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Octocorals from Costa Rica: The genus *Pacifigorgia* (Coelenterata: Octocorallia: Gorgoniidae)

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Table of contents

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Abstract

Species of the genus *Pacifigorgia* are surveyed for the first time in the shallow Pacific seas off Costa Rica. They are identified and described with detailed illustrations. The main collection belongs to the Zoology Museum, University of Costa Rica. Most of this material has been collected by means of SCUBA. This regional account of *Pacifigorgia* includes four species that were previously described: *P. adamsii, P. eximia, P. irene* and *P. stenobrochis*, and another nine that are new species.

Key words: Cnidaria, Coelenterata, Costa Rica, eastern Pacific, gorgonian, new species, octocoral, *Pacifigorgia*, sea fans, soft corals, taxonomy

Introduction

Octocorallia is a group of marine organisms with a wide geographical range and a broad environmental tolerance; they are found from the Arctic to the Antarctic Oceans and occur in different population densities from shallow waters to deep abysses (Bayer 1981). Many areas, such as the eastern Pacific, have not been extensively surveyed (Bayer 1981; Williams & Lindo 1997) and therefore, no comprehensive taxonomic accounts have been made.

Gorgonian octocorals (order Alcyonacea) are the most abundant components of the shallow eastern Pacific waters (Hickson 1928; Prahl et al. 1986; Breedy & Guzman 2002).

The lack of extensive surveys along the eastern Pacific and ambiguous descriptions of this fauna have led to taxonomic confusion and apathy in the study of these organisms. The most important general contributions on gorgonians of the eastern Pacific are Valenciennes (1846, 1855), Verrill (1868a–c, 1869a–b, 1870), Hickson (1928), Bielschowsky (1918, 1929), Kükenthal (1924), and Stiasny (1941, 1943). However, these authors failed to provide detailed illustrations and in most cases holotypes were not designated (Prahl et al. 1986; Breedy & Guzman 2002).

Eleven genera in four families have been previously reported for the eastern Pacific: Gorgoniidae (*Eugorgia, Leptogorgia, Pacifigorgia, Phycogorgia*); Paramuriceidae (*Heterogorgia*); Plexauridae (*Muricea, Psammogorgia, Thesea, Echinogorgia, Adelogorgia*); and Ellisellidae (*Ellisella*), (Bayer 1958; Bayer & Deichmann 1960). With the exception of the genus *Pacifigorgia*, which was recently revised (Breedy & Guzman 2002) the rest remain to be studied in detail.

Octocorals are common along the coasts of Costa Rica, ranging widely in distribution and depth. Very little taxonomic research has been carried out on this group: Guzman and Cortés (1985) described 23 species from the Caribbean, later, Guzman and Jiménez (1989) added one more to the list. Verrill (1868c) reported five species for the Pacific coast, and Breedy (2001) described one more.

The genus *Pacifigorgia* was established for reticulated fan-shaped gorgoniids with a thin coenenchyme, containing mainly different types of girdled spindle-shaped sclerites, but lacking scaphoid forms (Bayer 1951). The taxonomy of this genus is mainly based on the combination of three morphological characteristics: growth form of the colony; shape of the sclerites; and colour of the colonies and the sclerites (Breedy & Guzman, 2002).

The genus *Pacifigorgia* is restricted, except for one western Atlantic species, to the Pacific Ocean. Eighteen species have been recognized as valid (Breedy & Guzman 2002). The present work deals with the species of *Pacifigorgia* that occur in the shallow Pacific waters (1-50 m deep) off Costa Rica. This study represents the first survey of the octocorallian fauna of the Costa Rican Pacific and the second contribution in a series that attempts to evaluate and identify the genera of Gorgoniidae in the shallow central eastern Pacific.

Abbreviations

BM: The Natural History Museum (former British Museum), London, UK; CASIZ: California Academy of Science, Invertebrate Zoology, San Francisco, USA; CIMAR: Centro de Investigación en Ciencias del Mar y Limnología, Universidad de Costa Rica, Costa Rica; CIEMIC: Centro de Investigación en Estructuras Microscópicas, Universidad de Costa Rica; ICZN: International Code of Zoological Nomenclature; MNHN: Muséum National d'Histoire Naturelle, Paris, France; MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, USA; SEM: Scanning Electron Microscopy; STRI: Smithsonian Tropical Research Institute, Panamá; UCR: Museo de Zoología, Escuela de Biología, Universidad de Costa Rica; USNM: National Museum of Natural History (former United States National Museum), Smithsonian Institution, Washington, D.C., USA; YPM: Yale Peabody Museum of Natural History, New Haven, USA.

Material and methods

The specimens for this research belong to the following octocorallian collections: UCR, CASIZ, MCZ, YPM and USNM. Fresh material collected recently by STRI from the Pacific coast of Panamá has also been examined and is included for reference. Holotypes, paratypes, and additional material from the CASIZ, MCZ, YPM, and USNM, were obtained by loan, or personal visits (1999, 2001). The UCR and STRI material was collected by hand using SCUBA or skin diving. It was air-dried or fixed in 70% ethanol. Most of the specimens are dry colonies as are the types (Breedy & Guzman 2002). Diagnoses were made using characteristics that are mostly detectable in dry specimens. When alcohol preserved specimens were available, other features were taken in account, such as the colour of the polyps and the arrangement of the polyp's sclerites.

Costa Rica is located in Central America between Nicaragua and Panamá [10° North, 84° West (Plate 1)]. Its Pacific coastline is around 1000 km long, very irregular, with many peninsulas and gulfs which present very different oceanographic characteristics. In general, tides range from 1.5 m to 6 m. The thermocline is shallow from 20-50 m, producing upwellings in some areas close to the coast. The collection sites are indicated on the map (Plate 1).

Specimens were treated following Bayer's (1961) methodology with a few modifications (Breedy & Guzman 2002). A Nikon compound microscope with a Nikon NFX-35 camera was used to take photomicrographs. For SEM, sclerites were treated according to Breedy & Guzman (2002). Size of sclerites was obtained from pictures and directly from the microscope using an optical micrometer. Given ranges of sizes are based on the smallest and the largest measures of a specific kind of sclerite found. Number of meshes per cm^2, counted at the middle of each fan, is given for reference. Identification and descriptions are based on Verrill (1868a, c; 1870), Kükenthal (1924), Hickson (1928), Stiasny (1941), Bayer (1951), and Breedy and Guzman (2002). Data about the habitats and distribution along the Pacific coast of Costa Rica is taken from the Museum catalogues and from personal observation. Published records of some species are indicated in conformity with the literature (Verrill 1868a, c; Hickson 1928; Bayer 1951; Breedy & Guzman 2002).

In this study, the terminology proposed by Bayer, Grasshoff and Verseveldt (1983) and Breedy and Guzman (2002) is used for species descriptions.

The holotypes of the new species are deposited in the UCR museum and the paratypes are available in the MCZ.

Family Gorgoniidae Lamouroux, 1812

Pacifigorgia Bayer, 1951

Synonymy. See Breedy and Guzman 2002: 791.

Diagnosis. Adapted from Bayer (1951: 94): Colony flabellate branched in one or several perpendicular planes. Branches regularly anastomosed to form a network of variable sized mesh. Polyps retractile within low calyces or flush with the surface of the coenenchyme. Coenenchymal sclerites basically of 4 kinds: long spindles with acute ends and several whorls of warts; blunt spindles, long or short with several whorls of warts; and girdled capstans with different levels of complexity. Anthocodial sclerites are flattened rods with smooth, scalloped, serrated or lobed margins.

Distribution. From Bayer (1951): Eastern Pacific, from southern California to Chile and the Galápagos Islands; Atlantic coast from Trinidad to Brazil.

***Pacifigorgia adamsii* (Verrill, 1868)**
(Plate 2, Fig. 1)

Litigorgia adamsii Verrill 1868b: 422 (partial).
For complete synonymy Breedy and Guzman 2002: 793

Material examined

***Lectotype*:** YPM 1173k, Pearl Islands, Gulf of Panamá, F. H. Bradley, 1866-1867.

***Paralectotypes*:** YPM 1173d,m,n,o, MCZ 1173, same data as Lectotype; MCZ 4031 (MCZ 374), MCZ 4031 (MCZ 391), MCZ 4032 (MCZ 375), Panamá, J. H. Sternberg 1863.

***Other material*:** UCR 924, 925, Isla Chora, Sámara Bay, Costa Rica, 18 m, O. Breedy and H. Guzman, 30 May 1999; UCR 989, 990, Isla Chora, Sámara Bay, 18 m, O. Breedy and H. Guzman, July 1999; UCR 994 to 997, 1006, Bajo Ballena, Parque Marino Ballena, Costa Rica, 19 m, O. Breedy, 25 April 2002; UCR 1008 (2), Punta Carrillo, Costa Rica, 20 m, O. Breedy and H. Guzman, 25 June 1998; UCR 1011, 1012, Isla Chora, Sámara Bay, 18 m, O. Breedy and H. Guzman, 31 March 1998; UCR 1014, Piedra Ballena, Parque Marino Ballena, 12 m, O. Breedy, 24 April 2002; UCR 1023, Isla Chora, Sámara Bay, 20 m, O. Breedy, March 1999.

Diagnosis. Colonies small, from purple to dark purple or golden ochre, wider than high, up to 210 mm long, 210 mm wide (Plate 2A). Normally formed of a single erect fan with margins rounded or lobed, some colonies have a small secondary fan perpendicular to the main one. Colonies finely and evenly reticulated (27 meshes/cm²). Branches thin and squarish in section (up to 0.8 mm diameter). Branch network of square, polygonal, and sometimes round meshes, between 1 and 2.5 mm wide. Stem short when present (up to 20 mm), and fans with no trace of strong midribs, just some short thick branches at the base. End-branchlets very short (up to 3 mm long). Raised, pointed calyces occur in 2 alternating rows evenly spaced on all sides of the branches, producing a warty surface. Polyps white with collaret-like masses of slender, light orange rods arranged vertically but forming a thin ring at the base of the tentacles. Coenenchymal sclerites red, yellow, colourless, and some bi-coloured: long spindles (up to 0.13 by 0.04 mm), having acute ends and 2-6 whorls of warty tubercles (Fig. 1A), some with one tapered end (up to 0.07 by 0.03) (Fig. 1B); capstans (up to 0.06 by 0.03 mm) (Fig. 1C), and immature sclerites (up to 0.06 by 0.03 mm), with smooth tubercles (Fig. 1D). Anthocodial rods yellow or light orange (up to 0.10 mm by 0.03 mm) with scalloped or serrated borders and small thorny warts (Fig. 1E).

