

**Illustrated Key and Synopses of Shallow-water Gorgonians and Pennatulaceans of the Central Philippines, Part 2
(Cnidaria: Anthozoa: Octocorallia)**

Gary C. Williams

Department of Invertebrate Zoology and Geology, California Academy of Sciences, 55 Music Concourse Drive, San Francisco, California 94118, USA. E-mail: gwilliams@calacademy.org

This paper represents the second part of a two-part series that covers shallow-water sea fans and sea pens of the central region of the Philippine Archipelago, from the Verde Island Passage in southern Luzon to southern Negros and the Bohol Sea. The first paper (Williams and Chen, 2014), treated commonly encountered species from the region of the Verde Island Passage, and provided an assessment of the regional biogeographic setting, a key to the taxa, and a glossary of terms used in the key and the descriptions. Included were twenty-six genera in twelve octocoral families – Briareidae, Anthothelidae, Subergorgiidae, Melithaeidae, Acanthogorgiidae, Plexauridae, Gorgoniidae, Ellisellidae, Isididae, Veretillidae, Virgulariidae, and Pennatulidae. The present paper provides an illustrated key that deals with an additional ten species in nine genera of the families Keroeidae, Acanthogorgiidae, Plexauridae, Gorgoniidae, Ellisellidae, Ifalukellidae, and Scleroptilidae.

KEYWORDS: Part 2, Illustrated key, gorgonian and pennatulacean octocorals, sea fans, sea pens, central islands of the Philippine Archipelago

During a fifteen year period from the early 1990s to 2017, field research has been conducted by invertebrate zoologists from the California Academy of Sciences regarding coral reef biotic surveys on several of the island groups of the approximately 7100 islands in the extensive Philippine Archipelago. A detailed introduction to this two part treatise, including synopses of the biogeographic setting, coral biodiversity, octocoral biology, and the current status of our knowledge of relevance, is contained in the first part of the study (Williams and Chen 2014:67–71).

MATERIALS AND METHODS

The geographical area covered in this paper extends from the central region of the Philippines from the Lubang and Busuanga Islands in the northwest to Siquijor and Bohol in the southeast (Fig. 1). SCUBA diving operations on numerous coral reefs within this region were conducted between 2010 and 2017 in depths less than 40 m.

Regarding the collected material that was examined and described in this paper, the following fieldwork was conducted in the Philippines between 2010 and 2017: February 2010 Coral Triangle Expedition November; 2012 Coral Triangle Expedition; December 2013 Philippine Deep Reef Expedition; May 2014 Verde Island Passage Expedition; March/April 2015 Verde Island Passage Expedition; April 2016 Verde Island Passage Expedition; March/April 2017 Verde Island Passage Expedition. All material is currently housed in the marine invertebrate collections of the Depart-

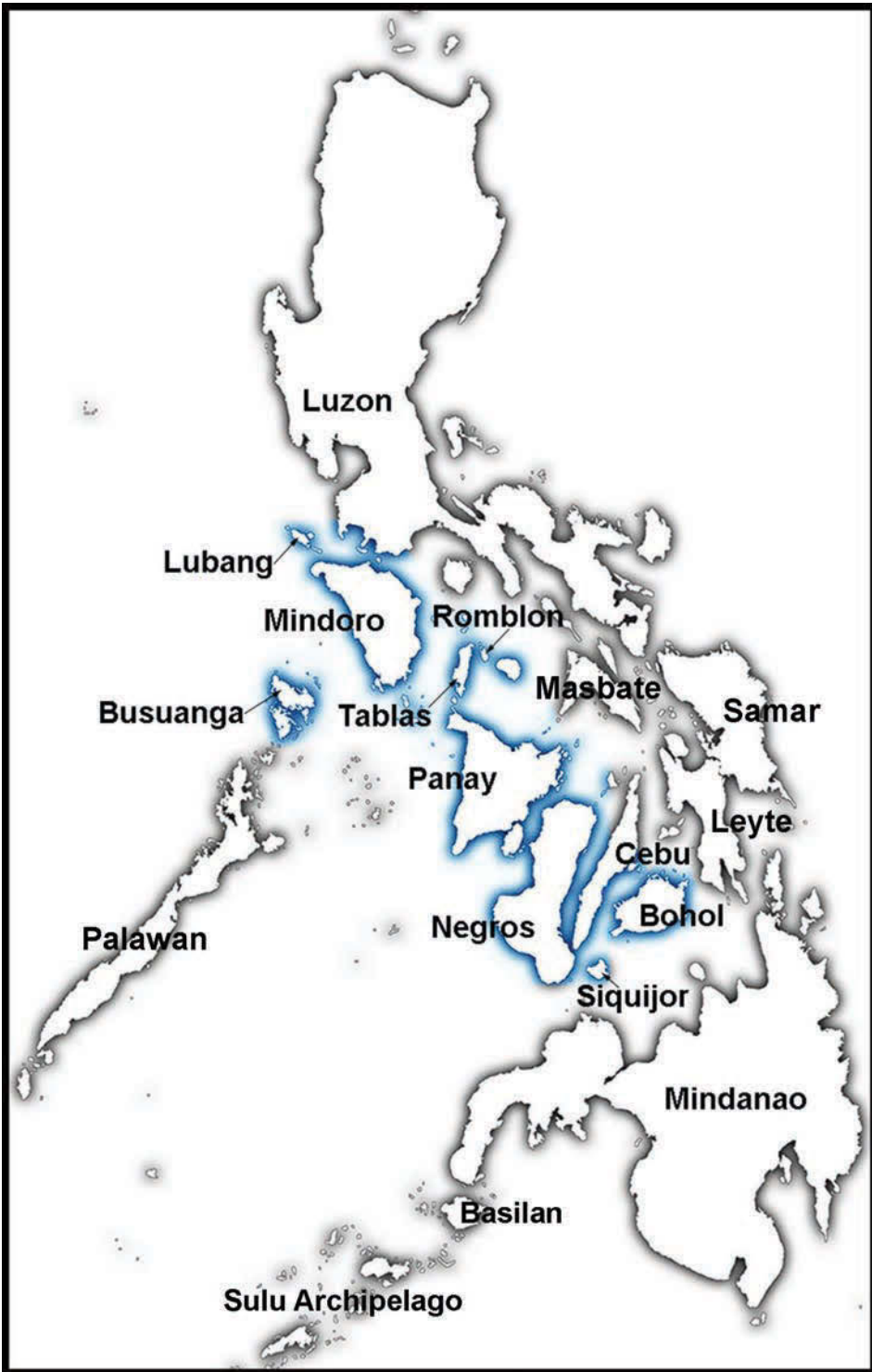


FIGURE 1. Map of the Philippine Archipelago, showing major islands of the central Philippines shaded in blue.

ment of Invertebrate Zoology and Geology, California Academy of Sciences, abbreviated as CASIZG.

Sclerites from octocoral tissues were obtained using the procedure outlined by Williams and Mattison (2018). Scanning electron micrographs were made using a Hitachi SU3500 Scanning Electron Microscope. All skeletal material for SEM examination was coated with gold/palladium using a Cressington 108 Auto Sputter Coater.

Williams and Chen (2014) provides a glossary of terms used in the keys and descriptions. That source is also applicable for use in the present paper. For additional terms used in this paper that may not be present in the 2014 glossary, see Bayer et al. (1983).

Key to additional shallow-water Gorgonians and Pennatulaceans of the Central Philippines

- 1a. Unbranched octocorals composed of a sterile stalk and polyp-bearing rachis, imbedded in unconsolidated sediments (such as sand, mud or gravelly rubble) by a basal muscular peduncle. Calcified central axis extends throughout length of colony. Sclerites absent. *Calibelemnon indicum* (Fig. 26A)
- 1b. Branched octocorals attached to hard substrata by a basal holdfast. Axial material highly variable – composed of sclerites, a hard dark protein, or consolidated calcium carbonate. Sclerites present and abundant, highly variable in shape and size. 2
- 2a. Axis segmented, composed of alternating swollen, rounded nodes and straight, elongate internodes. Branching occurs at the nodes. Axial sclerites are smooth rods. *Melithaea* spp. (Fig. 2)
- 2b. Axis uniform throughout, composed of sclerites, a dark proteinaceous material, or a light-colored predominantly calcareous material 3
- 3a. Axis composed of sclerites, some of which are imbedded in a proteinaceous matrix. Colonies copiously branched, red in color, with conical polyp calyces that are not particularly densely-set or crowded on the branches *Keroeides gracilis* (Figs. 3-4)
- 3b. Axis composed of hard proteinaceous material or with solid calcareous material 4
- 4a. Axis of hard, usually dark, proteinaceous material in concentric layers around a narrow hollow cross-chambered core. 5
- 4b. Axis of solid, predominantly calcareous material that can be white to variably-colored 9
- 5a. Polyps non-retractile, forming long cylindrical or dome-shaped projections perpendicular to the branches. Polyp wall sclerites arranged en chevron *Anthogorgia* spp. (Figs. 5-8)
- 5b. Polyps fully retractile into conical permanent calyces, or retractile forming small mounds 6
- 6a. Polyps retractile into small, conical or hemispherical, permanent calyces 7
- 6b. Polyps retractile into coenenchyme forming small rounded mounds, calyces absent 8
- 7a. Sclerites of the calyces and surface of the coenenchyme are rosettes *Bebryce grandicalyx* (Figs. 9-11)
- 7b. Sclerites of the polyps, calyces, and surface coenenchyme are triradiates, thornscales, and spindles *Trimuricea inermis* (Figs. 12-15)
- 8a. Sclerites are clubs, spindles, and large rods *Hicksonella princeps* (Figs. 16-18)
- 8b. Sclerites include curved and irregularly-shaped spindles *Pinnigorgia flava* (Figs. 19-21)
- 9a. Sclerites are minute, flattened ovals *Plumigorgia hydroides* (Figs. 25-27)
- 9b. Sclerites are clubs, capstans, and/or double heads 10
- 10a. Sclerites are clubs and capstans *Heliania spinescens* (Figs. 22A, 23)
- 10b. Sclerites are double heads. *Verrucella* spp. (Figs. 22B-C, 24)

SYSTEMATIC ACCOUNT

Alcyonacea Lamouroux, 1816**Family Melithaeidae Gray, 1870*****Melithaea* spp.**

Figure 2

REMARKS.— In part 1 of this study, Williams and Chen (2014:76-77) distinguished the genus *Acabaria* from *Melithaea*. Fabricius and Alderslade (2001) recognized the intermediate nature of of particular morphological features that were used by previous authors to distinguish between several melithaeid genera, and suggested that with future research the several melithaeid genera might eventually be synonymized with the first described genus *Melithaea*. Subsequently, Alderslade (2006) and Reijnen et al. (2014) maintained that there are two valid genera of melithaeids (*Melithaea* Milne Edwards and Haime, 1857, and *Asperaxis* Alderslade, 2006), and that molecular and morphological evidence suggests that five previously recognized genera (*Acabaria*, *Clathraria*, *Melitodes*, *Mopsella*, and *Wrightella*) are best recognized as synonyms of the genus *Melithaea*.

REFERENCES.— Alderslade (2006), Fabricius and Alderslade (2001), Gosliner et al. (1996), Ofwegen (2016), Reijnen et al. (2014), Williams (1992).

Family Keroeididae Kinoshita, 1910**Genus *Keroeides* Studer, 1887*****Keroeides gracilis* Whitelegge, 1897**

Figures 3, 4

MATERIAL EXAMINED.— CASIZG 201396; Philippines, Occidental Mindoro, Lubang Island (13.77°N 120.12°E); ca. 34 m depth; 31 May 2014; coll. G.C. Williams; one whole colony wet-preserved in 95% ethanol.

REMARKS.— Colonies of this species are planar or nearly so, are copiously branched, and exhibit lateral branching. The calyces of the polyps are conspicuous and conical in shape, and are not particularly densely set or crowded on the branches. The sclerites of the outer coenenchyme are large spindles with relatively small tubercles that are uniformly-distributed over the sclerite surface. Due to the numerous and densely-disposed spindles of the surface of the colonies, these sea fans are relatively fragile or brittle, not exhibiting a high degree of flexibility without sustaining breakage of some branches. The tissues do not harbor zooxanthellae. The color of the colony examined here is brick red with pale yellow anthocodiae.

Kükenthal (1924) and Bayer (1949) consider *Keroeides gracilis* as a junior synonym of *K. koreni* Wright and Studer, 1889. However, Grasshoff (1999) and Grasshoff and Bargibant (2001) disagree and maintain that they are separate species — *K. gracilis* from mesophotic reefs (30–164 m), red in color with yellow polyps, and *K. koreni* from deeper water (250–450 m), brick red in color throughout. I therefore concur with Grasshoff's assessment and consider *Keroeides gracilis* to as the proper identification in this case.

SPECIES.— There are six described species in the genus. Color of the various species can vary from orange to deep red, or white to light grey or tan.

OCCURRENCE AND DISTRIBUTION.— The genus is widely distributed in the Indo-Pacific, Red Sea to Japan, New Caledonia, and Hawaii; usually encountered below 30 m, mostly in mesophotic depths or deep sea, rarely seen in shallower depths. *Keroeides gracilis* is widely distributed in

and to the east of the Coral Triangle and is known from central Indonesia, the Philippines, New Guinea, Northern Mariana Islands, Palau, Tuvalu, and New Caledonia.

REFERENCES.— Bayer (1949, 1981); Fabricius and Alderslade (2001); Grasshoff (1999); Grasshoff and Bargibant (2001); Kükenthal (1924); Ofwegen (2010c).

Family Acanthogorgiidae Gray, 1859

Genus *Anthogorgia* Verrill, 1868

Anthogorgia spp.

Figures 5, 6, 7, 8

MATERIAL EXAMINED.— CASIZG 207505; Philippines, Romblon Province, Cobrador Island (12.65170 N 122.23086 E); 20 m depth; 20 February 2010; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol. CAS 222412; Philippines, Luzon, Batangas Province, Caban Island, Kirby's Rock (13.69°N 120.84°E); 30 March 2017; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol.

REMARKS.— These are mostly planar sea fans often up to or exceeding 0.5 m in height with lateral branching. The coenenchyme is relatively thick giving the branches a thicker appearance compared to most other sympatric sea fans. The polyps are non-retractile and conspicuous, often tall and cylindrical or domelike in shape. Colony color deep orange to reddish brown, tips of polyps often yellowish. Polyp and coenenchyme sclerites are robust spindles with numerous tubercles covering the entire surface. Many of these tubercles are strongly displayed — large and rounded to oval in shape.

SPECIES.— The genus *Muricella* Verrill, 1968, is quite similar to *Anthogorgia* and may eventually be shown to be synonymous with it (Fabricius and Alderslade 2001). There are 34 described species that are currently recognized as belonging to *Muricella*, and thirteen described species in *Anthogorgia*. Several species may be present in the Philippines. There has been a considerable amount of confusion in past literature with superficial similarities regarding other gorgonian genera such as *Muricella* (Acanthogorgiidae), *Astrogorgia* (Plexauridae), and *Nicella* (Ellisellidae) pertaining to the gross morphology of whole colonies.

OCCURRENCE AND DISTRIBUTION.— Infrequently encountered on coral reef slopes in the central Philippines. The genus is known from throughout much of the Indo-West Pacific.

REFERENCES.— Fabricius and Alderslade (2001); Grasshoff (1999); Grasshoff (2000); Grasshoff and Bargibant (2001); Ofwegen (2010d).

Family Plexauridae Gray, 1859

Genus *Bebryce* Philippi, 1841

Bebryce grandicalyx (Kükenthal, 1924)

Figures 9, 10, 11

MATERIAL EXAMINED.— CASIZG 216253; Philippines, Visayas, Siquijor Island, Tambisan Point North (9.18°N 123.45°E); 24 m depth; 2 April 2016; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol. CASIZG 216316 (same data as CASIZG 216253).

REMARKS.— The genus *Bebryce* is characterized by the possession of unique sclerites known as rosettes — also referred to as double cups or spiny rosettes (Bayer et al. 1983:18), commonly found in the surface of the coenenchyme. Bayer and Ofwegen (2016) provided a revision and re-examination of type material of all species of the genus. In addition, Matsumoto and Ofwegen (2016) described three additional new species from Japan. According to these works, the two

Philippine specimens examined here most closely resemble the Indonesian species *Bebryce grandicalyx*, by the appearance of the colonies as well as that of the rosettes and other sclerites. The colonies in life are vivid red to red-orange, and change to dark-brown when wet-preserved in ethanol.

