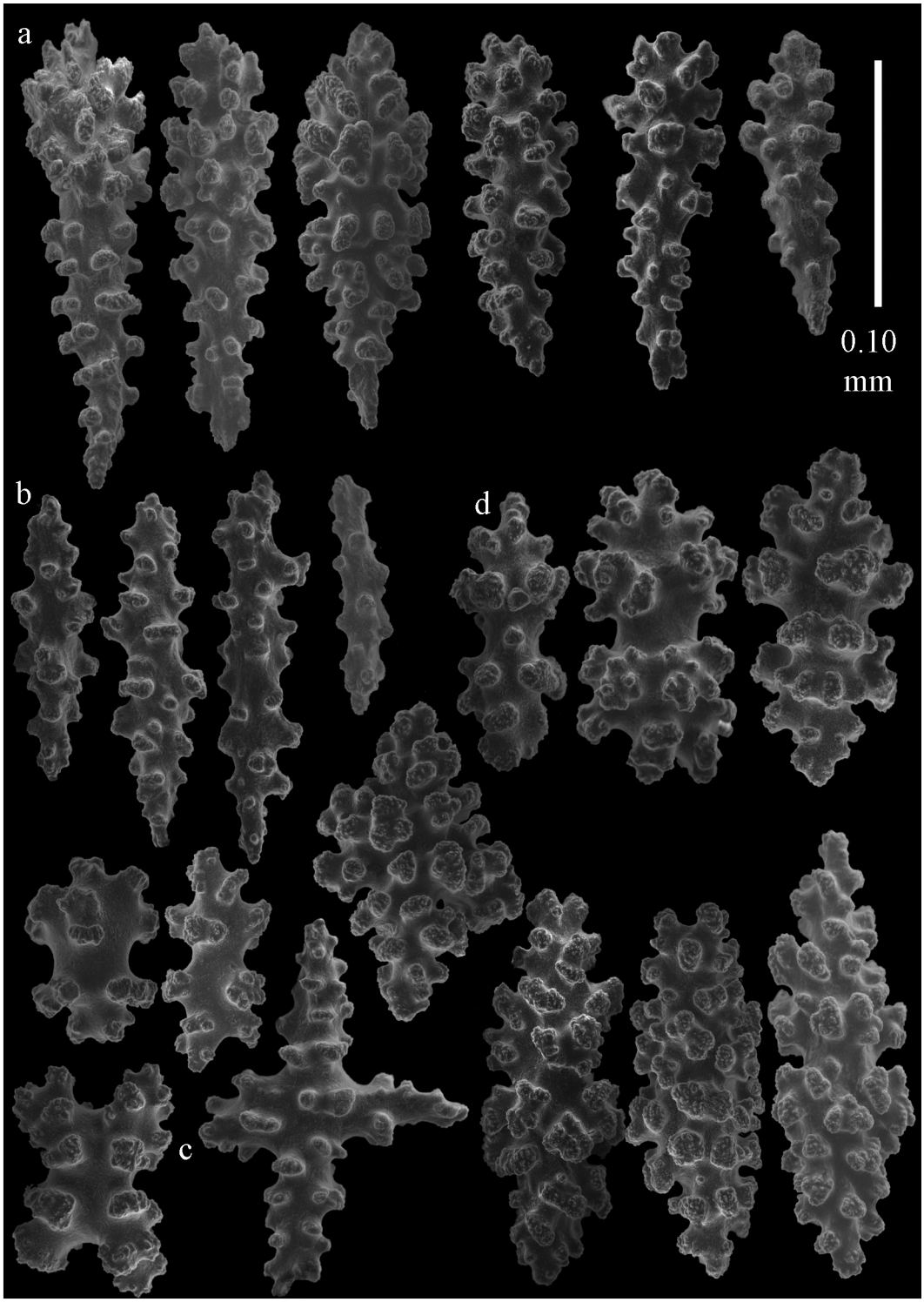

FIGURE 20. *Calcigorgia spiculifera* Broch, 1935 USNM 1011030 **a** clubs of polyps **b** spindles of polyps **c** two crosses of coenenchyme **d** double heads and spindles of coenenchyme.