Remarks. *Pacifigorgia adamsii* was found from a depth of 20-35 m, growing on rocky substrates, shells or directly attached to coarse sand. They could be found in turbid or clear water. They are abundant in rocky reefs affected by strong swell where they are firmly attached to large rocks.

This species was originally considered the juvenile form of another species (Verrill 1868c) that was later identified as *Pacifigorgia irene* Bayer, 1951. These two species are

rarely found together. In general *P. adamsii* is found deeper than *P. irene* and in places with fine muddy sediments.

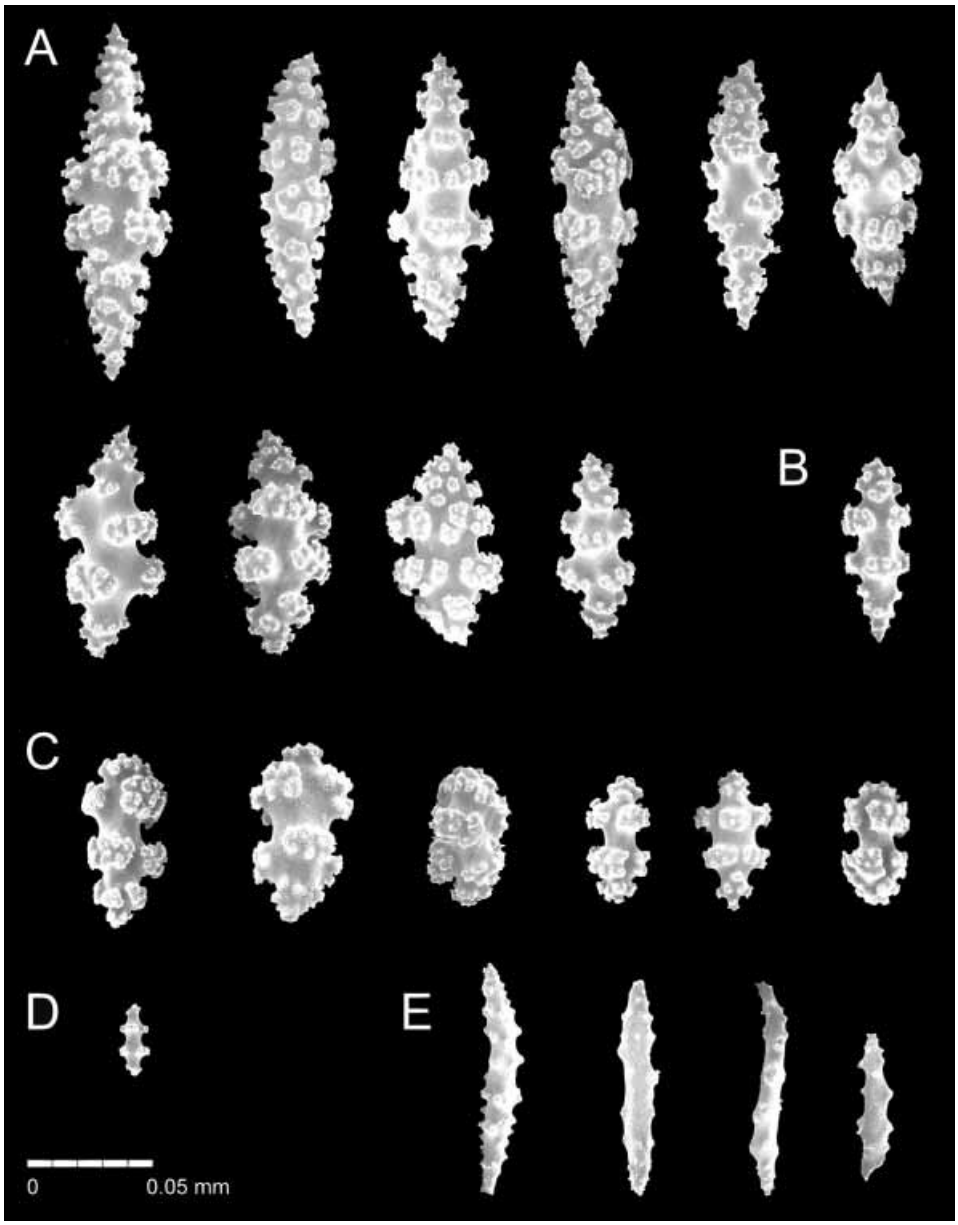

FIGURE 1. *Pacifigorgia adamsii* Verrill (UCR 924); SEM-micrographs of the sclerites: A-B, spindles; C, capstans; D, immature sclerite; E, anthocodial rods.

Distribution in Costa Rica. Found all along the coast and explored islands.

Published records. From Verrill (1868c): Acapulco, México; Corinto, Nicaragua; Puntarenas, Costa Rica; Pearl Islands, Panamá; Zorritos, Perú.

Pacifigorgia bayeri Breedy, 2001

Pacifigorgia bayeri Breedy 2001: 182–186.

Material examined.

Holotype: UCR 922, Bajo Diablo, Caño Island, 12 m, O. Breedy, 11 February 2000.

Paratypes: UCR 949a,b, 950, 951a,b, Bajo Diablo, Caño Island, 12 m, O. Breedy, 17 February 2000.

Other material: UCR 494, Punta Uvita, Dominical, Costa Rica, 14 m, J. Cortés and M. Murillo, 24 February 1984; UCR 952, Bajo Diablo, Caño Island, 12 m, O. Breedy, 10 May 1998; UCR 1113 to 1117, Roca Prosper, Chiriquí Gulf, Panamá, 16–18 m, H. Guzman, 11 December 2001.

Diagnosis. Colonies wider than high, up to 350 mm in height, and 420 mm in width, deep yellow intermingled with dark purple, and sometimes bicoloured. Fans single or complex, of a fine network with closed, rounded and oblong meshes around 2–5 mm in diameter (10 meshes/cm²). Holdfasts wide and strong. Midribs not distinct. Branches up to 1.5 mm thick. Calyces round, raised, surrounded by rings of yellow sclerites, crowded and distributed mostly in pairs around the branches. Coenenchymal sclerites red and bright yellow: blunt spindles (up to 0.11 by 0.05 mm); few, wide spindles with acute ends (up to 0.12 by 0.06 mm); various kinds of capstans (up to 0.1 by 0.06 mm), with an abundance of small ones (0.03–0.04 by 0.02–0.02 mm); immature capstans with low tubercles (up to 0.08 by 0.05 mm). Anthocodial rods yellow or pink (up to 0.10 by 0.04 mm) with lobed or scalloped margins.

Habitat and remarks. Abundant on a single rocky reef at Caño Island, 10–12 m in depth, with very strong currents. The species grows on rocky substrate and is the dominant fan at this site. It has not been collected on any other rocky reef at Caño Island. Even though it was thought that this species occurred only at Caño Island (Breedy 2001) a specimen from Dominical, mainland Costa Rica, was found in the Museum collection. Additional specimens of this species have been recently observed and collected by one of us (H.G.) on a rocky reef at Roca Prosper, Chiriquí Gulf. Specimens from Panamá and the one from Dominical show more spindles with acute ends than the holotype. These new records extend the geographic range of this species.

Distribution in Costa Rica. Bajo Diablo, Caño Island (type locality); and Dominical, Puntarenas.

Published records. From Breedy (2001): Caño Island, Costa Rica.

Pacifigorgia cairnsi, new species

(Plate 3, Fig. 2)

Material examined.

***Holotype*:** UCR 913, Punta sureste, Caño Island, 18 m, O. Breedy, 13–14 September, 1996.

***Paratypes*:** UCR 934, Plataforma sureste, Caño Island, 18 m, O. Breedy, 16 February 2000; UCR 935, Bajo Diablo, Caño Island, 24 m, O. Breedy, 12 February 2000; UCR 953, Isla Chora, Sámara Bay, 16 m, O. Breedy, 29 March 1998; UCR 973(3), MCZ 51915, Bajo Tiburones, Caño Island, 23 m, O. Breedy, 15 February 2000; UCR 979, Isla Chora, Sámara Bay, 10–12 m, O. Breedy, 28-29 July 1999; UCR 980, Punta sureste, Caño Island, 16-18 m, O. Breedy, 13-14 September 1996; UCR 982, Punta sureste, Caño Island, 16-18 m, O. Breedy, 26 April 1997; UCR 1001, 1002, Noreste Isla Ballena, Ballena Marine National Park, 7 m, O. Breedy, 27 April 2002; UCR 1016, 1017, Rocas sureste, Ballena Marine National Park, 26 m, O. Breedy, 27 April 2002.

Diagnosis. Colonies large, up to 340 mm in height and 500 mm in width, wider than high, consisting of several fans. Colour brownish-orange when alive or preserved and of a very pale purple when dry. Network loose (9 meshes/cm^2), meshes up to 9.5 by 3.1 mm in diameter, with short free twigs. Midribs prominent and rounded in cross section. Branches up to 1.3 mm in diameter, with smooth surface. Calyces round, slightly raised, occurring all around the branches. Polyps greenish-yellow. Coenenchymal sclerites red, deep red, most of them with a lemon-yellowish halo: blunt spindles (up to 0.08 by 0.04 mm); capstans (up to 0.07 by 0.04 mm); and a few spindles with acute ends (up to 0.115 by 0.04 mm). Anthocodial rods flat, yellow (up to 0.12 by 0.02 mm), with smooth or scalloped margins.