SPECIES.— Twenty-seven described species are currently recognized.

OCCURRENCE AND DISTRIBUTION.— The genus *Bebryce* is distributed in the Indian, Pacific, and tropical western Atlantic Oceans. Twenty-four species have been described from the Indo-Pacific. Three species were described by Deichmann (1936) from the Bahamas, Gulf of Mexico, and Caribbean Sea — *Bebryce cinerea*, *B. grandis*, and *B. parastellata*.

REFERENCES.— Deichmann (1936); Ofwegen (2010f); Bayer and Ofwegen (2016); Matsumoto and Ofwegen (2016).

Genus *Trimuricea* Gordon, 1826

Trimuricea inermis (Nutting, 1910)

Figures 12, 13, 14, 15

MATERIAL EXAMINED.— CASIZG 207510; Philippines, Negros, Siaton Province, Si-it; 21 m depth; 5 April 2016; coll. G.C. Williams; one whole colony wet-preserved in 95% ethanol.

REMARKS.— Samimi-Namin and Ofwegen (2016) provided a taxonomic revision of the genus and added several new species from the Indian Ocean. According to their revision, the specimen examined here is most similar to *T. inermis* regarding colony shape and sclerite shape and size, but it would be beneficial to compare it with type material to better elucidate the taxonomic status of the Philippine material. Sclerites of the genus *Trimuricea* are unusual, in that the sclerite complements of the polyps and calyces are dominated by triradiates and thornscales. The color of living colonies of the Philippine material is pinkish red, turning to light brown when preserved in ethanol (Fig. 12).

SPECIES.— Eleven described species, according to Samimi-Namin and Ofwegen (2016) and Ofwegen (2010e). Nine of the eleven species are distributed in the Indian Ocean.

OCCURRENCE AND DISTRIBUTION.— The genus has an Indo-West Pacific distribution, and is rarely or infrequently encountered at many localities.

REFERENCES.— Grasshoff (1999); Fabricius and Alderslade (2001); Ofwegen (2010e); Samimi-Namin and Ofwegen (2016).

Family Gorgoniidae Lamouroux, 1812

Genus *Hicksonella* Nutting, 1910

Hicksonella princeps Nutting, 1910

Figures 16, 17, 18

MATERIAL EXAMINED.— CASIZG 201363; Philippines, Occidental Mindoro Province, Lubang Island (13.79 N 120.09 E); 23 May 2014; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol.

REMARKS.— *Hicksonella princeps* is similar in superficial appearance and can be confused with another sympatric zooxanthellate gorgonian, *Rumphella aggregata*. *H. princeps* differs by having a more gracile appearance, with thinner branches which are often more pointed at the tips. *R. aggregata* is more robust with thicker branches with more rounded tips. Both species are similar in colony color — varying from tan or grey to light brown or yellowish brown. In addition, similarly-shaped club-like sclerites are found in the surface of the coenenchyme of both species

(Fig. 17; Williams and Chen, 2014:119). However, *Hicksonella* differs from *Rumphella* by having some large rods in the inner coenenchyme that are relatively smooth at one end and conspicuously ornamented at the other end (Fig. 18: top row, second from the left). These are often undetected or overlooked. All sclerites in both species are colorless.

Many of the sclerites in the present material examined here differs somewhat from other known material of the species from outside the Philippines by having strongly acute or sharply pointed tips on the lateral tubercles (Figs. 17, 18).

SPECIES.— There are two other described species in the genus, *Hicksonella guishanensis* Zou and Chen, 1984, and *Hicksonella expansa* Alderslade, 1986.

OCCURRENCE AND DISTRIBUTION.— *Hicksonella princeps* is a zooxanthellate species that inhabits shallow-water areas of coral reefs flats and slopes, usually less than 15 m in depth. It has been encountered in the northeastern part of central Philippines — the Calatagan Peninsula and the Lubang Islands Group. The genus *Hicksonella* is known only from the tropical western Pacific.

REFERENCES.— Alderslade (1986a), Fabricius and Alderslade (2001), Ofwegen (2010b).

Genus *Pinnigorgia* Grasshoff and Alderslade, 1997

Pinnigorgia flava (Nutting, 1910)

Figures 19, 20, 21

MATERIAL EXAMINED.— CASIZG 201640; Philippines, Luzon, Batangas Province, Calatagan (13.92°N 120.60°E); 8 m depth; 19 May 2014; coll. G.C. Williams; three partial colonies wet-preserved in 95% ethanol. CASIZG 201407; Philippines, Lubang Island (13.78°N 120.10°E); 12 m depth; 30 May 2014; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol. CASIZG 222415; Philippines, Romblon Province, Cobrador Island (12.65°N 122.23°E); 11 m depth; 6 April 2017; coll. G.C. Williams; one whole colony wet-preserved in 95% ethanol.

REMARKS.— The colonies are richly-branched, the branches are planar and pinnate, and the tissues harbor zooxanthellae. The Philippine material exhibits similarities to the description of *Pinnigorgia flava* provided by Grasshoff and Alderslade (1997), in that the sclerites are relatively elongate — often >0.1 mm in length and somewhat curved. Color of the colonies in life as well as wet-preserved varies from cream-white or pale yellow to tan.

SPECIES.— There are two other described species in the genus besides *Pinnigorgia flava* — *Pinnigorgia perroteti* (Stiasny, 1940) and *Pinnigorgia platystoma* (Nutting, 1910).

OCCURRENCE AND DISTRIBUTION.— The genus is known from the tropical western Pacific Ocean — the Philippines, Sabah, Indonesia, and Palau. *Pinnigorgia flava* in the Philippines occupies shallow-water reef flats or gentle slopes, usually not in areas with consistently strong bottom currents.

REFERENCES.— Grasshoff and Alderslade (1997); Fabricius and Alderslade (2001).

Family Ellisellidae Gray, 1859

Genus *Heliania* Gray 1860

Heliania spinescens Gray, 1860

Figures 22A, 23

MATERIAL EXAMINED.— CASIZG 222404; Philippines, Batangas Province, Caban Island, Kirby's Rock; 34 m depth; 30 March 2017; coll. Peri Palaracio, one whole colony wet-preserved in 95% ethanol.

REMARKS.— Colonies are richly branched with lateral branching. The contracted polyps form numerous, conspicuous mounds that are congested along the branches. They are digitiform in

shape and often curve upward. Three genera in the family Ellisellidae have club-shaped sclerites in which the head has clusters of upward-facing tubercles — *Dichotella*, *Heliania*, and *Junceella*. Many of the club-like sclerites in *Heliania* have tubercles with acute tips that are relatively sharply pointed. Philippine specimens are bright red to brick-red in color, while colonies from other regions such as Papua New Guinea, Indonesia, Palau, and New Caledonia are usually reddish orange to orange or yellow-orange.

SPECIES.— *Heliania spinescens* is one of only two described species in the genus, the other is *Heliania racemosa* (Wright and Studer, 1889).

OCCURRENCE AND DISTRIBUTION.— Encountered infrequently on deeper reefs, mostly at mesophotic depths in the Philippines (ca. 34–95 m). The genus is widespread in the Indo-West Pacific region from approximately 23–600 m in depth.

REFERENCES.— Fabricius and Alderslade (2001); Grasshoff (1999); Grasshoff and Bargibant (2001).

Genus *Verrucella* Milne-Edwards and Haime, 1857

Verrucella spp.

Figures 22B, 22C, 24

MATERIAL EXAMINED.— CASIZG 197809; Philippines, Batangas Province, Caban Island (13.69°N 120.84°E); 40 m depth; 16 December 2013; coll. Sonia Rowley; one partial colony wet-preserved in 95% ethanol. CASIZG 197824; Philippines, Batangas Province, Caban Island (13.69°N 120.84°E); 27 m depth; 16 December 2013; coll. Sonia Rowley; one partial colony wet-preserved in 95% ethanol.

REMARKS.— The genus *Verrucella* is related to *Heliania*, but does not have any club-shaped sclerites. The sclerites in *Verrucella* are double heads (dumbbell-shaped) with a smooth narrow middle or waist. Spindles are also present. Both the double heads and spindles have oval-shaped tubercles with many acute triangular teeth. *Verrucella* has relatively short side branches, which are often more-or-less perpendicular to the main branches. The contracted polyps form low rounded mounds on the branches and are more sparsely distributed — not as highly congested as in *Heliania*.

SPECIES.— There are twenty six described species in the genus.

OCCURRENCE AND DISTRIBUTION.— Several species of *Verrucella* may be present in the central Philippines, occasionally encountered at mesophotic depths (usually below 30 m). The genus has a wide-ranging Indo-Pacific distribution.

REFERENCES.— Fabricius and Alderslade (2001); Grasshoff (1999); Grasshoff (2000); Grasshoff and Bargibant (2001).

Family Ifalukellidae Bayer, 1955

Genus *Plumigorgia* Nutting, 1910

Plumigorgia hydroides Nutting, 1910

Figures 25, 26B, 26C, 27

MATERIAL EXAMINED.— CASIZG 180888; Philippines, Palawan Province, Calamian Group, Busuanga Island; 10 m depth; 24 February 2010; coll. G.C. Williams; one colony in several pieces wet-preserved in 95% ethanol. CASIZG 207506; Philippines, Palawan Province, Calamian Group, Busuanga Island; 12 m depth; 24 February 2010; coll. G.C. Williams; one partial colony wet-preserved in 95% ethanol.

REMARKS.— Colonies with branches that are planar and pinnate, very thin, gracile, and flexi-

ble. Sclerites are small plate-like structures, more-or-less ovoid in shape, with coarse surfaces and no tubercles. Some sclerites are slightly restricted in the middle. Retracted polyps form numerous, minute conical bumps on the branches, or they retract completely into the coenenchyme. Colony color in life is white or cream-white.

SPECIES.— There are five described species in the genus — *Plumigorgia hydroides* (Indonesia, Philippines, Northwestern Australia); *P. schuboti* Alderslade, 1986 (Great Barrier Reef, New Caledonia); *P. terminosclera* Alderslade, 1986 and *P. astroplethes* Alderslade, 1986 (Great Barrier Reef) and *P. wellsi* Bayer, 1955 (Marshall Islands).

OCCURRENCE AND DISTRIBUTION.— *Plumigorgia hydroides* is a presumably zooxanthellate species that inhabits shallow coral reef flat and gentle slopes that exhibit frequent periods of substantive water movement. It has been observed in the eastern part of the central Philippines in the vicinity of Busuanga Island.

REFERENCES.— Alderslade (1986b); Bayer (1955); Bryce and Polisenio (2014); Fabricius and Alderslade (2001); Grasshoff and Bargibant (2001).

Pennatulacea Verrill, 1865

Family Scleroptilidae Jungersen, 1904

Genus *Calibelemnon* Nutting, 1908

Calibelemnon indicum (Thompson and Henderson, 1906)

Figure 26A

MATERIAL EXAMINED.— CASIZG 201545; Philippines, Luzon, Batangas Province, Calumpan Peninsula, Balayan Bay (13.72 N 120.87 E); 40 m depth; 2 May 2014; coll. Peri Paleracio; one whole colony wet-preserved in 95% ethanol.

REMARKS.— *Calibelemnon indicum* is a very thin and delicate sea pen with two longitudinal columns of polyps, in which the polyps are oppositely arranged along the length of the rachis. The axis is visible through the thin tissues of the rachis and peduncle. Siphonozooids are conspicuous as numerous low mounds in opposite columns along the rachis. Sclerites are absent altogether.

SPECIES.— Four species are described — *Calibelemnon hertwigi* (Balss, 1909), *Calibelemnon symmetricum* Nutting, 1908, *Calibelemnon indicum* (Thomson and Henderson, 1906), and *Calibelemnon francei* Williams and Alderslade, 2011. The latter two species are considered valid, while the status of the former two is uncertain.

OCCURRENCE AND DISTRIBUTION.— *Calibelemnon* is a rarely encountered genus from mesophotic depths and the deep-sea in the Indo-West Pacific (southeastern Africa to Japan and the Philippines, 40-1275 m) and the Western Atlantic (Bahamas Escarpment, 1969 m). In the Philippines, *Calibelemnon indicum* is known only from a single collection off the Calumpan Peninsula at 40 m depth, inhabiting deeper reefs in areas of unconsolidated sediments.

REFERENCES.— Kükenthal (1915); Ofwegen (2010c); Williams (1990); Williams (1995); Williams (1999); Williams (2011); Williams and Alderslade (2011).

DISCUSSION AND CONCLUSION

The Philippines comprises the northern-most portion of the Coral Triangle in the tropical western Pacific, and covers a relatively extensive longitudinal gradient (Williams and Chen 2014: Figs. 1A, 2A). The Philippine Archipelago, encompassing an estimated 7100 islands, is certainly one of the richest regions in the world (if not the richest region), with regard to coral reef biodiversity.

The first part of this study (Williams and Chen 2014) covered twenty-two genera of gorgoni-

ans and pennatulaceans from the Verde Island Passage region (VIP). The present paper treats several island groups of the central Archipelago as well as the VIP, and an additional ten genera — making a total of thirty-two genera covered, representing approximately forty species.

The number of species inhabiting the Philippine Archipelago belonging to these thirty-two genera is undeterminable at present. This is due in part to the necessity of taxonomic revisions of many Indo-Pacific octocoral genera to determine the actual number of valid species, as well as the relatively recent trend in the scientific community toward a decrease of trained taxonomists to do the necessary work of revision (Fabricius and Alderslade 2001:vii).

ACKNOWLEDGMENTS

Funding for fieldwork in the Philippines was made possible by NSF-DEB grant 1257630 to Terrence Gosliner, Kent Carpenter, Richard Mooi, Luiz Rocha and Gary Williams (Collaborative proposal: documenting diversity in the apex of the coral triangle: inventory of Philippine marine biodiversity), and by the Lindsay Field Research Fund of the California Academy of Sciences. I thank Peri Paleracio and Sonia Rowley for collection of some of the octocoral specimens, and Christina Piotrowski, Johanna Loacker, and Elizabeth Kools for curation of collected material at the California Academy of Sciences in San Francisco.

All the specimens from the Philippines were collected under our Gratuitous Permits (GP-0077-14, GP-0085-15). This is part of the joint Department of Agriculture-NFRDI-California Academy of Sciences Memorandum of Agreement for the ongoing implementation of the National Science Foundation-funded biodiversity expeditions for biotic surveys of Philippine coral reefs. The specimens were collected in accordance with the terms and conditions of the gratuitous permit and under the supervision of our partners from BFAR Fisheries Regulatory and Quarantine Division and NFRDI. I thank Ludivina Labe of the Bureau of Fisheries and Aquatic Resources (BFAR) and November Romena of the National Fisheries and Research Development Institute (NFRDI) for helping to make our work possible in the Philippines and for their continued support.

In addition, I am grateful to anonymous reviewers for their thoughtful comments.