The genus *Calcigorgia* seems to be confined to the northern Pacific Ocean and deeper water, up to 1497 m deep. The most common and widespread species of the genus is *C. spiculifera* from the Sea of Okhotsk to the East Pacific (Figure 1d). In contrast, *C. beringi* and *C. gigantea* **sp. nov.** are only found at the Aleutian Is., Bering Sea. *C. gracilis* **sp. n.** and *C. pacifica* **sp. n.** are only found from the Pacific side of Japanese waters. Type locality of *C. spiculifera* is the Sea of Okhotsk (Broch, 1935). Dautova reported *C. spiculifera* from the Sea of Okhotsk but did not show any sclerites of the examined two colonies (Dautova 2007, 2018) and did mention that the type material

of *C. spiculifera* was not examined. Therefore we could not compare the species reported as *C. spiculifera* by Dautova (2007, 2018). According to our study the type specimen of *C. spiculifera* may be missing. Bayer and we have examined a total of 26 specimen of *C. spiculifera* and noticed that there is considerable morphological intraspecific variation in *C. spiculifera*. Bayer mentioned in his unpublished manuscript that the type colony of *C. spiculifera* could be juvenile, and we also found both small and well developed colonies of *C. spiculifera* (Fig.14bc). It means the colony shape information in the original description of Broch (1935) is insufficient for the identification. We found colonies with intermediate sclerites between *C. spiculifera* and *C. beringi*, and also *C. spiculifera* and *C. japonica*. Dautova (2018) described *C. simushiri* and mentioned that *C. simushiri* may be confused, at first glance, with *C. spiculifera* in terms of composition of sclerites from the polyp wall. The size of sclerites as given by Dautova differs significantly between the two species, spindles and club-like spindles are up to 0.4 mm long in C. *simushiri* vs 0.25 mm in *C. spiculifera*. However, there are spindles up to 0.36 mm long in our examined material. Therefore we consider *C. simushiri* Dautova (2018) as representing intraspecific variation of *C. spiculifera* and have synonymized the two species.

Two groups of species can be recognized. First *C. matua—C. beringi—C. spiculifera—C. japonica—C. gigantea* (*C. spiculifera*-group). The other is the *C. gracilis—C. pacifica* group, which is only found on the Pacific side of Japan main island; they could represent endemic species. *C. gracilis* and *C. pacifica* colonies are slender and the clubs have smooth handles distinctive from the species of the *C. spiculifera*-group. These two are also found in rather deep waters, *C.gracilis* 1188–1497 m, *C. pacifica* 445–789 m and so seem to be isolated from the others in both distribution and morphological characters. *C. gracilis* is the deepest found species and the southernmost species of the genus.

C. japonica and *C. spiculifera* in the North East Pacific coast are found in quite shallow waters, such as scuba depth below 50 m, but never found at that depth range in the North West Pacific. These depth differences are commonly observed in other octocoral species such as *Primnoa pacifica* (Cairns, 2011; Matsumoto, 2005, 2010) between the North West Pacific and the North East Pacific. The distribution of the genus is now extended to the south at the latitude 33°23'30"N with *C. gracilis* **sp. n.** in Pacific Japan, and extended to the east at the longitude 124.935°W with *C. japonica* in the west coast of the North American continent.

Acknowledgements

We thank Stephen Cairns (USNM) for entrusting the manuscript of the late Dr. Bayer to us and Tim Coffer (USNM) for sending us the SEM images of *Calcigorgia beringi*, *C. gracilis*, and *C. spiculifera*. We thank Dr. Sergey D. Grebelnyi, ZIN, St. Petersburg, Russia for allowing us to examine material, and for hosting and translating data information. The captain and crew of RV *Tansei-maru* (KT08-3) and RV *Shinyo-maru* (KS03) are thanked for collecting. Dr. Tina Molodtsova, Institute of the Russian Academy of Sciences (IORAS), Moscow, Russia, is acknowledged for arrangements for visiting ZIN and translating Russian to English. We thank Dr. Robert Stone, NOAA Fisheries, who checked original data and corrected information of USNM materials previously sent to Dr. Bayer from Dr. Wing, and Mr. Geoff Keel (USNM) who helped me to contact with Dr. Stone and let us have accurate dataset of the specimen. Dr. Allen Collins (USNM) also helped to examining material in USNM. We thank the following persons for the chance to examine material of RV *Natsushima* (NT12-22): Dr. Ichiro Takeuchi, Ehime University and Mr. Ryosuke Mimori, Tokyo Sea Life Park, Japan.