Description. The holotype is a large, 220 by 300 mm, ethanol preserved colony with prominent rounded-section midribs (6–7 mm thick) that can be followed up to the middle of the fan where they merge into the network (Plate 3A). The colony arises from a thick holdfast, subdividing into thinner rounded branches (0.9–1.3 mm), thus producing a wide fan. The colony comprises four separate, wide, lobed secondary fans, which develop in the same plane as the primary fan. The lateral fans partially coalescence leaving some short twigs free, which project into the larger spaces. Network loose and irregular with mostly oblong and rectangular meshes (up to 9.5 by 2.4 mm). End-branchlets range from 2–15 mm long. Coenenchymal sclerites are: spindles (0.10–0.12 by 0.03–0.04 mm), having acute ends and 4–6 whorls of tubercles (Fig. 2A), not abundant; blunt spindles (0.06–0.08 by 0.02–0.04 mm) with 4 whorls of tubercles (Fig. 2B); some spindles are tapered at one end and acute and the other (up to 0.1 by 0.04 mm) (Fig. 2C); wide, rectangular butterfly-like rods (around 0.07 by 0.05 mm) (Fig. 2D); six-radiate-like sclerites (0.04–0.07 by 0.03–0.04 mm) with warty small projections, or wide tuberculate ends (Fig. 2E); capstans (0.04–0.07 by 0.03–0.04 mm) with tuberculate ends, warty or smooth (Fig. 2F); immature sclerites (0.04–0.07 by 0.02–0.04) with low tubercles, some are long with pointed ends (Fig. 45), others short with blunt ends. Anthocodial sclerites are flat, lemon-yellow rods (0.06–0.12 by 0.01–0.02 mm) with smooth margins and few projections, or with scalloped margins (Fig. 2G), and slender, spiny capstans (around 0.05 by 0.03 mm) (Fig. 2I).

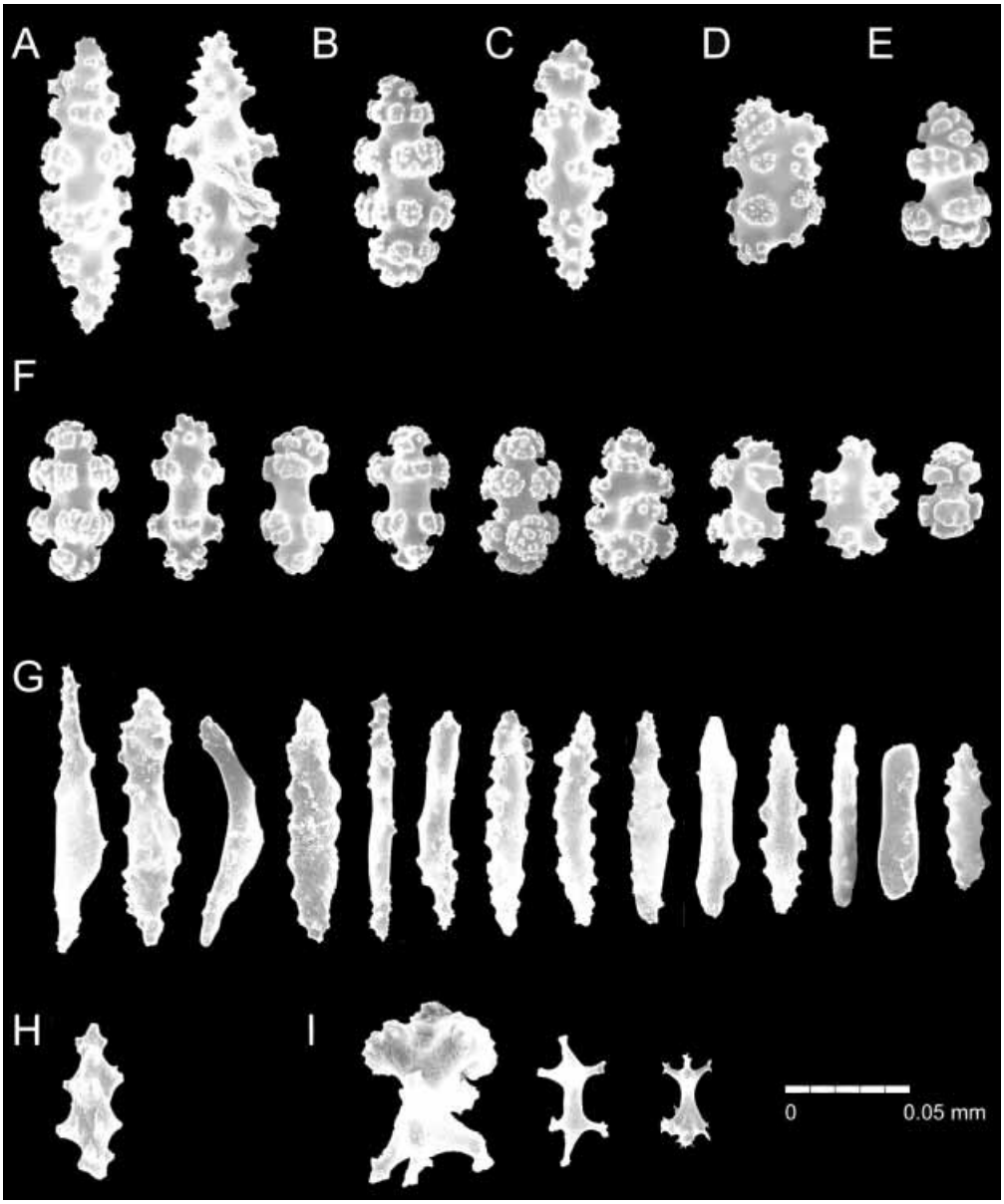

FIGURE 2. *Pacifigorgia cairnsi* new species, holotype (UCR 913), SEM-micrographs of the sclerites: A–C, spindles; D, rectangular warty rod; E, six-radiate; F, capstans; G, anthocodial rods; H, immature sclerite; I, spindly capstans.

Remarks. Even though small colonies of this species could be mistaken for *Pacifigorgia samarensis* new species, there are some very distinct differences: in the latter the branches are thinner, the fan is completely reticulated, has no free-twigs, lacks midribs, and the surface is not smooth. In both species there are few spindles with acute ends, but the colour and size of the sclerites are different: in *P. samarensis* new species, they are red

and yellow whereas in *P. cairnsi* they are red with a characteristic lemon-yellowish halo. Due to the shape of the colony and the prominent midribs, *P. cairnsi* is very similar to *Pacifigorgia media* (Verrill, 1846), however, the latter has a tighter and mostly square meshwork (2–2.5 mm). The branches are thicker (1.2–2 mm) as are the midribs, which lay flat in the plane of the fan. The sclerites of *P. media* also show differences: they are red and yellow, and the pointed spindles and the blunt spindles are larger (0.13 by 0.05 mm and 0.09 by 0.05 mm respectively) than the ones in *P. cairnsi*. The anthocodial rods are similar in size and shape but the colour in *P. media* is a pale orange. Apart from discussed similarities, this species does not agree with any other of the *Pacifigorgia* species described.

Habitat. The specimens were found on rocky reefs at Caño Island on vertical rock walls covered by sponges, bryozoans and algae, at a depth of 18–24 m. The species lives together with *P. irene* and *Pacifigorgia rubicunda* new species, but is the dominant species in some sites. The colonies found in Ballena Marine National Park are smaller than the ones from Caño Island. We found the shallowest (7 m) and the deepest record (26 m) of this species in two different rocky sites with strong currents at Ballena Marine National Park. This species has been observed and collected recently (December 2001) by one of us in Chiriquí Gulf, living on vertical walls in deep rocky reefs.

Etymology. We named this species in honour of Stephen Cairns (USNM) for his encouragement, guidance, and precious friendship during the entire course of this project, which began four years ago.

Distribution in Costa Rica. Caño Island; Sámara Bay; and Ballena Marine National Park.

***Pacifigorgia curta*, new species**
(Plate 4, Fig. 3)

Material examined.

***Holotype*:** UCR 650, Isla Pájara, Cocos Island, Costa Rica, 25 m, 3 April 1992, M. Montoya.

***Paratypes*:** UCR 661, MCZ 51919, Isla Pájara, Cocos Island, 27 m, M. Montoya, 5 April 1992; UCR 1030 to 1032, Dos Amigos, Cocos Island, 25 m, H. Guzman, 28 September 2002.

Diagnosis. Colonies erect, bushy, and small, up to 95 mm in height and up to 115 mm in width. Colour pale yellow intermingled with light purple or purple when dry and deep purple when preserved. Network irregular, of open meshes up to 13 by 4 mm (7.5 meshes/cm^2). Free-twigs numerous. End-branchlets with light purple to purple, wide, finger-like tips, up to 9 mm long. No distinct midribs present. Long stems and small holdfasts. Branches from 0.5–1.0 mm in diameter with smooth surface. Calyces almost flat, with small yellowish spots around the openings, arranged all around the branches. Coenenchymal sclerites dark purple, yellow and some bicoloured; wide spindles (up to 0.16 by 0.05

mm) with acute ends; blunt spindles (up to 0.14 by 0.05 mm); large capstans (up to 0.09 by 0.05 mm); and some four-radiates (around 0.06 by 0.04 mm). Anthocodial rods yellow, oblong (up to 0.12 by 0.02 mm), very distinct, with smooth or scalloped margins, acute ends, and few tubercles.