LITERATURE CITED

- ALDERSLADE, P. 1986a. An unusual leaf-like gorgonian (Coelenterata: Octocorallia) from the Great Barrier Reef. *The Beagle, Occasional Papers of the Northern Territory Museum of Arts and Sciences* 3:81–93.
- ALDERSLADE, P. 1986b. New species of the gorgonian genus *Plumigorgia* (Coelenterata: Octocorallia) with a review of the family Ifalukellidae. *The Beagle, Occasional Papers of the Northern Territory Museum of Arts and Sciences* 3:95–122.
- ALDERSLADE, P. 2006. New subfamilies and a new genus and species of Melithaeidae (Coelenterata: Octocorallia: Alcyonacea) with comparative data on the structure of both melithaeid and subergorgiid axes. *Zootaxa* 1199:19–47.
- BAYER, F.M. 1949. The Alcyonaria of Bikini and other atolls in the Marshall Group. Part I: The Gorgonacea. *Pacific Science* 3:195–210.
- BAYER, F.M. 1955. Contributions to the nomenclature, systematics, and morphology of the Octocorallia. *Proceedings of the United States National Museum* 105:207–220.
- BAYER, F.M. 1981. Key to the genera of Octocorallia exclusive of the Pennatulacea (Coelenterata: Anthozoa) with diagnoses of new taxa. *Proceedings of the Biological Society of Washington* 94:902–947.
- BAYER, F.M., M. GRASSHOFF, AND J. VERSEVELDT. 1983. *Illustrated Trilingual Glossary of Morphological and Anatomical Terms Applied to Octocorallia*. E.J. Brill/Dr. W. Backhuys, Leiden, The Netherlands. 75 pp.
- BAYER, F.M., AND L.P. VAN OFWEGEN. 2016. The type specimens of *Bebryce* (Cnidaria, Octocorallia, Plexauridae) re-examined, with emphasis on the sclerites. *Zootaxa* 4083 (3):301–358.
- BRYCE, M., AND A. POLISENO. 2014. Two new records of octocorals (Anthozoa, Octocorallia) from north-west

- Australia. *Records of the Western Australian Museum* 29:159–168
- DEICHMANN, E. 1936. The Alcyonaria of the western part of the Atlantic Ocean. *Memoirs of the Museum of Comparative Zoology, Harvard* 53:1–317.
- FARBRIEUS, K., AND P. ALDERSLADE. 2001. *Soft Corals and Sea Fans — A Comprehensive Guide to the Tropical Shallow-Water Genera of the Central-West Pacific, the Indian Ocean and the Red Sea*. Australian Institute of Marine Science, Townsville, Queensland, Australia. 264 pp.
- GOSLINER, T.M., D.W. BEHRENS, AND G.C. WILLIAMS. 1996. *Coral Reef Animals of the Indo-Pacific — Animal Life from Africa to Hawai'i Exclusive of the Vertebrates*. Sea Challengers, Monterey, California, USA. 314 pp.
- GRASSHOFF, M. 1999. The shallow water gorgonians of New Caledonia and adjacent islands (Coelenterata: Octocorallia). *Senckenbergiana Biologica* 78 (1/2):1–245.
- GRASSHOFF, M. 2000. The gorgonians of the Sinai coast and the Strait of Gubal, Red Sea (Coelenterata, Octocorallia). *Courier Forschungsinstitut Senckenberg* 224:1–125.
- GRASSHOFF, M., AND P. ALDERSLADE. 1997. Gorgoniidae of Indo-Pacific reefs with description of two new genera (Coelenterata: Octocorallia). *Senckenbergiana biologica* 77:23–35.
- GRASSHOFF, M. AND G. BARGIBANT. 2001. *Coral Reef Gorgonians of New Caldeonia (Les gorgones des récifs coralliens de Nouvelle-Calédonie)*. Paris, Éditions de l'IRD, Institut de Recherche pour le Développement, Collections Faune et Flore tropicales 38. 335 pp.
- KÜKENTHAL, W. 1915. Pennatularia. *Das Tierreich* 43:1–132. Verlag von R. Friedländer, Berlin, Germany..
- KÜKENTHAL, W. 1924. Gorgonaria. *Das Tierreich* 47:1–478. Walter de Gruyter & Co, Berlin und Leipzig, Germany.
- MATSUMOTO, A.K., AND L.P. VAN OFWEGEN. 2016. The genus *Bebryce* (Cnidaria, Octocorallia, Plexauridae) at Japan, with descriptions of three new species. *ZooKeys* 587:1–20.
- OFWEGEN, L. 2010a. *Calibelemon* Nutting, 1908. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://www.marinespecies.org/aphia.php?p=axdetails&id=205127>> on 2017-12-28.
- OFWEGEN, L. 2010b. *Hicksonella* Nutting, 1910. In: Cordeiro, R. 2017. World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://www.marinespecies.org/aphia.php?p=taxdetails&id=267486>> on 2017-12-29.
- OFWEGEN, L. 2010c. *Keroeides*. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://www.marinespecies.org/aphia.php?p=taxdetails&id=267529>> on 2018-01-10.
- OFWEGEN, L. 2010d. *Anthogorgia* Verrill, 1868. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://marinespecies.org/aphia.php?p=taxdetails&id=205062>> on 2018-01-11.
- OFWEGEN, L. 2010e. *Trimuricea*. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://www.marinespecies.org/aphia.php?p=taxdetails&id=267922>> on 2018-01-15.
- OFWEGEN, L. 2010f. *Bebryce* Philippi, 1841. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://www.marinespecies.org/aphia.php/aphia.php?p=taxdetails&id=12530>> on 2018-01-15.
- OFWEGEN, L. 2016. *Asperaxis* Alderslade, 2006. In: Cordeiro, R., 2017, World List of Octocorallia. Accessed through: World Register of Marine Species at <<http://marinespecies.org/aphia.php/aphia.php?p=taxdetails&id=267239>> on 2017-12-28.
- REIJNEN, B.T., C.S. MCFADDEN, Y.T. HERMANLIMANTO, AND L.P. VAN OFWEGEN. 2014. A molecular and morphological exploration of the generic boundaries in the family Melithaeidae (Coelenterata: Octocorallia) and its taxonomic consequences. *Molecular Phylogenetics and Evolution* 70:383–401. doi: 10.1016/j.ympev.2013.09.028.
- SAMIMI-NAMIN, K., AND L.P. VAN OFWEGEN. 2016. A revision of *Trimuricea* Gordon, 1926 (Cnidaria: Octocorallia: Plexauridae) with the description of six new species. *Zootaxa* 4105 (1):1–44.
- WILLIAMS, G.C. 1990. The Pennatulacea of southern Africa (Coelenterata, Anthozoa). *Annals of the South African Museum* 99 (4):31–119.

- WILLIAMS, G.C. 1992. The Alcyonacea of southern Africa. Gorgonian Octocorals (Coelenterata, Anthozoa). *Annals of the South African Museum* 101 (8):181–296.
- WILLIAMS, G.C. 1995. Living genera of sea pens (Coelenterata: Octocorallia: Pennatulacea): illustrated key and synopses. *Zoological Journal of the Linnean Society* 113:93–140.
- WILLIAMS, G.C. 1999. Index Pennatulacea — annotated bibliography and indexes of the sea pens (Coelenterata: Octocorallia) of the world 1469–1999. *Proceedings of the California Academy of Sciences*, ser.4, 51(2):19–103.
- WILLIAMS, G.C. 2011. The global diversity of sea pens (Cnidaria: Octocorallia: Pennatulacea). *PLoS ONE* 6 (7):1–11.
- WILLIAMS, G.C. AND P. ALDERSLADE. 2011. Three new species of pennatulacean octocorals with the ability to attach to rocky substrata (Cnidaria: Anthozoa: Pennatulacea). *Zootaxa* 3001:33–48.
- WILLIAMS, G.C., AND J.-Y. CHEN. 2014. Illustrated key to shallow-water gorgonians and pennatulaceans of the central Philippines, including synopses of the taxa and glossary of terms (Cnidaria: Anthozoa: Octocorallia). Pages 67–128 in G.C. Williams and T.M. Gosliner, eds., *The Coral Triangle: The 2011 Hearst Philippine Biodiversity Expedition*. California Academy of Sciences, San Francisco, California, USA. 592 pp.
- WILLIAMS, G., AND C. MATTISON. 2018. Microscope slide or SEM stub preparation for octocoral sclerites or other invertebrate spicules. In: Octocoral Research Center Website. Research Techniques. <<http://researcharchive.calacademy.org/research/izg/OctoResearchTech.htm>>

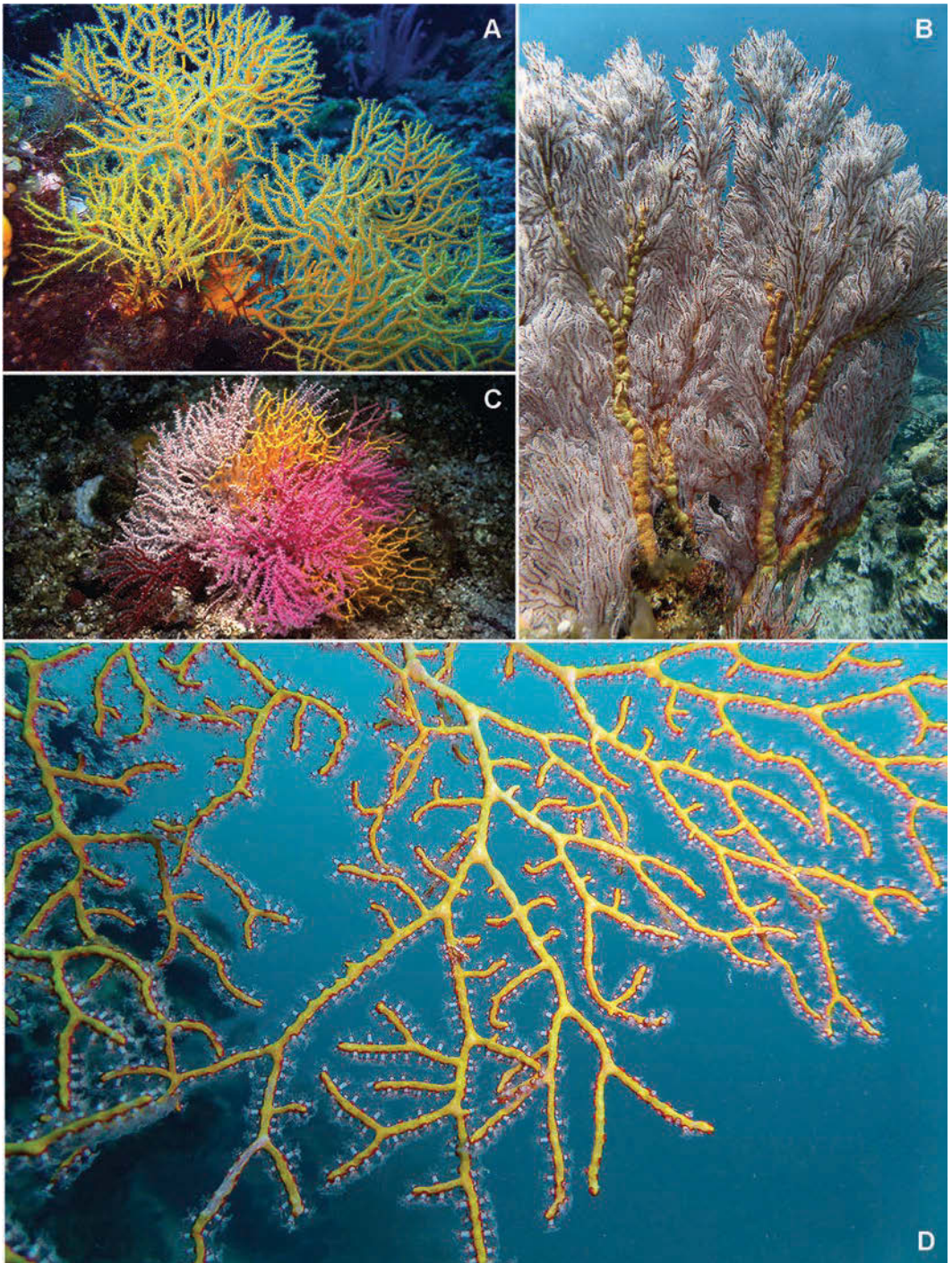


FIGURE 2. Underwater photographs of various species of *Melithaea* from the central Philippine islands; those in A, C, and D were formerly included in the genus *Acabaria*, which is now considered as a junior synonym of *Melithaea*.

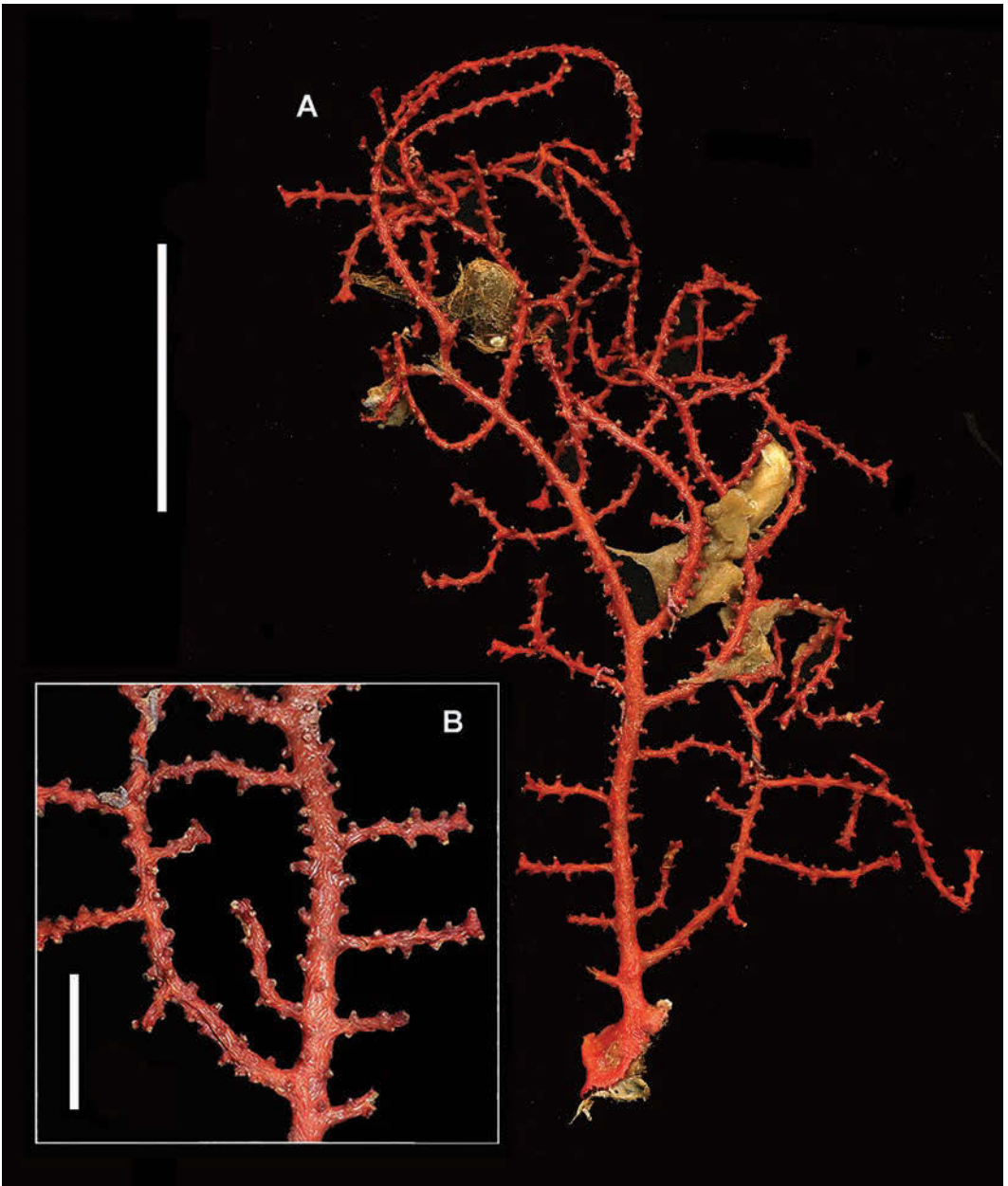


FIGURE 3. *Keroeides gracilis*. A. Entire wet-preserved colony (CASIZ 201396); scale bar = 30 mm. B. Detail of lower portion of colony in A; scale bar = 10 mm.