References

Bayer, F.M. (1981) Key to the genera of Octocoralia exclusive of Pennatulacea (Coelenterata: Anthozoa), with diagnosis of new tax.a. *Proceedings of the Biological Society of Washington,* 94 (3), 902–947.

Bayer, F.M., Grasshoff, M. & Verseveldt, J. (1983) *Illustrated trilingual glossary of morphological and anatomical terms applied to Octocorallia*, Leiden, 1–75.

Bielschowsky, E. (1918) *Eine revision der Familie Gorgoniidae* (Dissertation). Breslau, 66 pp.

Broch, H. (1935) Oktokorallen des Nördlichsten Pazifischen Ozeans. *Avhancllinger utgitt av det Norske Videnskaps-Akademi i Oslo. I. Mat-Naturv,* 1935 (1), 1–53.

Broch, H. (1940) Anthozoa, mainly from Pacific waters, collected by USSR expeditions 1903-1932. *Explorations des Mers de l'USSR,* 23, 5–22.

Cairns, S.D. (2011) A revision of the Primnoidae (Octocorallia: Alcyonacea) from the Aleutian Islands and Bering Sea. *Smithsonian Contributions to Zoology,* 634, 1–55.
https://doi.org/10.5479/si.00810282.634

Dautova, T.N. (2007) Gorgonians (Anthozoa: Octocorallia) of the Northwestern Sea of Japan. *Russian Journal of Marine Biology,* 33 (5), 297–304.
https://doi.org/10.1134/S1063074007050045

Dautova, T.N. (2018) Two new species of deep-water *Calcigorgia* gorgonians (Anthozoa: Octocorallia) from Kurile Islands, Sea of Okhotsk, with a review of distinctive characters of the known species of the genus. *European Journal of Taxonomy*, 408, 1–22.
https://doi.org/10.5852/ejt.2018.408

Deichmann, E. (1936) The Alcyonaria of the western part of the Atlantic Ocean. *Memoires of the Museum of Comparative Zoology, Harvard*, 53,1–317.

Kükenthal, W. (1919) Gorgonaria. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898–1899*, 13 (2), 1–946.

Kükenthal, W. (1924) *Gorgonaria—Das Tierreich 47*. Berlin and Leipzig, 478 pp.

Matsumoto, A.K. (2005) Recent Observations on the Distribution of Deep-sea Coral Communities on the Shiribeshi Seamount, Sea of Japan. *In*: Freiwald, A. & Roberts, J.M. (eds), 2005, *Cold-water Corals and Ecosystems*. Springer-Verlag Berlin Heidelberg, pp 345–356.
https://doi.org/10.1007/3-540-27673-4_17

Matsumoto, A.K. (2010) Estimation of in situ distribution of carbonate produced from cold-water octocorals on a Japanese seamount in the NW Pacific. *Marine Ecology Progress Series*, 399, 81–102.
https://doi.org/10.3354/meps08392

Nutting, C.C. (1912) Descriptions of the Alcyonaria collected by the U.S. Fisheries steamer "Albatros", mainly in Japanese waters, during 1906. *Proceedings of the United States National Museum*, 43, 1–104.
https://doi.org/10.5479/si.00963801.43-1923.1

Sánchez, J.A., Cairns, S.D. (2004) An unusual new gorgonian coral (Anthozoa: Octocorallia) from the Aleutian Islands, Alaska. *Zoologische Mededelingen Leiden*, 78 (15), 265–274.

Takahashi, N., Mimori, R., Komi, R., Nemoto, S., Iwase, N., Oshima, M., Hirata, D., Shibata, K., Mori, S., Tanaka, Y., Nishikawa, T., Ohashi, M., Kitsuzawa, K., Fujioka, K. & members of the KO-OHO-O group (2016) Visual Observation Report on Topographic and Geologic features of the Nojima Submarine Canyon, off Boso Peninsula, with Marine Organisms, based on the ROV HYPER-DOLPHIN #1426 dive during NT12-22 Cruise. *Bulletin of Kanagawa prefectural Museum (Natural Science)*, 45, 29–39.