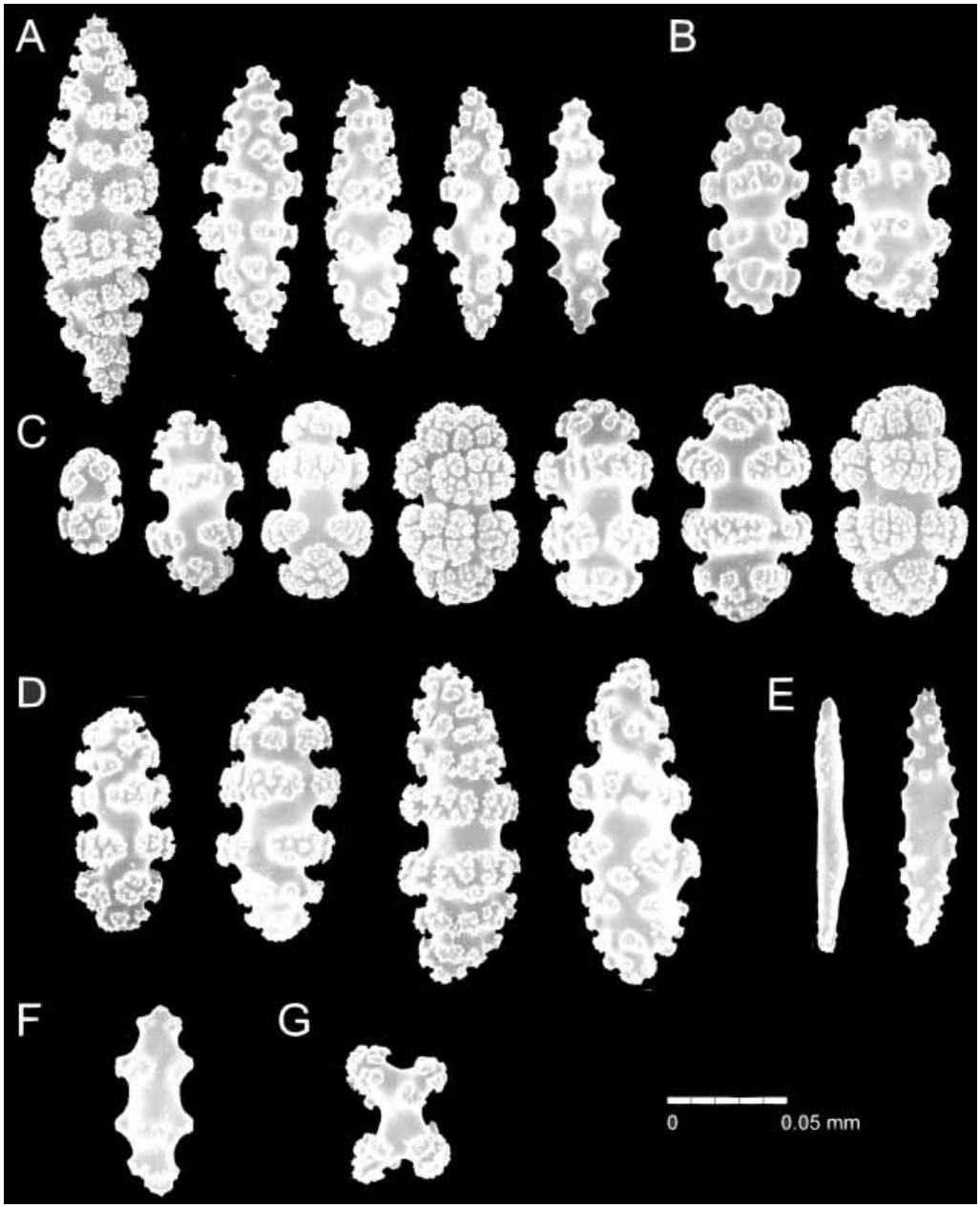

FIGURE 3. *Pacifigorgia curta* new species, holotype (UCR 650), SEM-micrographs of the sclerites: A, D, spindles; B–C, capstans; E, anthocodial rods; F, immature sclerite; G, four-radiate.

TABLE 1. Comparative general features of the species of the genus *Pacifigorgia* in the eastern Pacific off Costa Rica.

Species	Colour of the colony	Branch thickness (mm)	Fan network	Number of meshes/cm²	Mesh shape and size range (mm)	Midrib	Surface of the colony
P. adamsii	purple/dark purple/gold-ochre	0.05–0.08	fine/irregular	27	square, 1–2.5	absent	warty
P. bayeri	deep yellow/dark purple	1–1.5	close/regular	9	round/oblong, 2–2.5	absent	warty
P. cairnsi	red-crimson/pale purple	0.9–1.3	open/regular	9	oblong/rectangular, 1.7–9.5 x 1.8–3.1	present	smooth
P. curta	brownish orange/purple	0.5–1	open/irregular	7.5	oblong/polygonal, 2–13 x 2–4	absent	smooth
P. eximia	deep red/light burnt orange	1–1.5	open/regular-irregular	9	rectangular, 1–30 x 2–3	absent	smooth
P. firma	light brown/dark purple	1–2.5	close/regular	11.5	rectangular, 3–12 x 2–6	present	smooth
P. flavimaculata	yellow ochre, speckled with purple	2–2.5	open/irregular	3	rectangular, 5–24 x 3–7	present	warty
P. irene	dark purple/dark pink/greenish borders	0.05–0.07	fine/irregular	32	square, 1–5 x 1–4	present	warty
P. lacerata	dull violet/shades of pink	0.8–1	close/regular	12.5	oblong/square, 2–8 x 1–3	present	smooth
P. rubicunda	deep orange	0.8–0.13	close/regular	17	square, 1.2–5 x 0.9–2.51	present	warty
P. samarensis	red/light orange	0.5–0.8	close/regular	14	square /rectangular, 3–7 x 2–2.5	absent	warty
P. senta	pink/white	1–1.5	open/irregular	4	polygonal, 8–22 x 3–7	present	warty
P. stenobrochis	reddish purple/brown	2–5	open/regular	2	oblong/rectangular, 10–35 x 1–4	absent	smooth
P. tupperi	wine red/dark pink	1–1.5	close/regular	13.5	oval/circular, 2–5	absent	smooth

TABLE 2. Comparison among the sclerites of the species of the genus *Pacifigorgia* in the eastern Pacific off Costa Rica. The size of the sclerites is a range from the maximum to the minimum for length and width.

Species	Colour of sclerites	Acute spindles size range (mm)	Blunt spindles size range (mm)	Capstans size range (mm)	Anthocodial rods: colour and size range (mm)
P. adamsii	red/yellow/ colourless	0.08–0.13 x 0.03–0.04	0.06–0.07 x 0.03	0.03–0.06 x 0.02–0.03	yellow/orange, 0.06–0.11 x 0.01–0.03
P. bayeri	red/yellow/bicoloured	0.09–0.12 x 0.05–0.06	0.07–0.11 x 0.03–0.05	0.025–0.100 x 0.015–0.061	pink/yellow, 0.05–0.1 x 0.02–0.04
P. cairnsi	deep red/ lemon yellow	0.10–0.12 x 0.03–0.04	0.06–0.08 x 0.02–0.04	0.04–0.07 x 0.03–0.04	lemon yellow, 0.06–0.12 x 0.01–0.02
P. curta	dark purple/yellow/bicoloured	0.13–0.16 x 0.05	0.09–0.14 x 0.03–0.05	0.08–0.09 x 0.04–0.05	yellow, 0.06–0.07 x 0.02–0.03
P. eximia	red/whitish	0.10–0.16 x 0.04–0.05	0.08–0.11 x 0.04–0.05	0.04–0.07 x 0.03–0.04	pale yellow, 0.05–0.07 x 0.02–0.03
P. firma	red/pale yellow/ orange/bicoloured	0.10–0.11 x 0.04–0.05		0.07–0.09 x 0.02–0.05	light orange, 0.06–0.10 x 0.01–0.03
P. flavimaculata	reddish brown/ yellow/ bicoloured	0.14–0.15 x 0.05–0.06	0.09–0.12 x 0.04–0.05	0.06–0.07 x 0.04–0.05	light orange, 0.07–0.09 x 0.02–0.03
P. irene	red/lemon yellow/bicoloured	0.09–0.20 x 0.02–0.05	0.05–0.09 x 0.02–0.04	0.04–0.09 x 0.02–0.04	colourless/light pink, 0.07–0.10 x 0.01–0.02
P. lacerata	red	0.09–0.12 x 0.03–0.04		0.05–0.10 x 0.04–0.05	pink /colourless, 0.09–0.14 x 0.01–0.02
P. rubicunda	orange/yellow	0.09–0.12 x 0.02–0.04	0.09–0.1 x 0.02–0.04	0.04–0.09 x 0.02–0.04	light yellow, 0.05–0.14 x 0.01–0.02
P. samarensis	red/yellow/bicoloured	0.08–0.12 x 0.03–0.05	0.06–0.09 x 0.03–0.04	0.04–0.10 x 0.02–0.04	yellow, 0.05–0.10 x 0.003–0.02
P. senta	brownish pink/ colourless	0.12–0.22 x 0.02–0.06	0.11–0.14 x 0.05–0.06	0.06–0.09 x 0.01–0.02	colourless, 0.06–0.14 x 0.01–0.02
P. stenobrochis	pink/grey/yellowish	0.09–0.12 x 0.03–0.04	0.08–0.1 x 0.03–0.05	0.06–0.01 x 0.03–0.05	light yellow, 0.04–0.09 x 0.03–0.04
P. tupperi	dark red	0.09–0.10 x 0.04	0.09–0.13 x 0.04–0.05	0.04–0.13 x 0.03–0.08	pink, 0.06–0.07 x 0.01–0.02

Description. The holotype is a small colony, dry preserved, 90 by 115 mm, forming a short bush-like fan (Plate 4A). Four main branches arise from a long stem (25 mm tall and 5 mm thick) and spread into different planes forming a maze of smooth branches (0.5–1 mm in diameter). Some of them coalesce and form an irregular, open, reticulated fan of oblong rectangular and square meshes (2–13 by 2–4 mm) with many free-twigs. End-branchlets are long (2–9 mm) and finger-like with conspicuous wide, light purple tips.