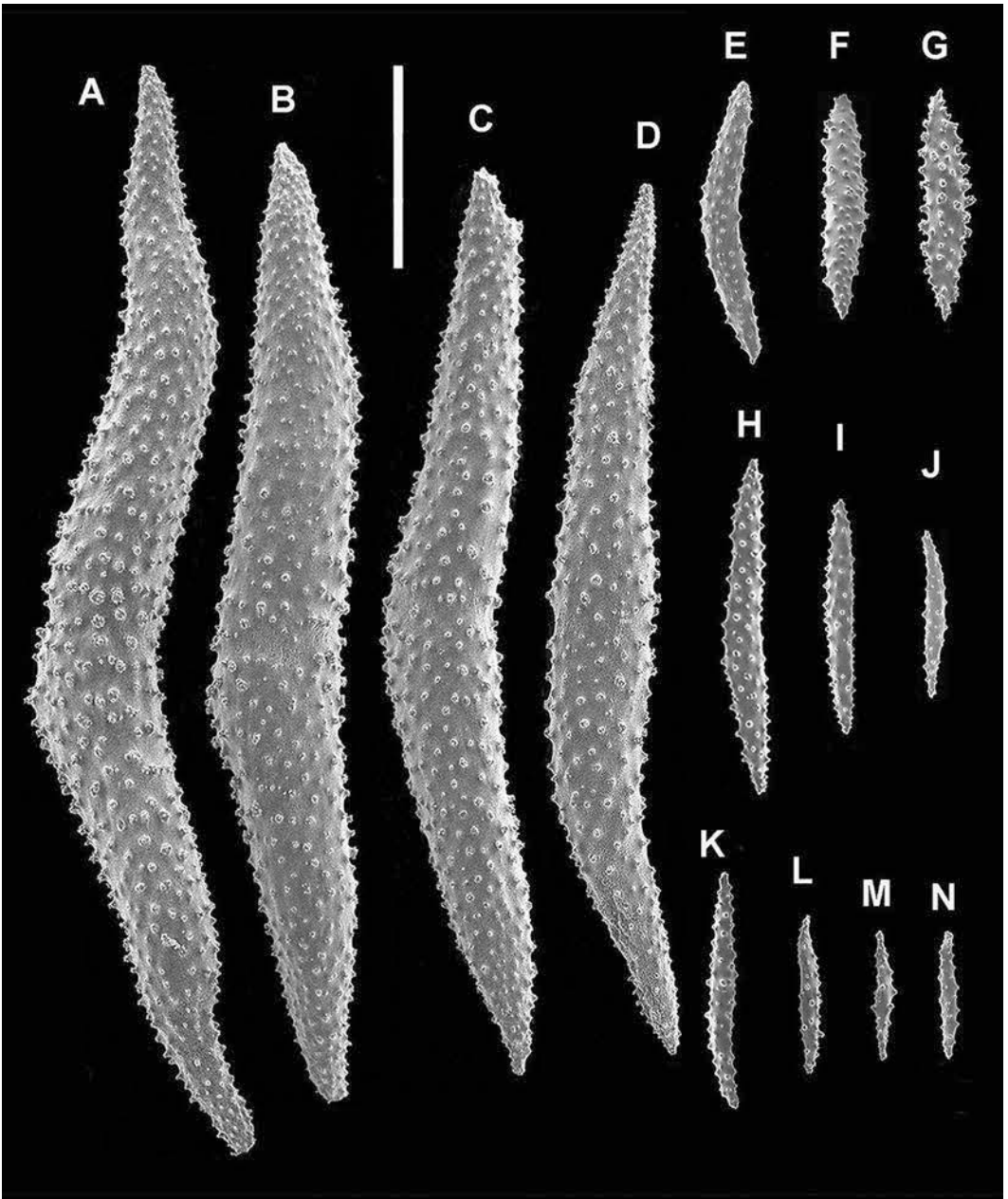


FIGURE 4. *Keroeides gracilis*. Scanning electron micrographs of sclerites from the coenenchyme and calyces (CASIZ 201396). A-D, sclerites from the coenenchymal surface. E-N, sclerites from various calyces. Scale bar = 0.3 mm.



FIGURE 5. *Anthogorgia* sp. indet. Underwater photographs, Calumpán Peninsula, March/April 2017. A. Anthocodiae retracted into the domelike proximal parts of the polyps. B. Anthocodiae fully expanded from the cylindrical proximal parts of the polyps.

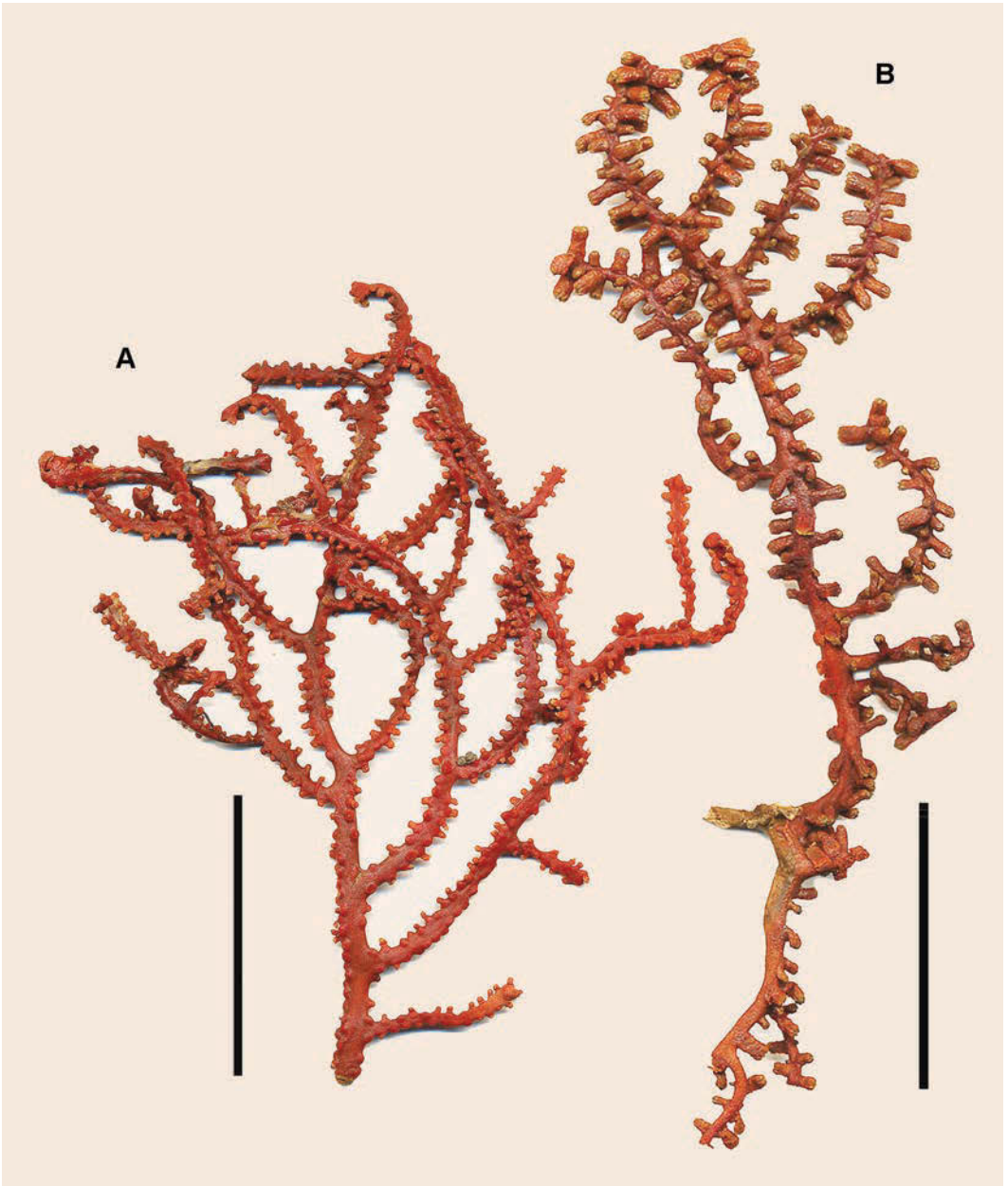


FIGURE 6. *Anthogorgia* spp. Wet-preserved specimens. A. *Anthogorgia* sp. 2, partial colony (CASIZG 207505), scale bar = 50 mm. B. *Anthogorgia* sp. 1, partial colony (CASIZG 222412), scale bar = 30 mm.

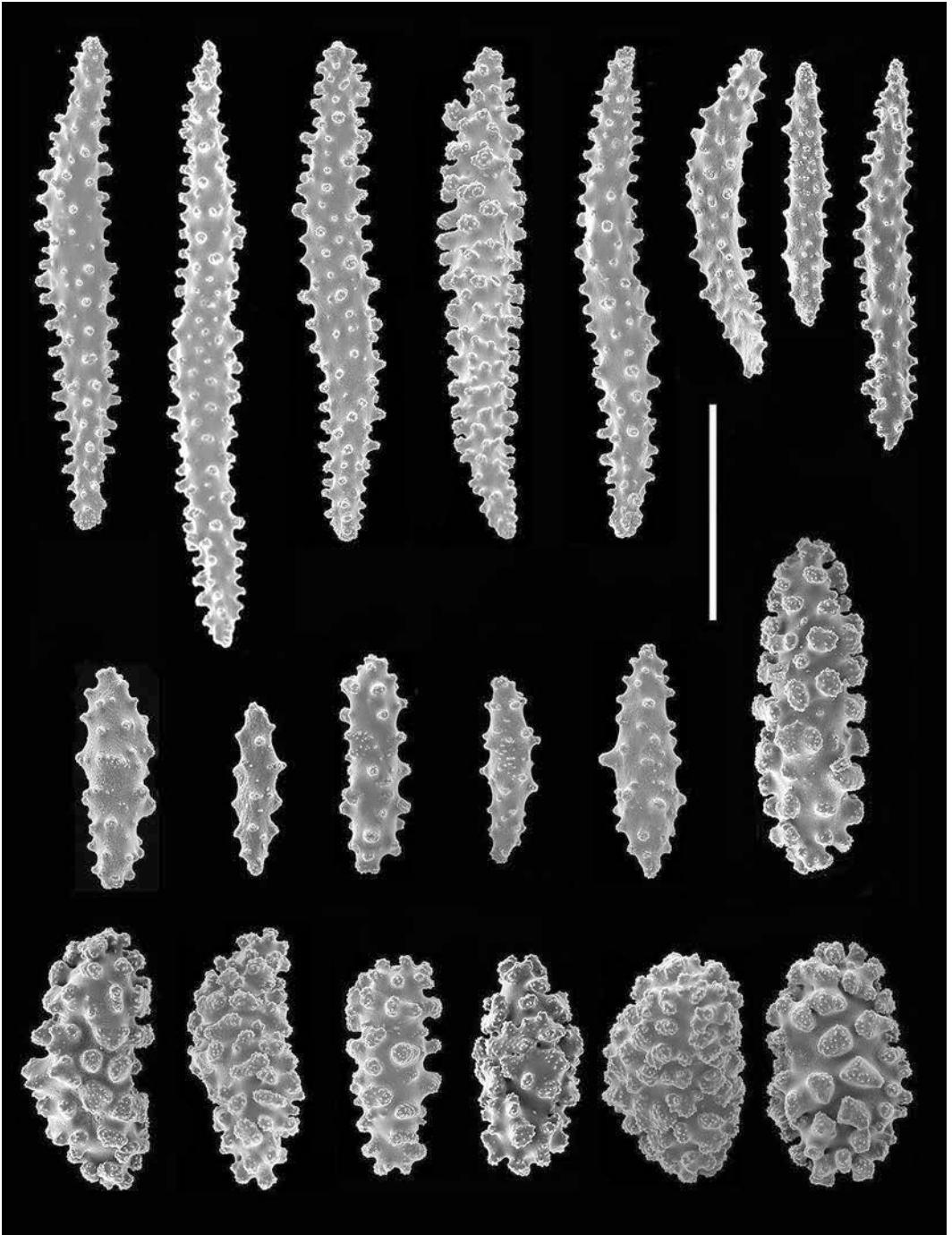


FIGURE 7. *Anthogorgia* sp. 1. Scanning electron micrographs of sclerites from the polyp walls and surface of the coenenchyme (CASIZG 222412), scale bar = 0.20 mm.

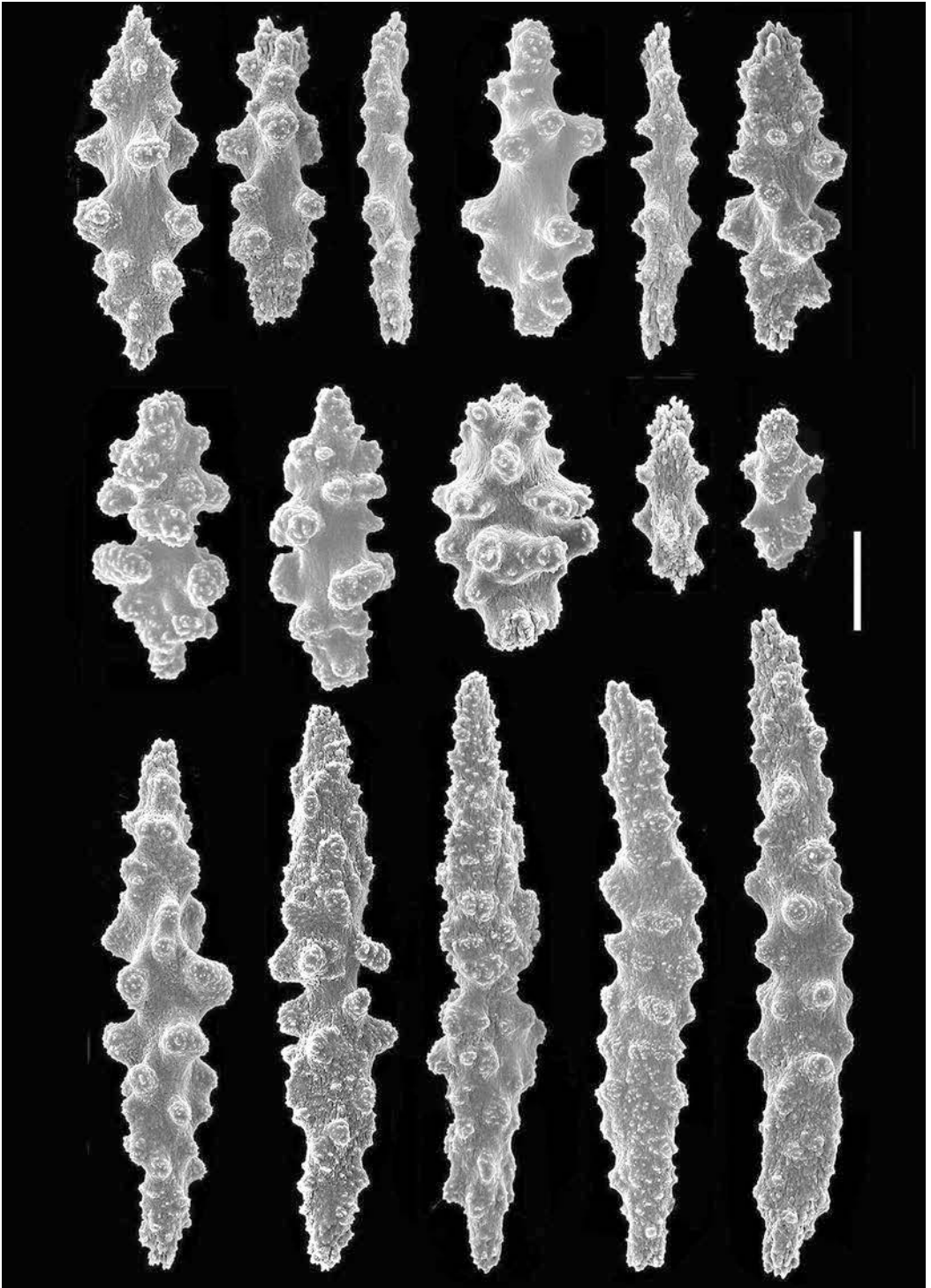


FIGURE 8. *Anthorgia* sp. 2. Scanning electron micrographs of sclerites from the polyp walls and surface of the coenenchyme (CASIZG 207505), scale bar = 0.03 mm.

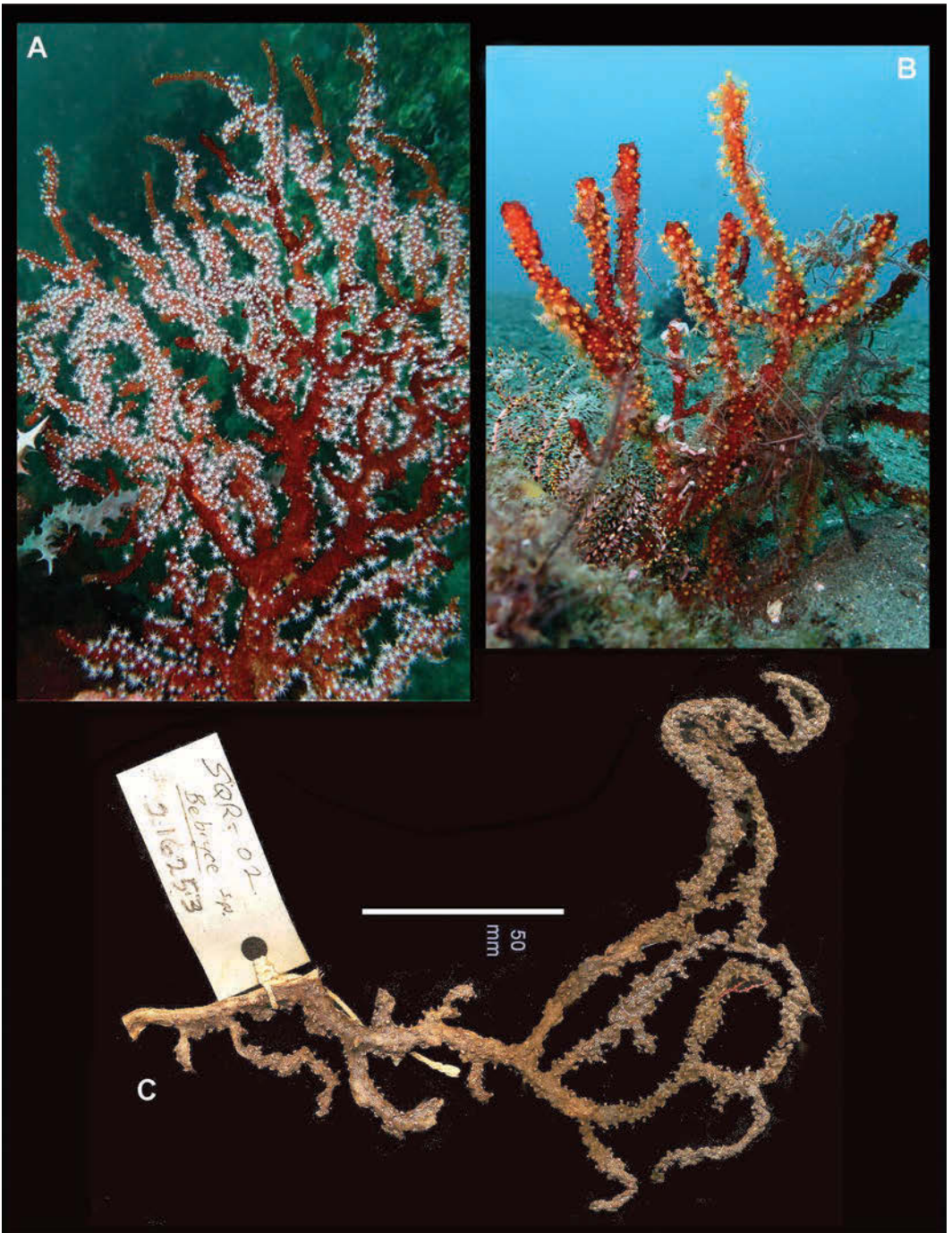


FIGURE 9. A. *Bebryce grandicalyx*. A-B. Underwater photographs of two colonies with polyps extended, southeastern Negros Island. C. Wet-preserved specimen (CASIZ 216253), Siquijor Island, scale bar = 50 mm.

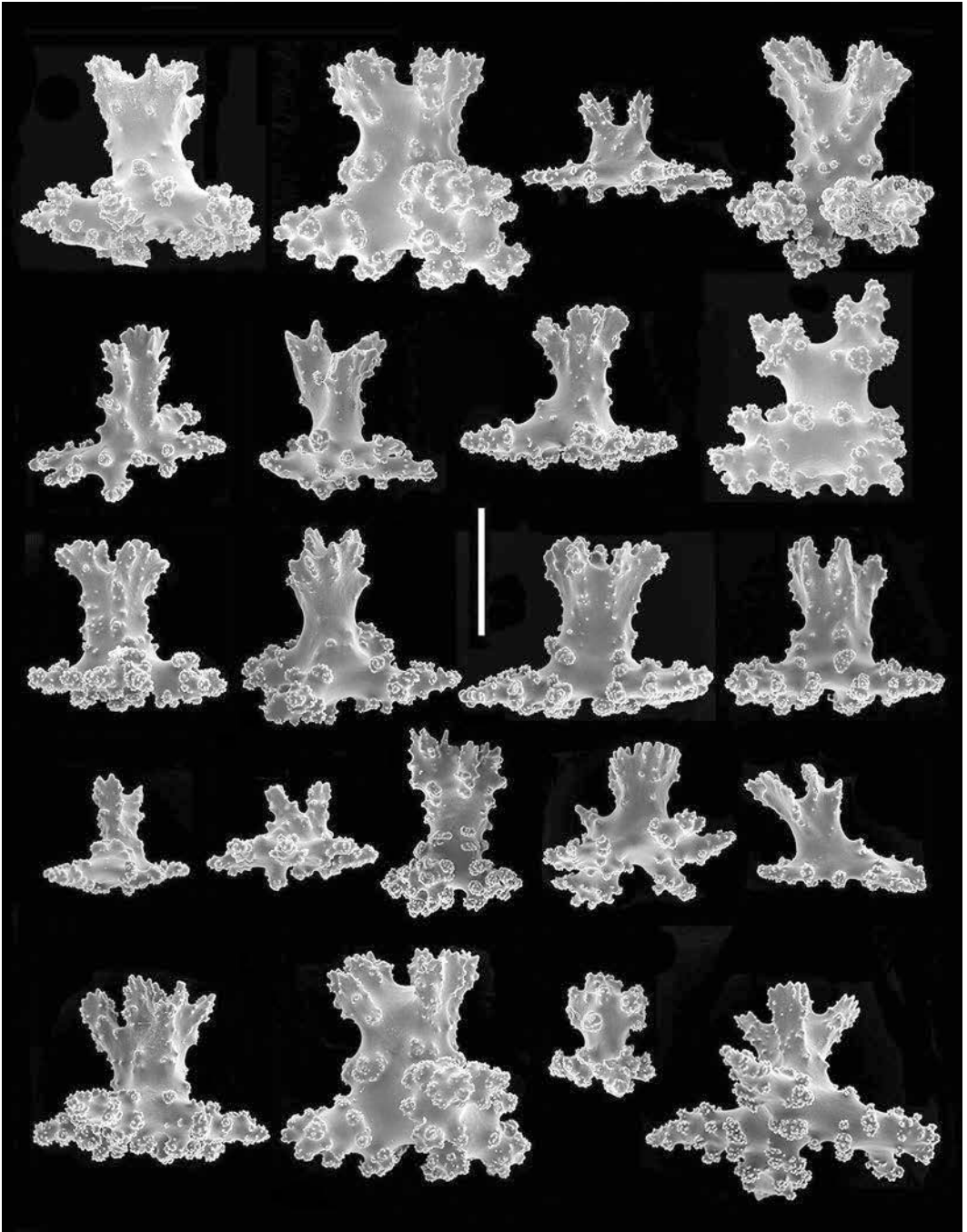


FIGURE 10. *Bebryce grandicalyx*. Scanning electron micrographs of sclerites; rosettes from the surface of the coenenchyme, scale bar = 0.10 mm.

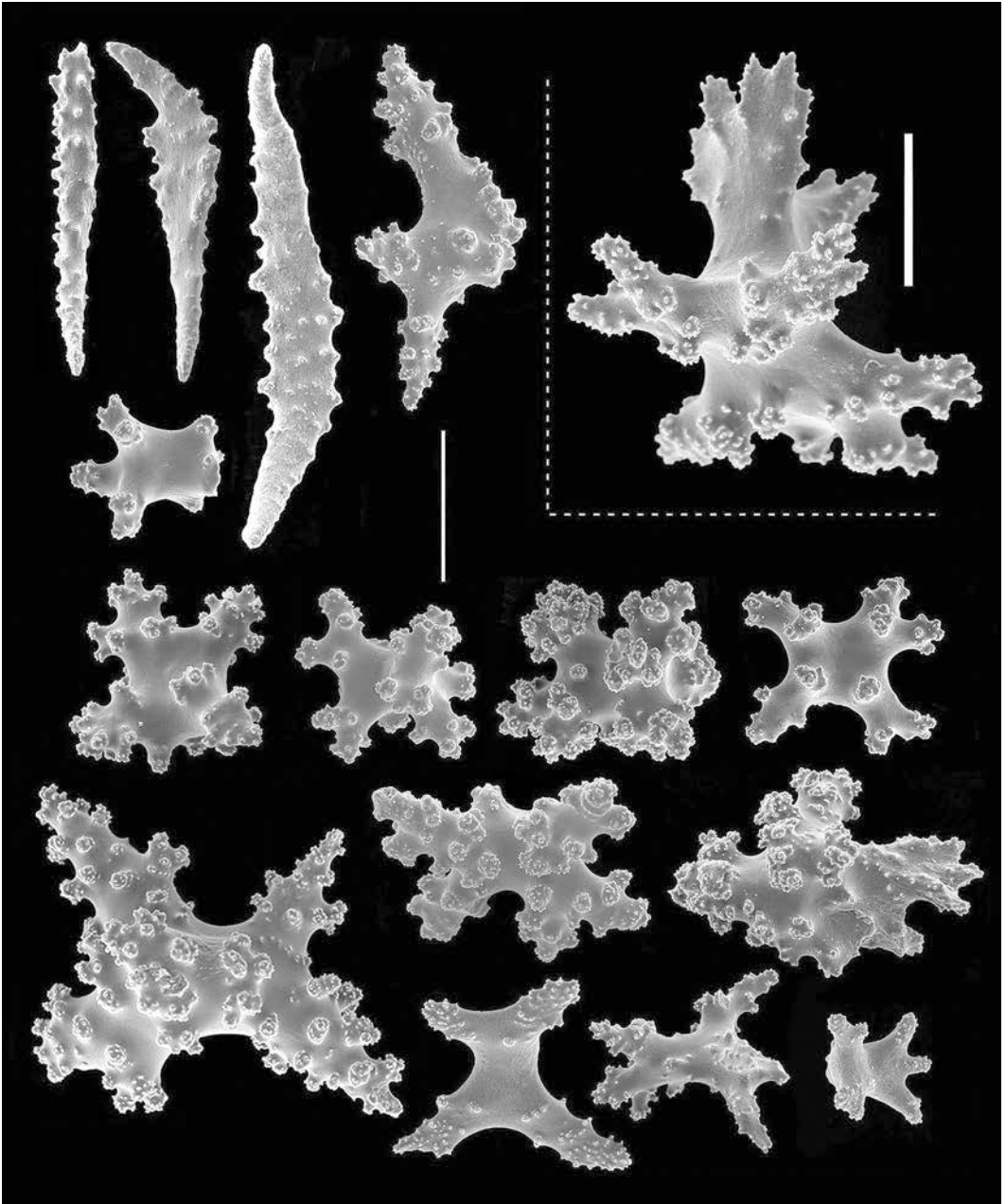


FIGURE 11. *Bebryce grandicalyx*. Scanning electron micrographs of sclerites. Four polyp sclerites (Top left); sclerites of the coenenchyme (Bottom half of figure), scale bar = 0.10 mm. A single rosette (Inset), scale bar = 0.05 mm.

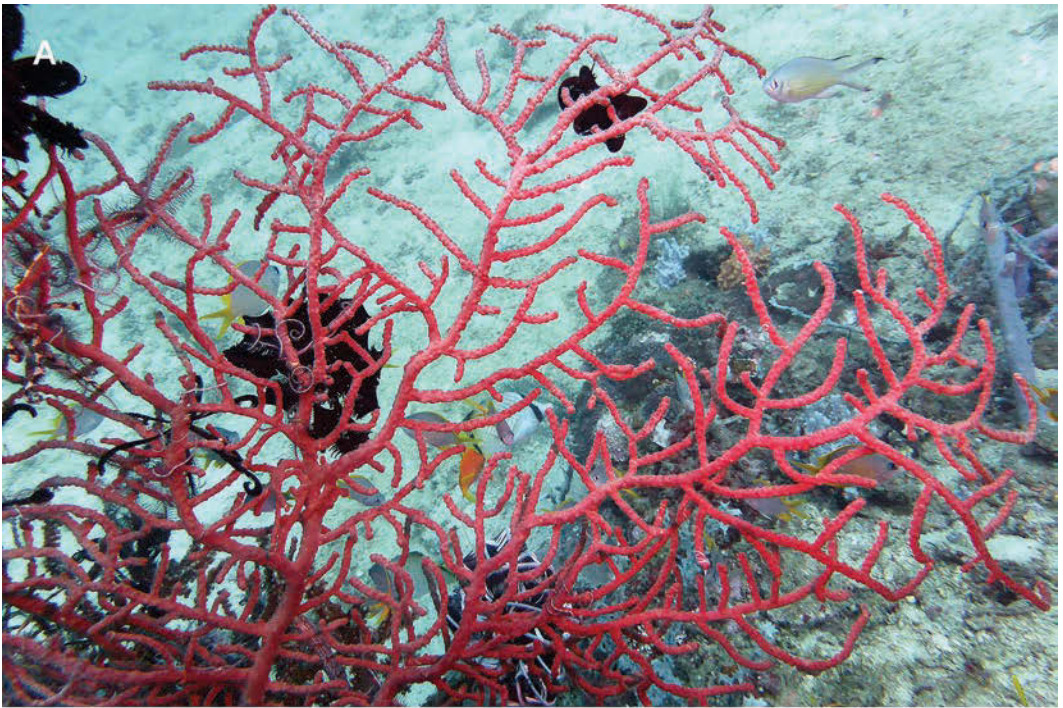


FIGURE 12. *Trimuricea cf. inermis* (CASIZ 207510). A. Underwater photograph, Negros (Siaton Province), April 2016. B. Wet-preserved colony, scale bar = 20 mm.

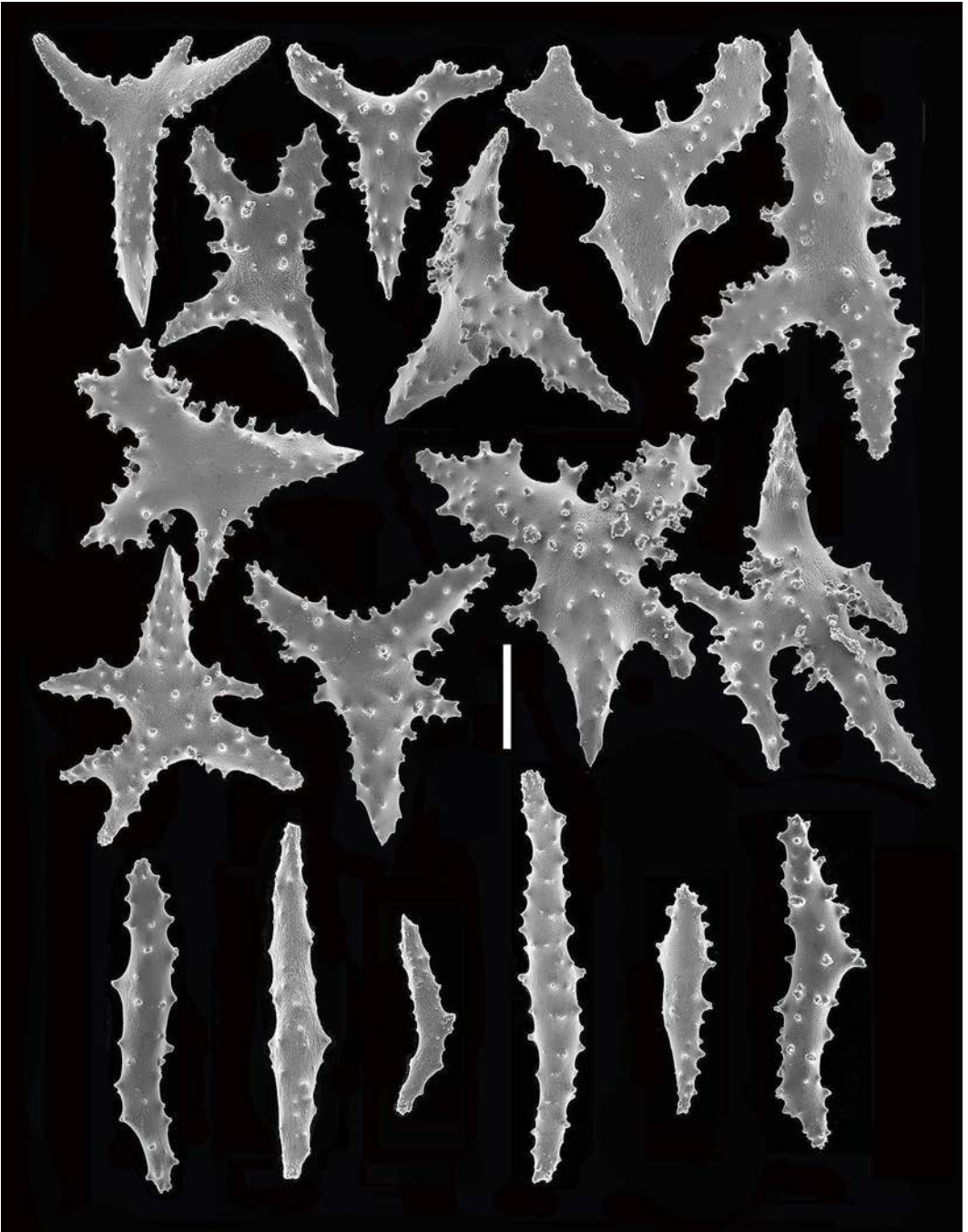


FIGURE 13. *Trimuricea cf. inermis*. Scanning electron micrographs of sclerites from the polyps, calyces, and surface coenenchyme, scale bar = 0.10 mm.