There are no distinct midribs, but some lateral thick branches can be followed until close to the end of the fan. Coenenchymal sclerites are: wide spindles (0.13–0.16 by 0.05 mm) with acute, warty ends, and either 4–8 whorls of warty tubercles or short warts (Fig. 3A); blunt spindles (0.09–0.14 by 0.03–0.05 mm) with 4 whorls of warty tubercles and warty ends which can be slightly bent (Fig. 3D); large, wide capstans (0.08–0.09 by 0.04–0.05 mm) with warty whorls of tubercles (Fig. 3C); capstans with smooth tubercles or with some separated warts (Fig. 3B); immature sclerites (0.06–0.07 by 0.02–0.03 mm) with low tubercles (Fig. 3F); and some four-radiates (around 0.06 by 0.04 mm) with warty ends (Fig. 3G). Anthocodial sclerites are yellow, oblong rods (0.10–0.12 by 0.01–0.02 mm), very distinct, with smooth or scalloped margins, acute ends and few tubercles (Fig. 3E).

Remarks. This species has not been found at any place alongside the mainland or nearby islands. It somewhat resembles small colonies of *Pacifigorgia firma* new species, but in that species the fans are regular networks, the stems, when present, are shorter, and the sclerites are different in size and in relative abundance of types (Table 1, 2). In addition, the specimens of *P. firma* come from shallower habitats than *P. curta*. Apart from the colonies of this species collected near Cocos Island in 1992, and others recently collected in 2002 by one of us (H. G.), no other record has been obtained, not even from the collection made by the Expedition to the Galápagos and Cocos Islands by the Harbor Branch Oceanographic Institution in 1986.

Habitat. This species was collected at 20–25 m depth living on rocks.

Etymology. An adjective (L), *curtus* = short.

Distribution in Costa Rica. Only from the type locality, Cocos Island, Costa Rica.

***Pacifigorgia eximia* (Verrill, 1868)**
(Plate 5, Fig. 4)

Litigorgia eximia Verrill 1868b: 422.
For full synonymy see Breedy and Guzman 2002: 820.

Material examined.

***Lectotype*:** YPM 1550a, Pearl Islands, Gulf of Panamá, F. H. Bradley, 1866–1867.

Paralectotypes: YPM 1550b,c, MCZ 4040, Pearl Islands, Gulf of Panamá, F. H. Bradley, 1866–1867; MCZ 4041, Pearl Islands, Gulf of Panamá, A. Agassiz, 1860; YPM 8746, Panamá, J. A. Mc Niel.

Other material: UCR 926, Caño Island, 20 m, O. Breedy, 13 November 1997; UCR 1006, Bajo Ballena, Parque Marino Ballena, 19 m, O. Breedy, 25 April 2002; UCR 1015, Rocas Sureste, Parque Marino Ballena, 26 m, O. Breedy, 27 April 2002, Costa Rica.

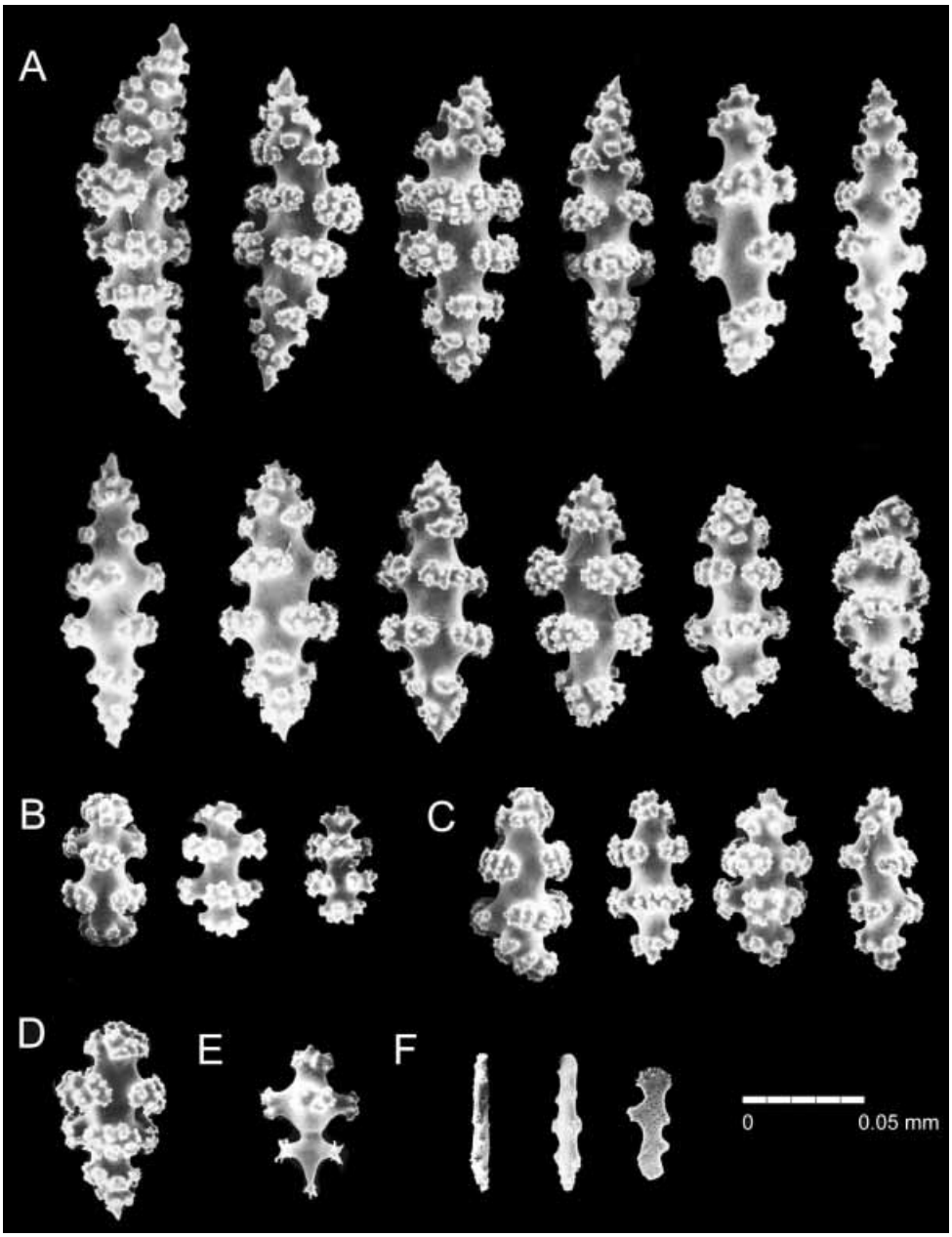

FIGURE 4. *Pacifigorgia eximia* Verrill (UCR 926), SEM-micrographs of the sclerites: A, D, spindles; B, C, capstans; E, spindly capstan; F, anthocodial rods.

Diagnosis. Colonies erect, higher than wide, up to 200 by 200 mm in size, with a single fan or with two or three secondary ones. Colour deep red or light burnt orange (Plate 5A). Network open, of square and oblong meshes from 1–30 mm by 2–3 mm (9 meshes/ cm^2), very irregular and incomplete in some cases. Free twigs up to 20 mm long. No dis-

tinct midribs present. Branches up to 5 mm in diameter at the base of the colony. Surface smooth with slightly raised calyces, arranged evenly around the branches. Polyps white. Coenenchymal sclerites red and whitish; mostly long spindles (up to 0.16 by 0.05 mm), with 2–4 whorls of tubercles and acute oblong ends with many small warts (Fig. 4A); capstans, short (up to 0.05 by 0.04 mm) (Fig. 4B) and elongate (up to 0.07 by 0.04 mm) (Fig. 4C); and spindles tapered at one end (up to 0.10 by 0.05 mm) (Fig. 4D). Anthocodial sclerites pale yellow or colourless rods (up to 0.07 by 0.03 mm), slender with scalloped margins (Fig. 4F), and some slender, spiny capstans (Fig. 4E).

Remarks. Some of the specimens studied showed thinner branches (1 mm) and a more flexible fan than those of the lectotype (YPM 1550a), but the sclerites closely matched those of that specimen.

We found a colony of *P. eximia* at the southeastern part of Caño Island, and thinking it was a specimen of *P. samarensis* new species, only a fragment was collected. It is very likely that more specimens are living at this site. Recently we collected more specimens from Ballena Marine National Park, which confirms the occurrence of the species along the mainland.

Habitat. The studied specimens were found in a depth of 25 m, growing on rocky substrate in a high-energy zone at Caño Island and in a turbid rocky reef with fine muddy sediments at Ballena Marine National Park.

Distribution in Costa Rica. Caño Island and Ballena Marine National Park.

Published records. From Verrill (1868c): Pearl Islands, Panamá.

***Pacifigorgia firma*, new species**
(Plate 6, Fig. 5)

Material examined.

***Holotype*:** UCR 915, Isla Chora, Sámara Bay, 10 m, O. Breedy and H. Guzmán, 29 July 1999.

***Paratypes*:** UCR 916, Sámara Bay, 1.5 m, O. Breedy, January1998; UCR 918, Punta sureste, Caño Island, 12 m, O. Breedy, 13–14 September 1996; UCR 940, Isla Chora, Sámara Bay, 2–3 m, O. Breedy and H. Guzman, 29 July 1999; UCR 1003, Ballena Marine National Park, 6–7 m, O. Breedy, 27 April 2002; UCR 1018, 1019, Rocas sureste, Ballena Marine National Park, 6–7 m, O. Breedy, 27 April 2002; USNM 44215, Nicoya Gulf, Costa Rica, M. Valerio, 20 February 1931; USNM 49382, Nicoya Gulf, M. Valerio, 1927; MCZ 51918, Cabeza de Mono, Culebra Bay, Costa Rica, 18 m, O. Breedy, 21 September 1997.