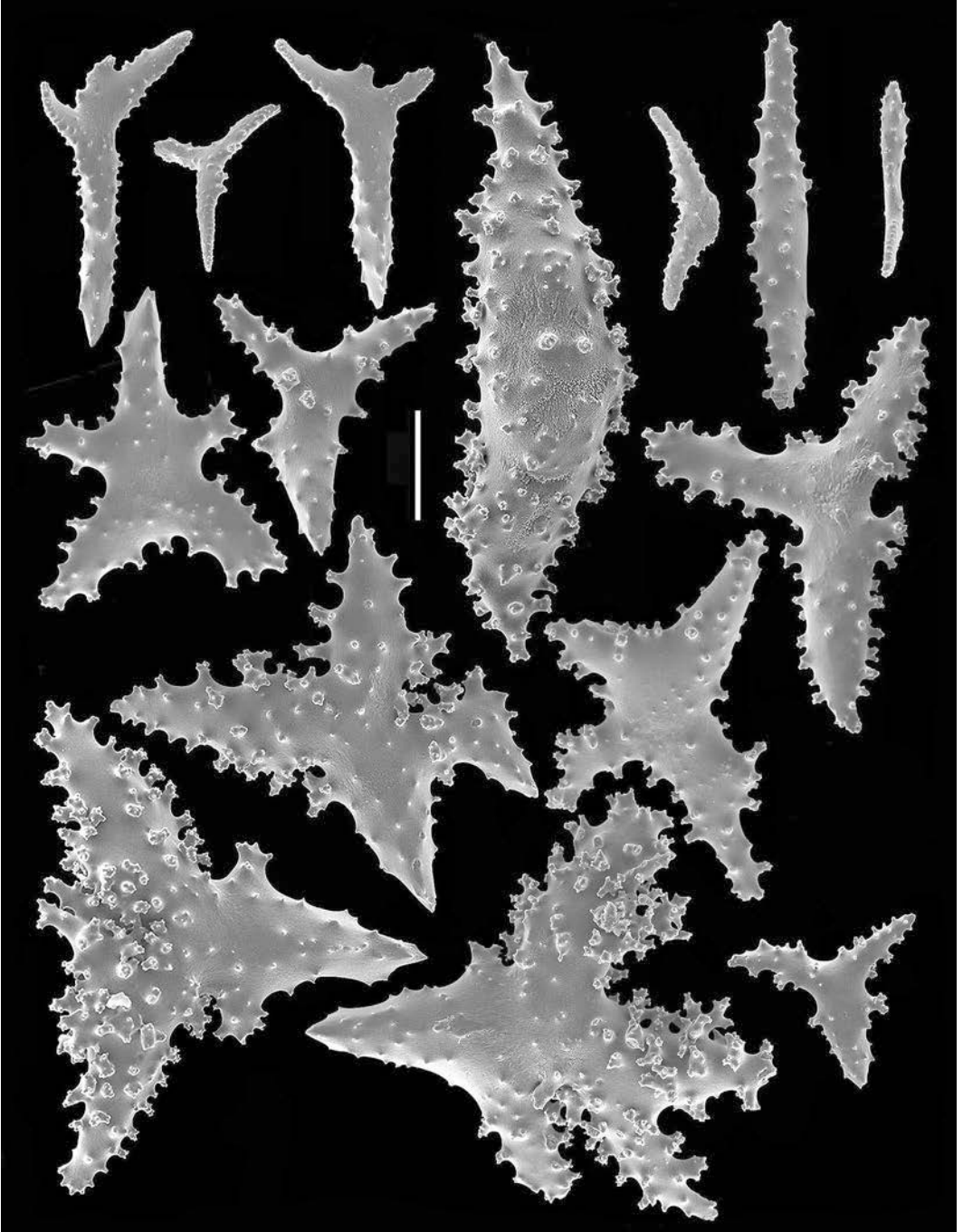


FIGURE 14. *Trimuricea* cf. *inermis*. Scanning electron micrographs of sclerites from the polyps, calyces, and surface coenenchyme, scale bar = 0.10 mm.

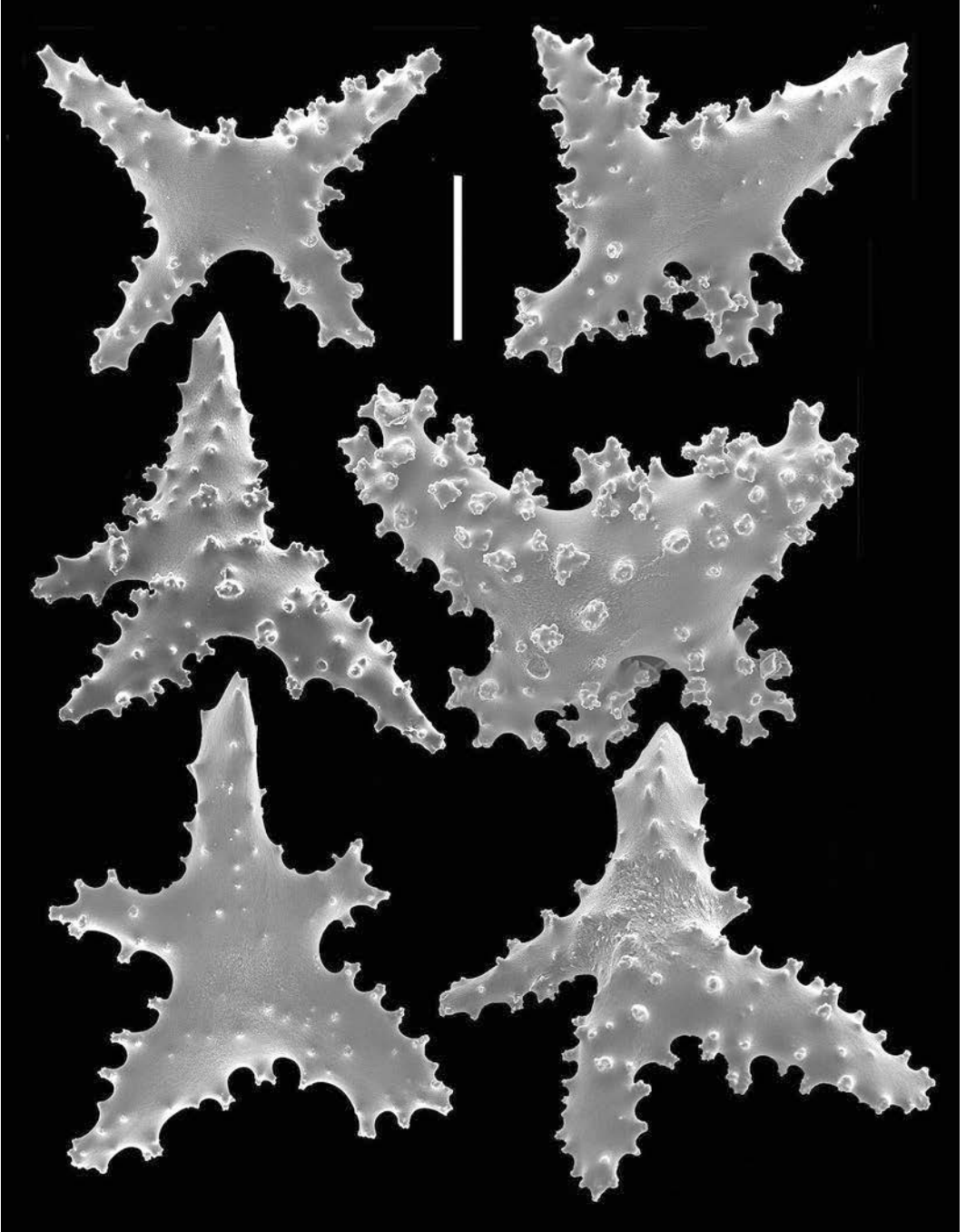


FIGURE 15. *Trimuricea cf. inermis*. Scanning electron micrographs of sclerites from the calyces and surface of the coenenchyme. Scale bar = 0.10 mm.

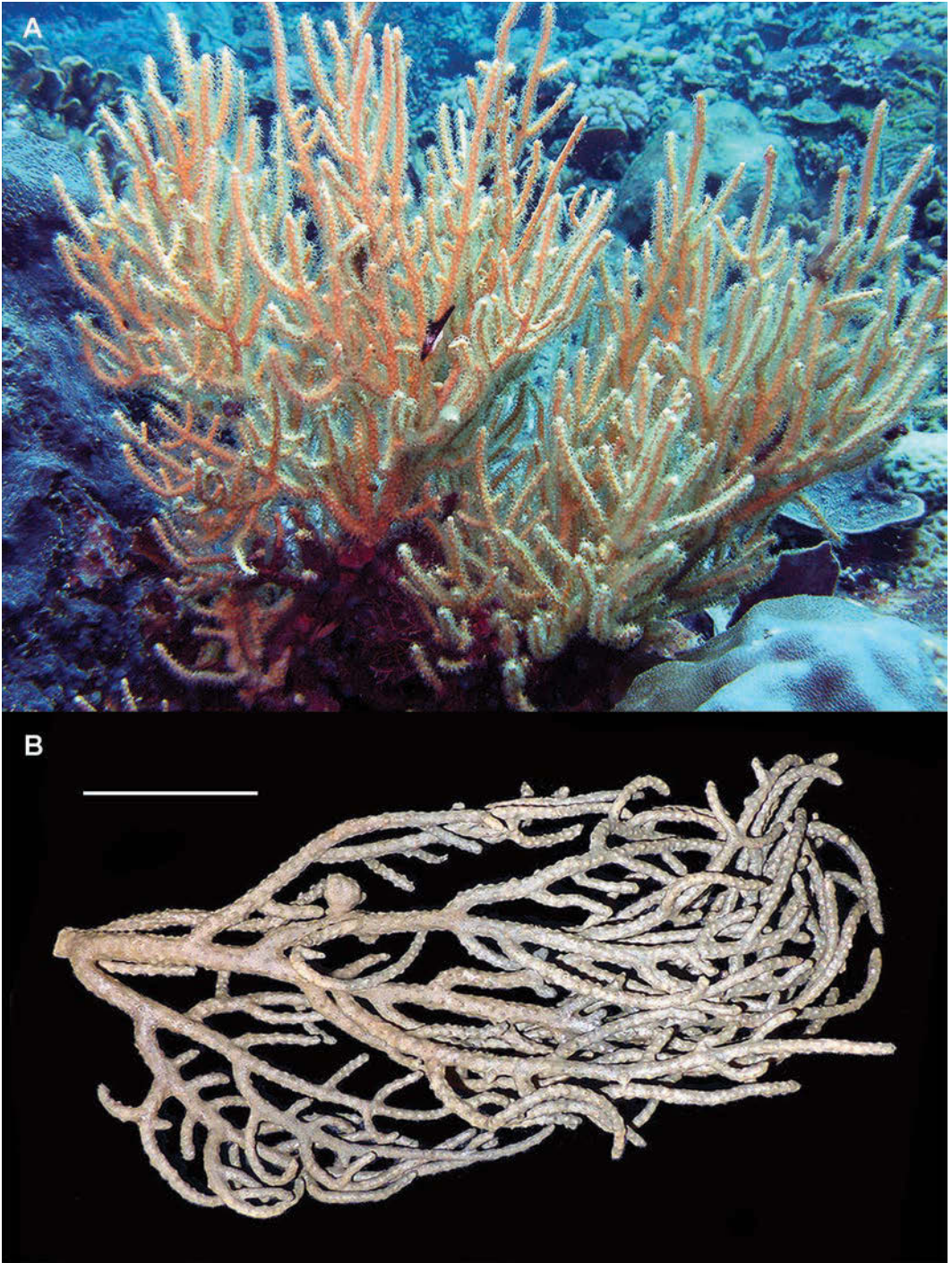


FIGURE 16. *Hicksonella princeps*. A. Underwater photograph, Lubang Island, May 2014. B. Wet-preserved partial colony (CASIZG 201363), Lubang Island, May 2014, scale bar = 25 mm.

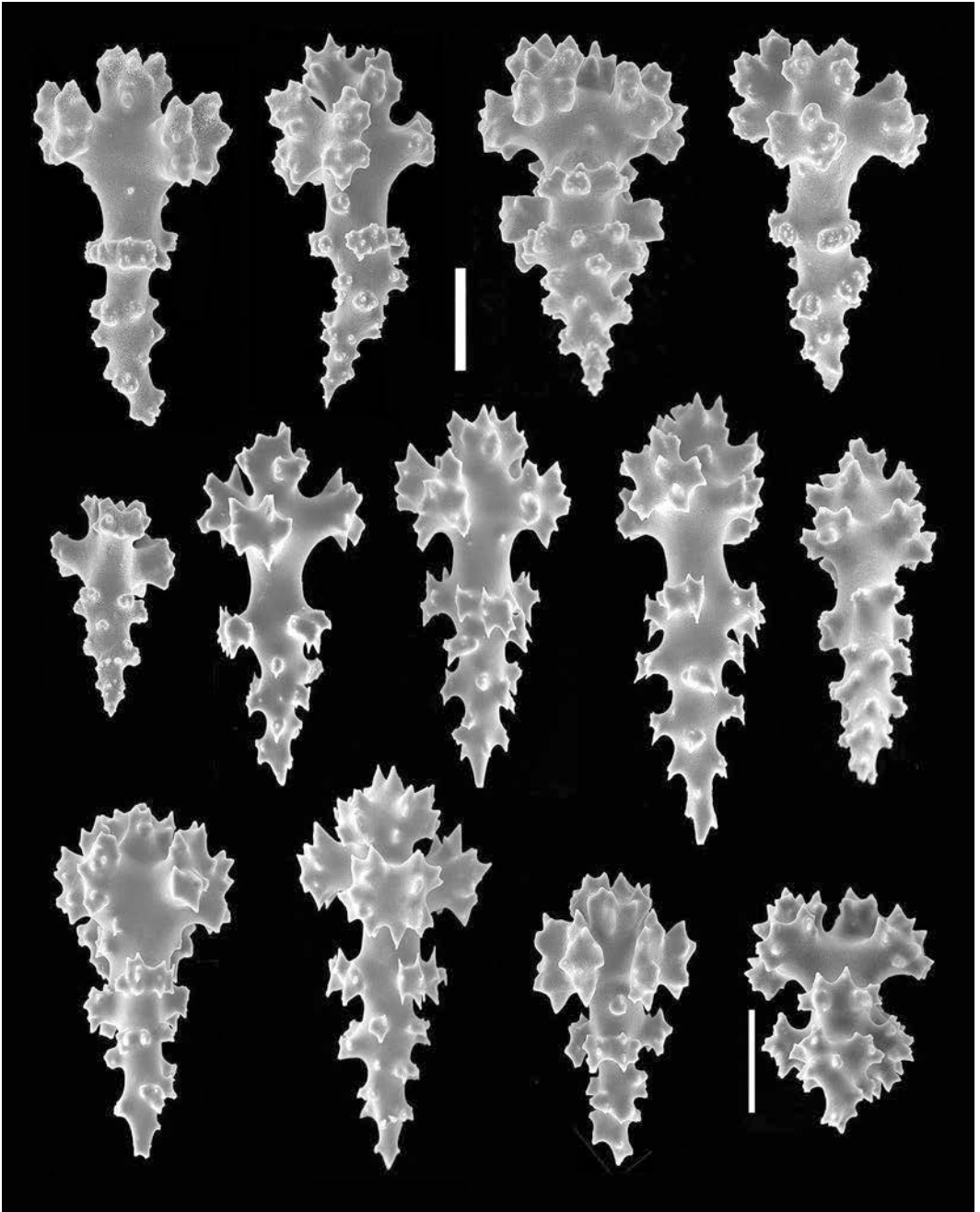


FIGURE 17. *Hicksonella princeps*. Scanning electron micrographs of sclerites from the surface coenenchyme, scale bar = 0.03 mm.