Diagnosis. Colonies thick, very rigid, of variable forms, mainly wider than high up to 250 mm in height, and 400 mm in width. Colour sienna to brown when dry, brownish intermingled with purple or a very dark purple when preserved and beige or yellowish when alive. Fan closely reticulated (11.5 meshes/cm²) with mostly rectangular meshes

(around 3–12 by 2–6 mm). Free-ends long and no free-twigs. Colonies formed of one or several fans with prominent midribs that have marked longitudinal grooves. Branches up to 3 mm thick with a smooth surface. Calyces slightly raised with slit-shaped openings, arranged in almost two longitudinal rows around the branches. Polyps white when expanded with a wide, red and orange, collaret-like mass of sclerites at the base of the tentacles. Coenenchymal sclerites red, orange, pale yellow or bi-coloured: spindles (up to 0.11 by 0.05 mm) with acute ends, and various types of warty capstans (up to 0.09 by 0.05 mm). Anthocodial rods flat, from light red to pale orange with scalloped or lobed borders (up to 0.09 by 0.03 mm) and longer ones (up to 0.10 by 0.02 mm) with acute, warty ends.

Description. The holotype is sienna intermingled with purple, and is formed by a single main, thick and rigid fan, measuring 200 by 240 mm. It is a dry colony (Plate 6A, B); the picture in Plate 6C is the colony whilst alive. It had a strong holdfast and a small portion of it has remained. Four thick prominent midribs cross the fan and can be followed halfway up the colony. The thicker sections of the midribs have longitudinal grooves with alternating bands of red and light yellow sclerites. Branches (1–2.5 mm in diameter) anastomose to form a network of almost square or rectangular meshes 3 by 4 mm, 5 by 2 mm, 6 by 4 mm, and 12 by 2 mm in size. End-branchlets are from 2 to 15 mm long. Calyces are crowded but more distantly distributed on the midribs. Collaret-like masses of sclerites form rings at the base of the tentacles that are visible when the polyps expand. These collaret-like arrangements are formed of orange sclerites vertically disposed, and surrounded by red ones. When the polyps are partially retracted (just with the tentacles folded) the rings close and look like red crowns on top of the polyps (Plate 6C). When the colony is alive (Fig.10C) the surface of the branches look yellowish speckled with red and orange. Coenenchymal sclerites consist of long spindles (0.10–0.11 by 0.04–0.05 mm) with acute ends that may be slightly bent (Fig. 5A). Capstans are abundant and vary in shape and size: asymmetric capstans (0.08–0.09 by 0.03–0.05 mm) with elongated warty ends (Fig. 5B); and wide, warty capstans (0.07–0.08 by 0.04–0.05 mm) (Fig. 5C). There are immature sclerites (0.04–0.05 by 0.02–0.03 mm) with low tubercles (Fig. 5D). Anthocodial sclerites are mostly flat rods, from light red to pale orange (0.06–0.09 by 0.02–0.03 mm) mostly with scalloped or lobed borders: longer ones (0.08–0.10 by 0.01–0.02 mm) with warty ends (Fig. 5E); and slender, spiny capstans (around 0.05 by 0.03 mm) (Fig. 5F). There are also many pale red, very tiny, bone-shaped rods (0.01–0.02 mm long) that were observed in the polyps as part of the collaret-like arrangement.

Variability. In paratype UCR 918, the midribs can be traced up to the end of the colony; they are round in section and project either at the front or back of the colony and at both sides. Branches project at right angles to form three small, perpendicular secondary fans, which grow parallel to the primary fan. Yet there are specimens with parallel branchlets that coalesce again with the main fan forming shapes like butterfly nets. Paratype UCR 916 is a small, dark brown colony, with many branches sprouting directly from the holdfast extending horizontally on the substrate. In general, the network of sec-

ondary fans tends to be looser with many free branches (6–8 meshes/cm²). Some variability exists as to the sclerite dominance among the UCR studied specimens; e.g., small colonies such as UCR 916 have more spindles with acute ends and some rounded, immature forms which are not present in the larger colonies. As we have also found small colonies in the same sampling sites that had sclerites closely matching those of the large colonies we regard those colonies with an abundance of acute sclerites as the same species.

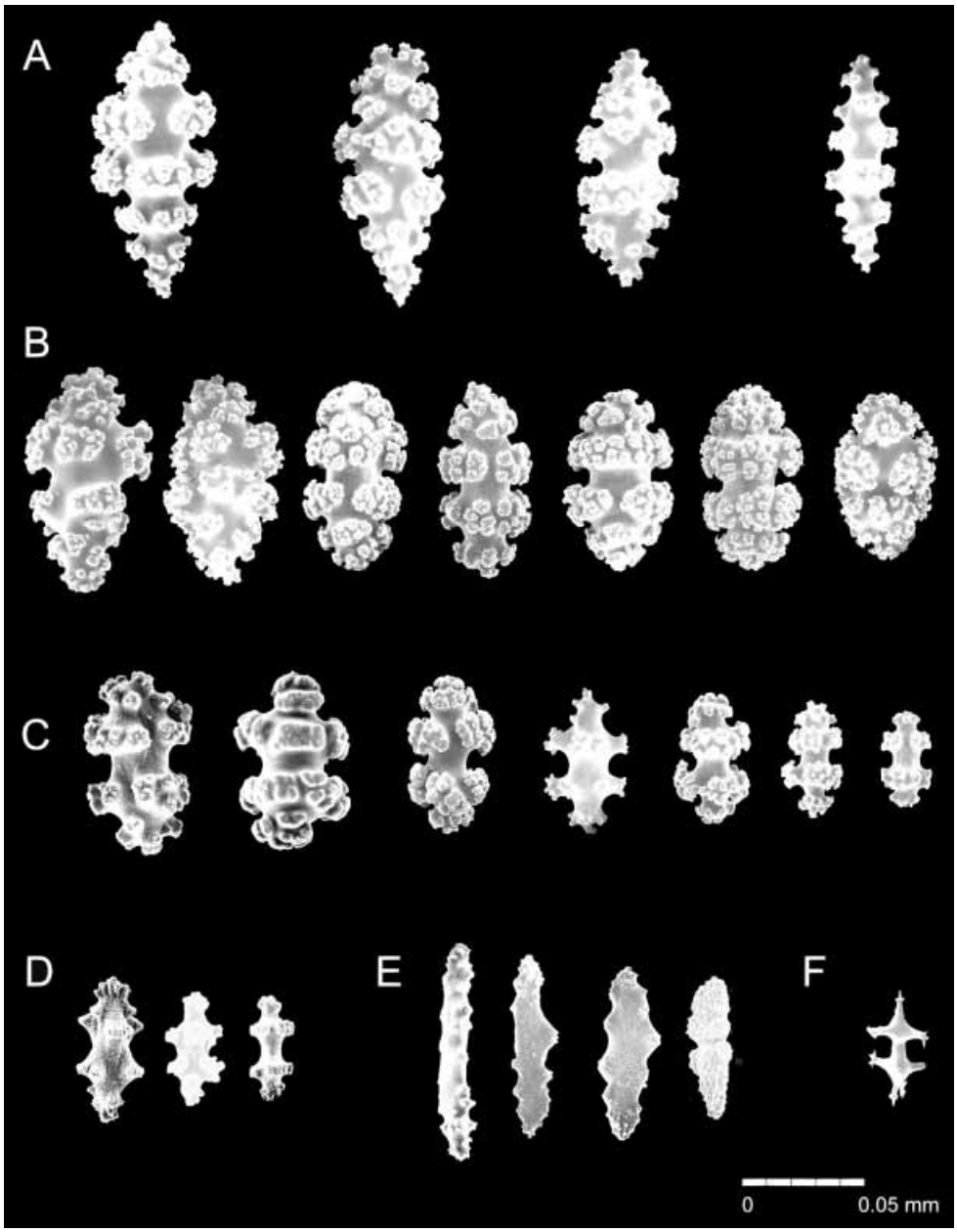

FIGURE 5. *Pacifigorgia firma* new species, holotype (UCR 915), SEM-micrographs of the sclerites: A, spindles; B–C, capstans; D, immature sclerites; E, anthocodial rods; F, spindly capstan.

Remarks. *Pacifigorgia firma* agrees with USNM 44212 and 44215 identified as *Gorgonia tabogae* Hickson, 1928 by E. Deichmann (not published), and with USNM 49382 identified as *Gorgonia cribrum* Valenciennes, 1846 also by E. Deichmann (not published). The studied colonies are consistent in many aspects to the description of *Pacifigorgia tabogae* (Hickson, 1928), but differ in colour and have distinct midribs. Such characters were not found by Hickson who wrote, "none of the specimens is quite complete but there is no evidence that any of them posses distinct midribs". Hickson (1928) worked with small fragments found either on fishing lines or collected from 7–15 m, probably by pearl divers. If Hickson's *P. tabogae* was like the presently examined colonies, which are big and strongly attached to the substratum, it could be imagined that the collectors just broke off pieces or collected new, easily breakable small fans that normally have very thin midribs or no midribs at all and we be may be talking about the same species. However, no type specimen of *P. tabogae* has been located for comparison. So far, only the holotype sclerites (BM 1961.2.6.163) of *P. tabogae* where available (Breedy & Guzmán 2002), which show differences in colour and size compared to the new species. The holotype sclerites of *P. tabogae* are darker and bigger than the ones in the holotype of the new species, with the exception of the anthocodial rods, which are smaller. Additionally, the new species generally occurs in waters shallower (from 0.5–8 m in depth) than reported for *P. tabogae*.

Several other species in the UCR collection showed certain similarities with *P. firma* and are discussed in each case below (Tables 1, 2).

Habitat. These specimens are common from 0.5–8 m deep, but some were found 12 m deep near Caño Island. They are attached to rocky substrates, basaltic walls or mudstone formations in zones highly impacted by waves. They can also be found in crevices and outcrops. They grow strongly attached to rocks and can be found upside-down arranged perpendicular to the currents.

Etymology. An adjective (L), *firmus* = strong, stout.

Distribution in Costa Rica. Gulf of Nicoya; Sámara Bay; Caño Island; Punta Argentina, Culebra Bay; and Cabo Blanco.

***Pacifigorgia flavimaculata*, new species**
(Plate 7, Fig. 6)

Material examined.

***Holotype*:** UCR 753, Punta Salsipuedes, Osa Peninsula, Costa Rica, 3 m, J. Cortés, 22 Jan 1994.

***Paratypes*:** UCR 753B, MCZ 51922, data as for the holotype.

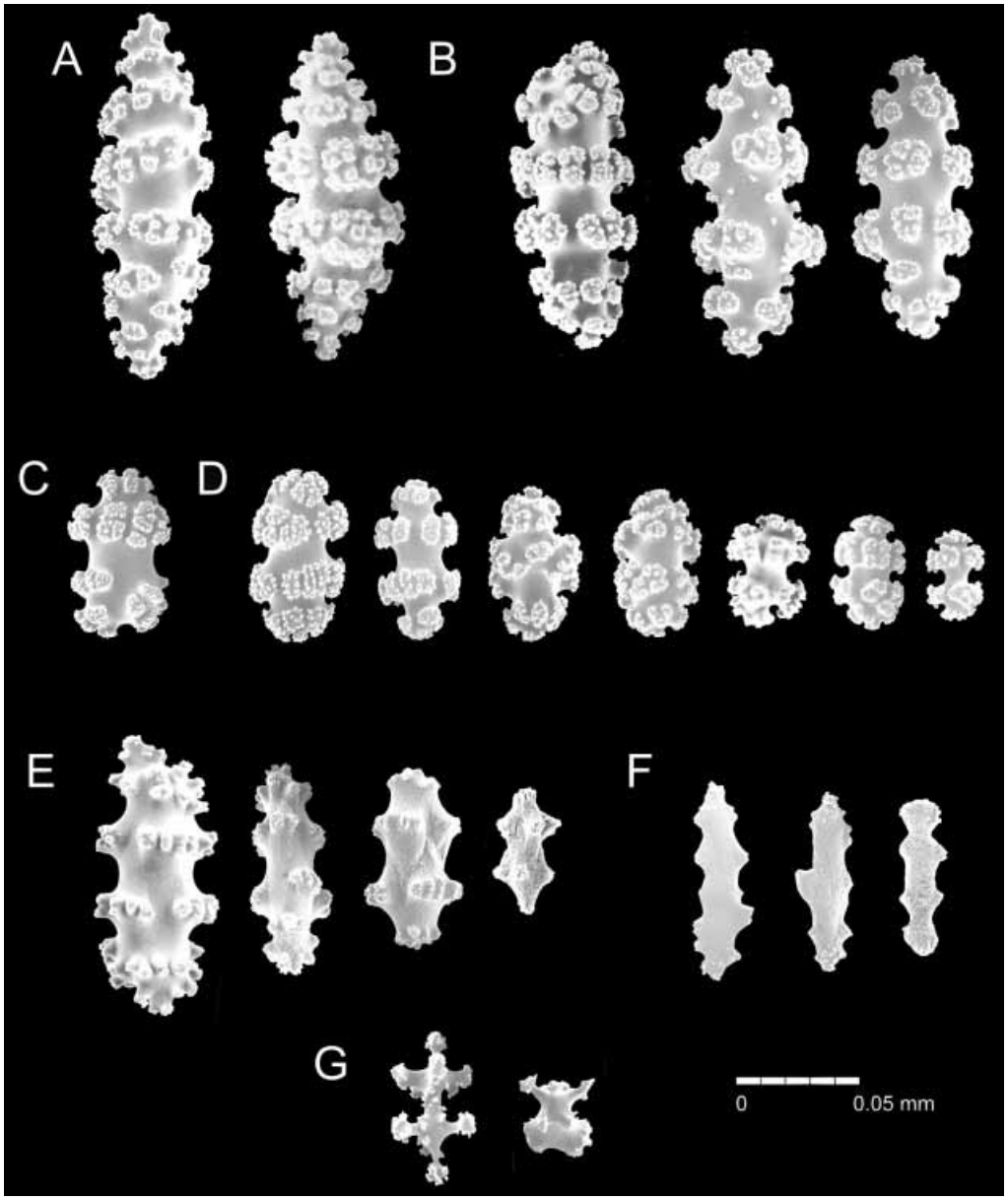

FIGURE 6. *Pacifigorgia flavimaculata* new species, holotype (UCR 753), SEM-micrographs of the sclerites: A, B, spindles; C, rectangular rod; D, capstans; E, immature sclerites; F, anthocodial rods; G, spindly capstans.

Diagnosis. Colonies erect, yellow ochre speckled with purple, faded when dry. Fans mostly higher than wide up to 130 mm in height, and 90 mm in width. Network loose, irregular, of mostly rectangular meshes up to 24 by 7 mm (3 meshes/cm²). Free-twigs long. End-branchlets long. Non distinct midribs present. Branches up to 2.5 mm in diameter with a warty surface. Calyces prominent mounds with oval openings closely arranged and evenly distributed around the branches. Polyps white. Coenenchymal sclerites brownish

red, shades of yellow and bicoloured; mostly big capstans (up to 0.08 by 0.04 mm); large spindles with acute ends (up to 0.15 by 0.05 mm); and blunt spindles (up to 0.12 by 0.05 mm). Flat, light orange anthocodial rods (up to 0.08 by 0.03 mm) with thorny and scalloped margins.

Description. The holotype is a preserved colony measuring 120 by 90 mm, with only a small part of the holdfast remaining. The colony is higher than wide with a loose and irregular network of mostly oblong meshes, which vary in size (5–24 by 3–7 mm). Some branches spread at right angles to form a small perpendicular fan and some grow freely, parallel and not anastomosing. Two thick branches arise and subdivide from a short stem (5 mm in diameter). The thick branches can be traced only for a short distance from the base before merging into the network. Branches are slender (2–2.5 mm in diameter) and with a warty surface. There are long end-branchlets around 5–16 mm, and many free-twigs that project into the big meshes or remain as long purplish free branchlets (5–16 mm). Coenenchymal sclerites are brownish red, from pale to lemon yellow, and bicoloured: large spindles (0.14–0.15 by 0.05–0.06 mm) with 4 or more whorls of tubercles and acute ends (Fig. 6A); wide blunt spindles (0.09–0.12 by 0.04–0.05 mm) with tuberculate-warty ends and 2–4 incomplete whorls of warty tubercles and scattered smaller warts (Fig. 6B); large capstans (0.06–0.07 by 0.03–0.04 mm) (Fig. 6D); some rectangular sclerites with warty tubercles (Fig. 6C); immature sclerites (0.04–0.08 by 0.03–0.04 mm) with low tubercles, and tuberculate ends (Fig. 6E). Anthocodial sclerites are light orange, flat rods (0.07–0.09 by 0.02–0.03 mm) (Fig. 6F) with thorny scalloped margins, and pink, small slender, spiny capstans (0.04 by 0.03 mm) (Fig. 6G).

Remarks. Thus far, colonies have been collected only in Punta Salsipuedes (Osa Peninsula) and have not been found in any of the other recently explored sites around Osa Peninsula and Golfo Dulce (pers. obs.). The absence of midribs crossing the fan, the thick branches, and the open meshes of this species can be compared with *Pacifigorgia stenobrochis* Valenciennes, 1846 (considering that this species presents a yellow variety). But the latter species forms larger colonies with a regular network, and the sclerites are very different in colour, size and shape (Table 1, 2). It is similar to *P. bayeri* regarding the colour of the colony, the yellow calyces and the shape and colour of the sclerites, however, *P. bayeri* has thinner branches, a regular network with closer meshes (Table 1), smaller spindles, and larger capstans (Table 2) (Breedy 2001). It can also be compared with *P. firma* regarding the sclerites: anthocodial rods in both species are orange and of a similar size and shape, but the coenenchymal spindles, even though having the same colour, are larger, wider, and more numerous in *P. flavimaculata* than in *P. firma* (Table 2).

Habitat. Holotype and paratypes were found 3 m deep. No more information was recorded.

Etymology. An adjective (L), *flavus* = yellow + *maculatus* = spotted, from *maculo* = to spot or stain in reference to the yellow spots.

Distribution in Costa Rica. Only reported for the type locality.

PLATE 1. Coast-line of the Pacific of Costa Rica. The stars show the collecting sites of *Pacifigorgia*.