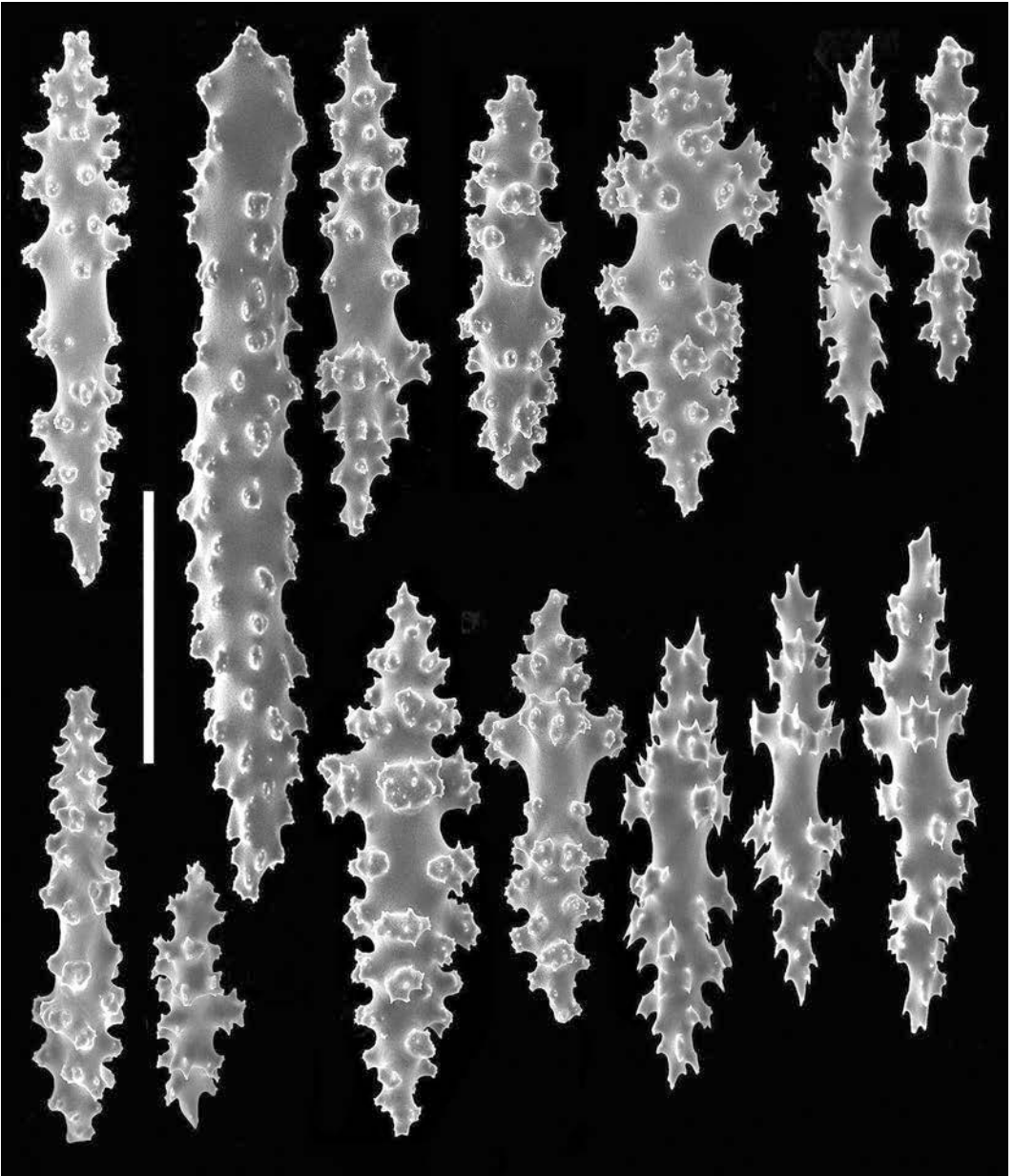


FIGURE 18. *Hicksonella princeps*. Scanning electron micrographs of sclerites from the subsurface coenenchyme, scale bar = 0.10 mm.

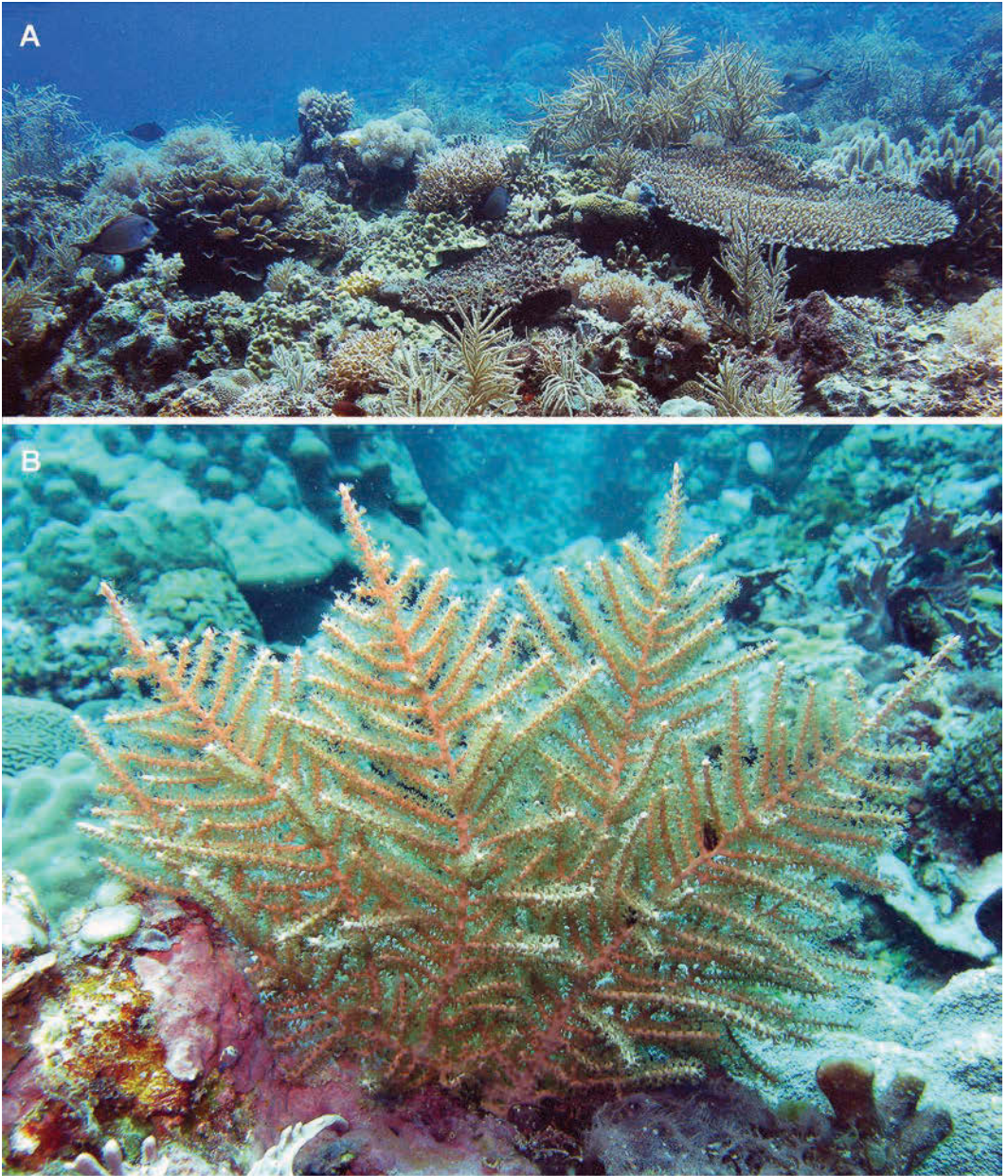


FIGURE 19. *Pinnigorgia flava*. Underwater images. A. Coral reef with numerous colonies, Lubang Island, 14 m depth. B. A single colony, Lubang Island, 12 m depth.



FIGURE 20. *Pinnigorgia flava*. Wet-preserved colonies (CASIZG 201640). A. Scale bar = 20 mm. B. Scale bar = 25 mm. C. Scale bar = 10 mm.

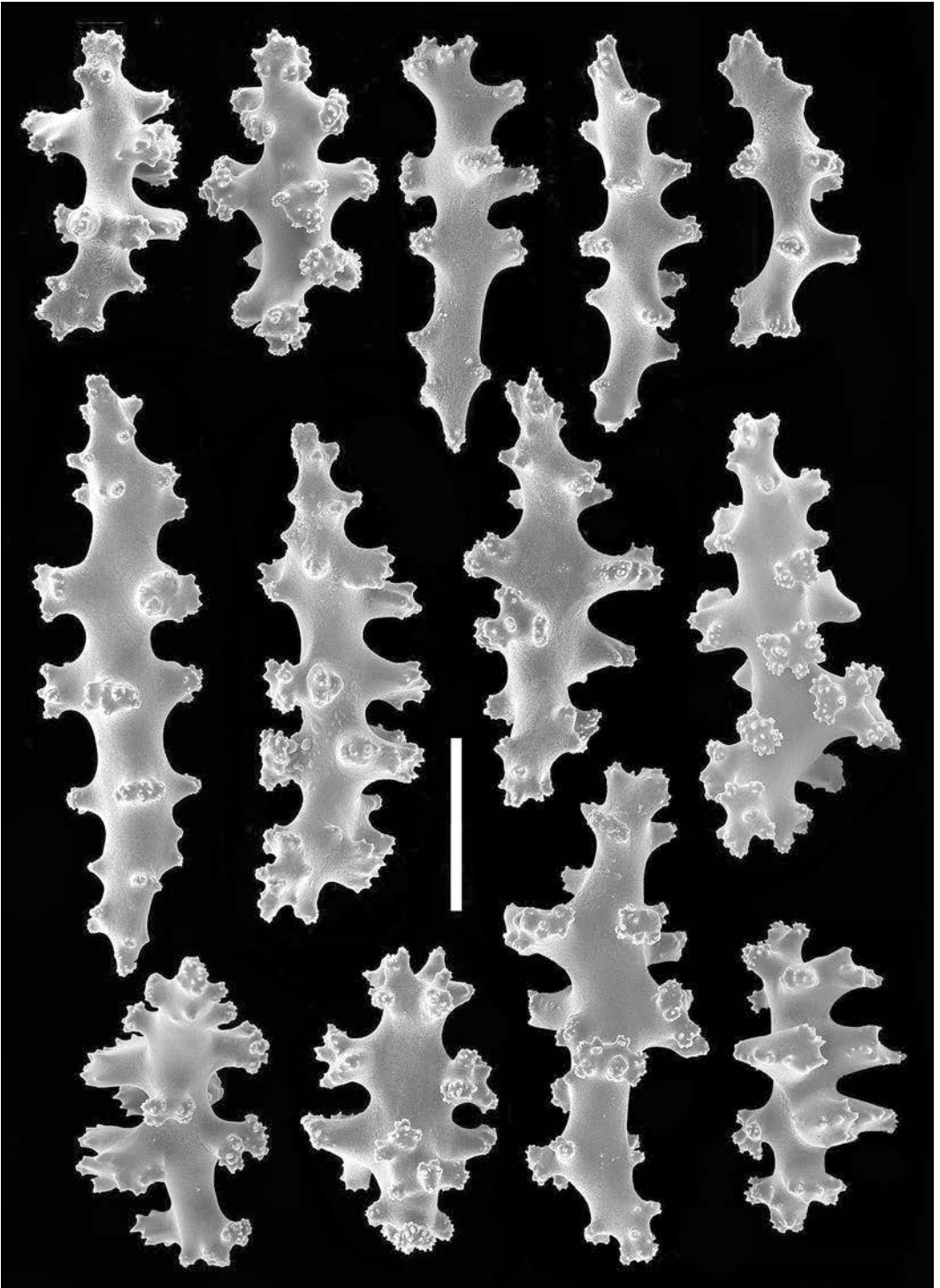


FIGURE 21. *Pinnigorgia flava*. Scanning electron micrographs of coenenchymal sclerites, scale bar = 0.08 mm.

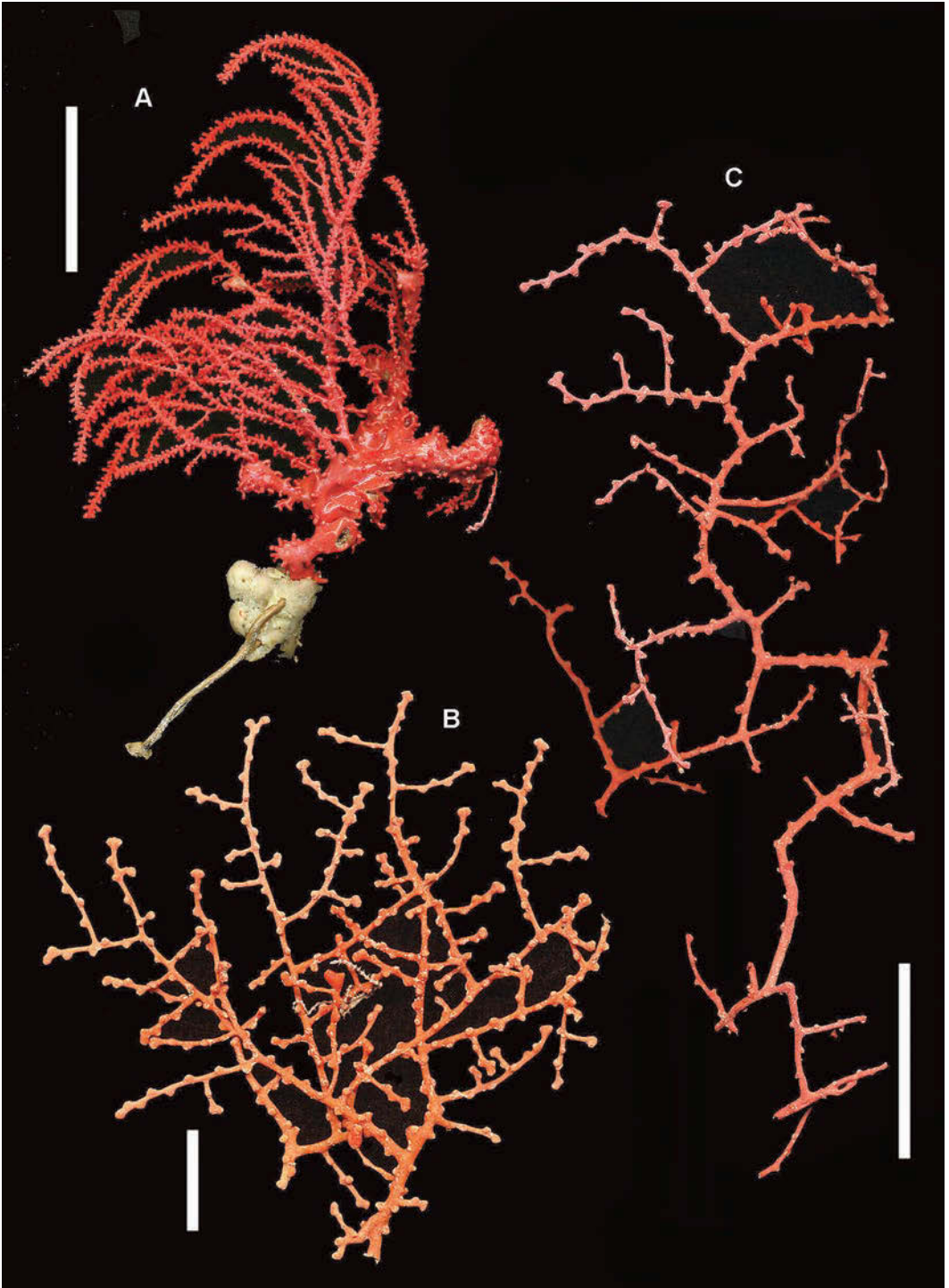


FIGURE 22. *Heliania spinescens* and *Verrucella* spp. A. *Heliania spinescens*, whole colony (CASIZG 222404), scale bar = 30 mm. B. *Verrucella* sp. 1, partial colony (CASIZG 197824), scale bar = 35 mm. C. *Verrucella* sp. 2, partial colony (CASIZG 197809), scale bar = 20 mm.

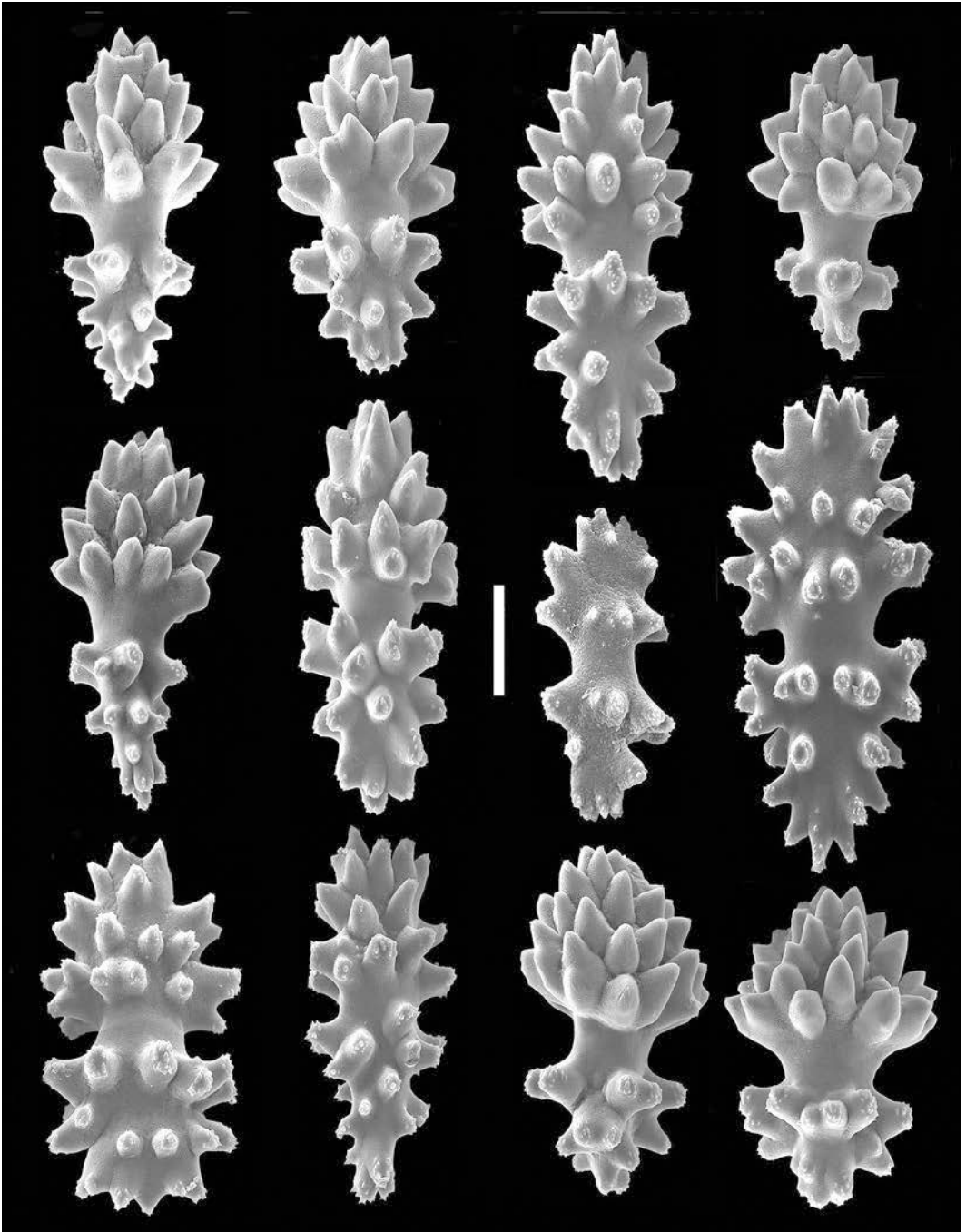


FIGURE 23. *Heliania spinescens*. Scanning electron micrographs of coenenchymal sclerites, scale bar = 0.02 mm.

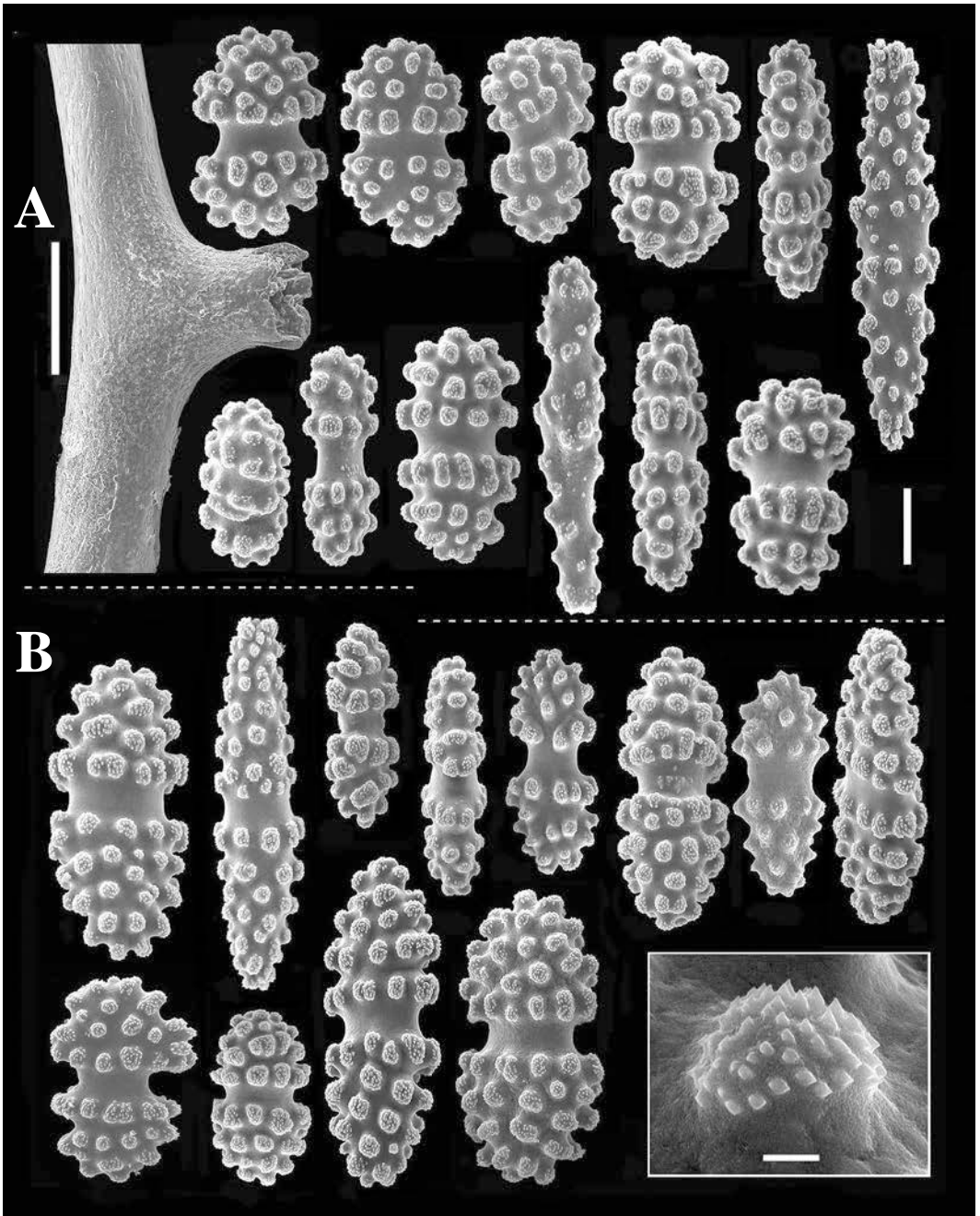


FIGURE 24. *Verrucella* spp. A. Scanning electron micrographs of internal axis and sclerites (CAS 197809). Scale bar for sclerites = 0.02 mm. Upper left, a portion of bare axis from a terminal branch with a lateral branch broken off near its base, scale bar = 0.5 mm. B. Scanning electron micrographs of sclerites (CAS 197824), scale bar = 0.02 mm. Lower right, Detail of a single multi-toothed tubercle from the sclerite on the adjacent left, scale bar = 0.002 mm.

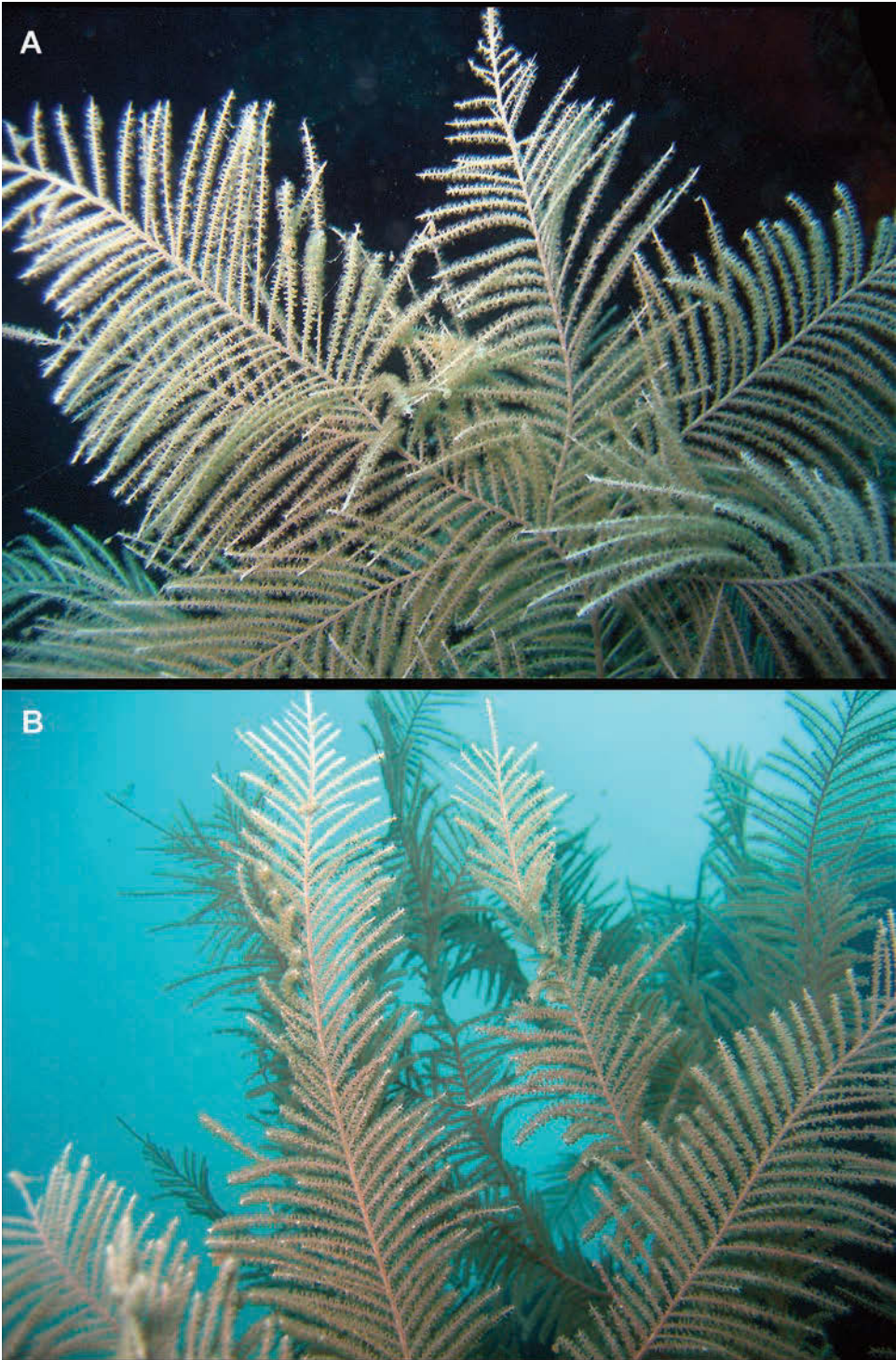


FIGURE 25. *Plumigorgia hydroides*. A-B. Underwater photographs in situ, Busuanga Island – Calamian Group, Palawan Province, 9-12 m depth, February 2010.



FIGURE 26. A. *Calibelemnon* sp., wet-preserved whole specimen (CASIZG 201545), scale bar = 15 mm. B. *Plumigorgia hydroides*, wet-preserved specimens (CASIZG 207506), scale bar = 20 mm. C. *Plumigorgia hydroides* (CASIZG 180888), scale bar = 35 mm.

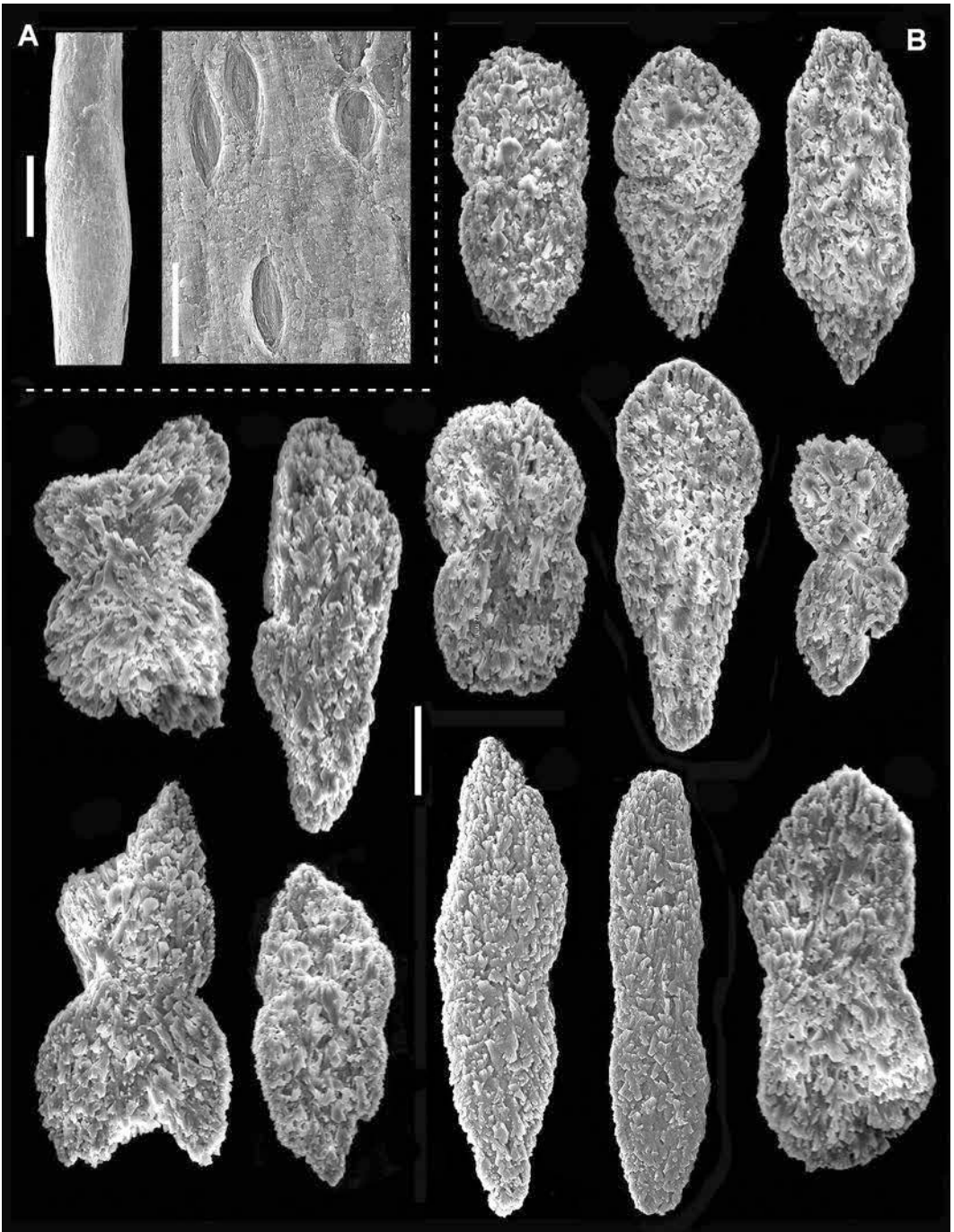


FIGURE 27. *Plumigorgia hydroides*, scanning electron micrographs. A. Surface of axis: Left, portion of axis near a distal branch tip, scale bar = 0.2 mm. Right, magnified detail of surface showing slit-like surface perforations, scale bar = 0.02 mm. B. Coenenchymal sclerites, scale bar = 0.02 mm.