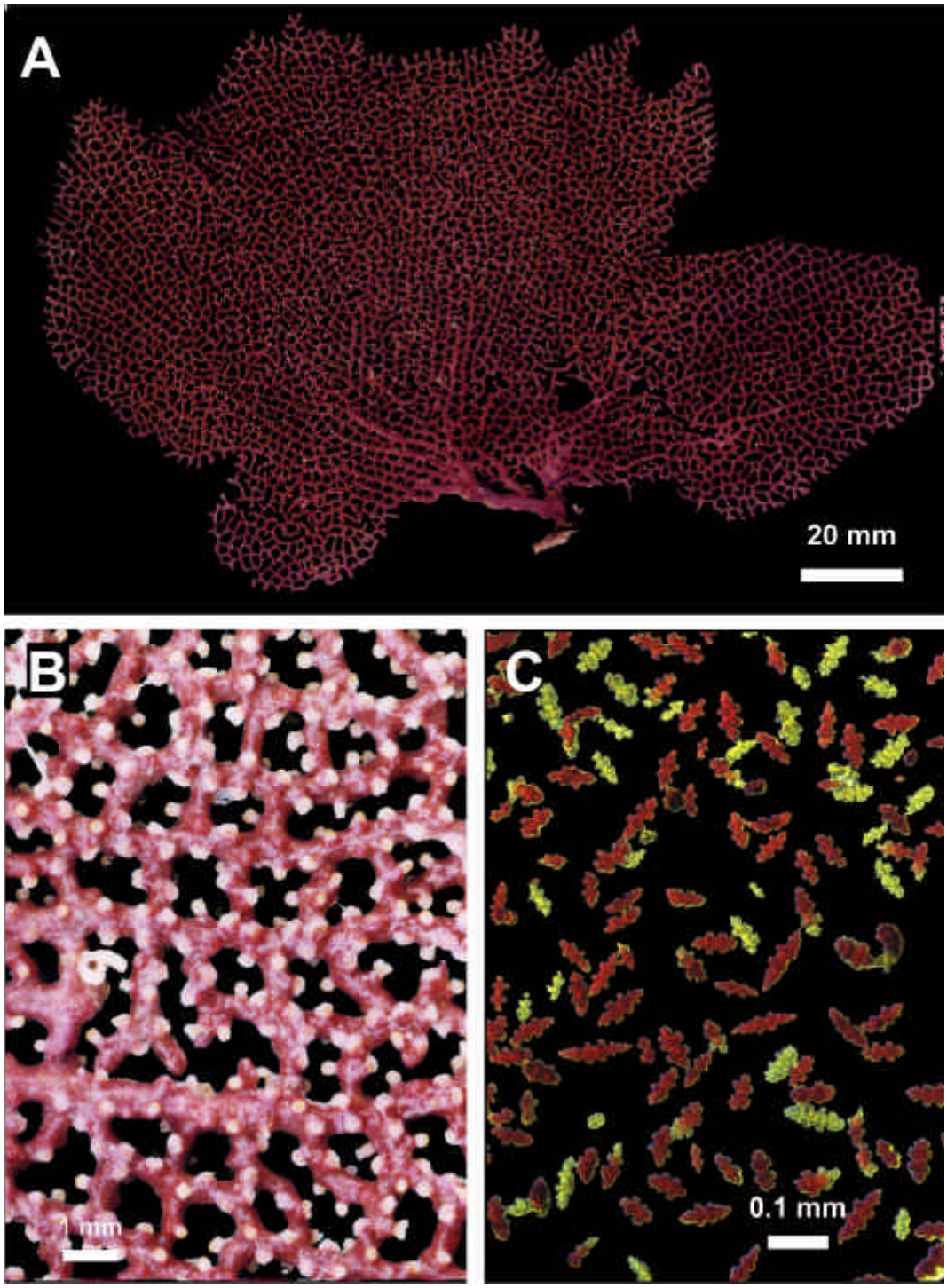

PLATE 2. *Pacifigorgia adamsii* Verrill (UCR 924) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

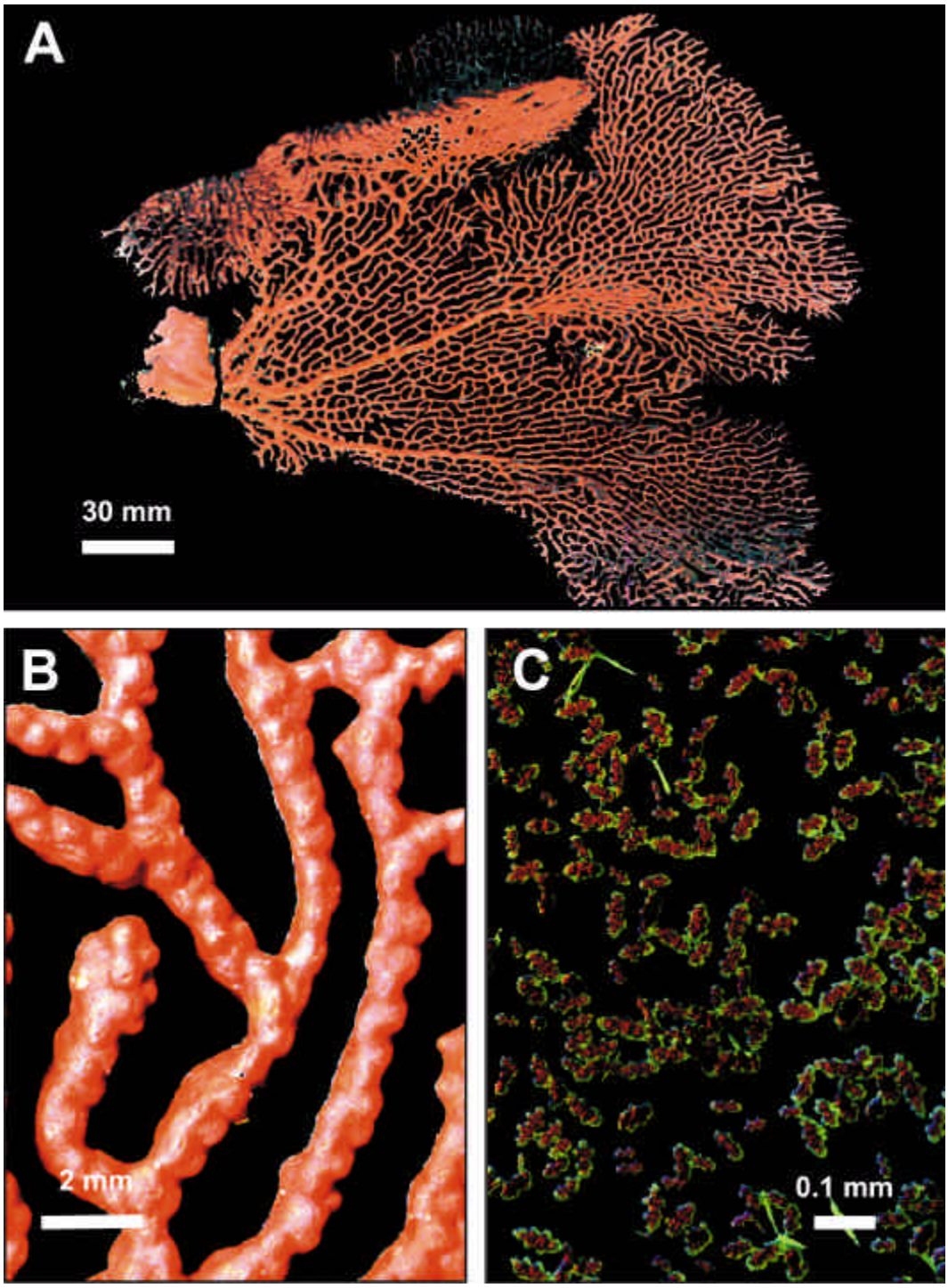

PLATE 3. *Pacifigorgia cairnsi* new species, holotype (UCR 913) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

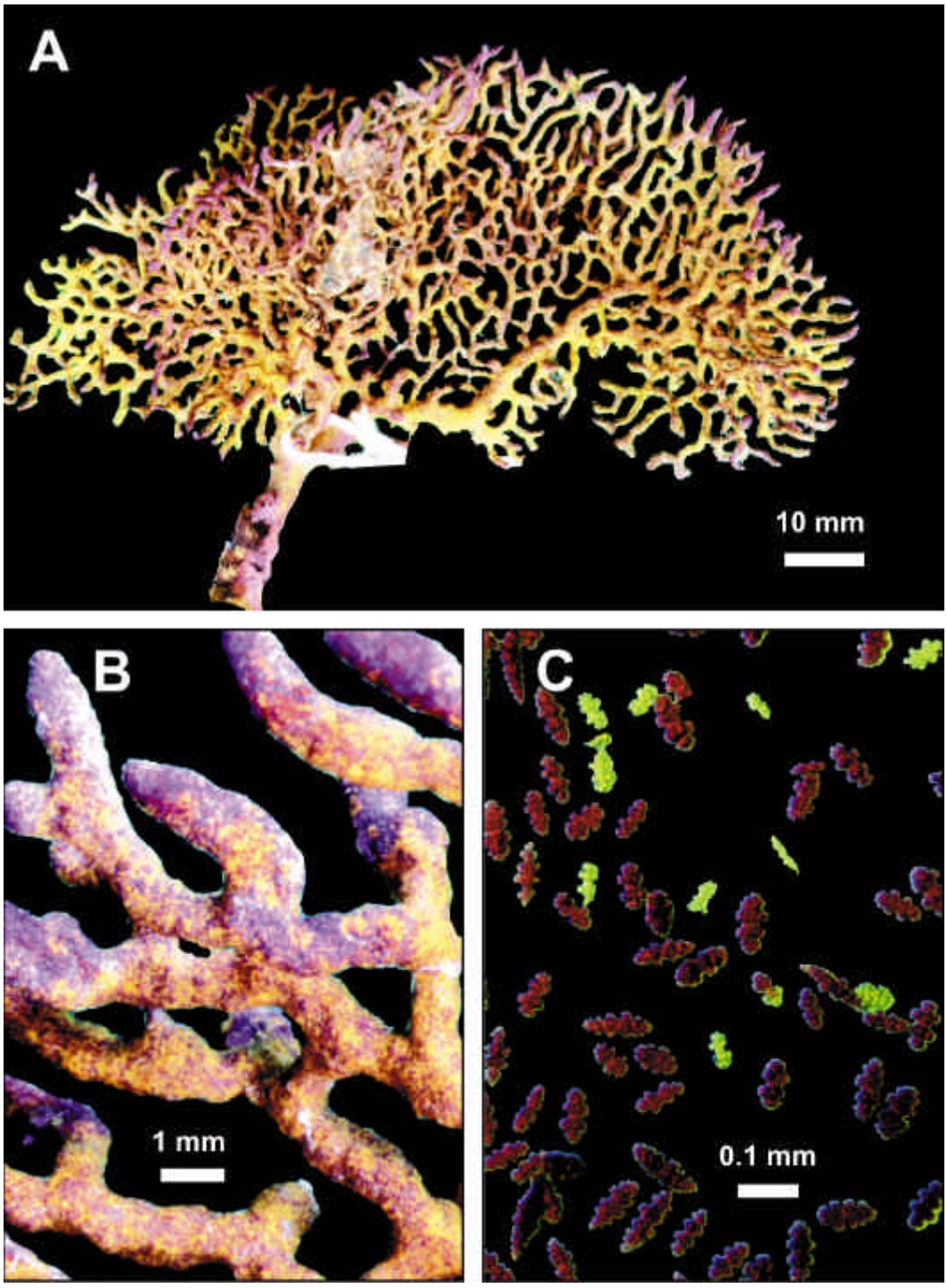

PLATE 4. *Pacifigorgia curta* new species, holotype (UCR 650) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

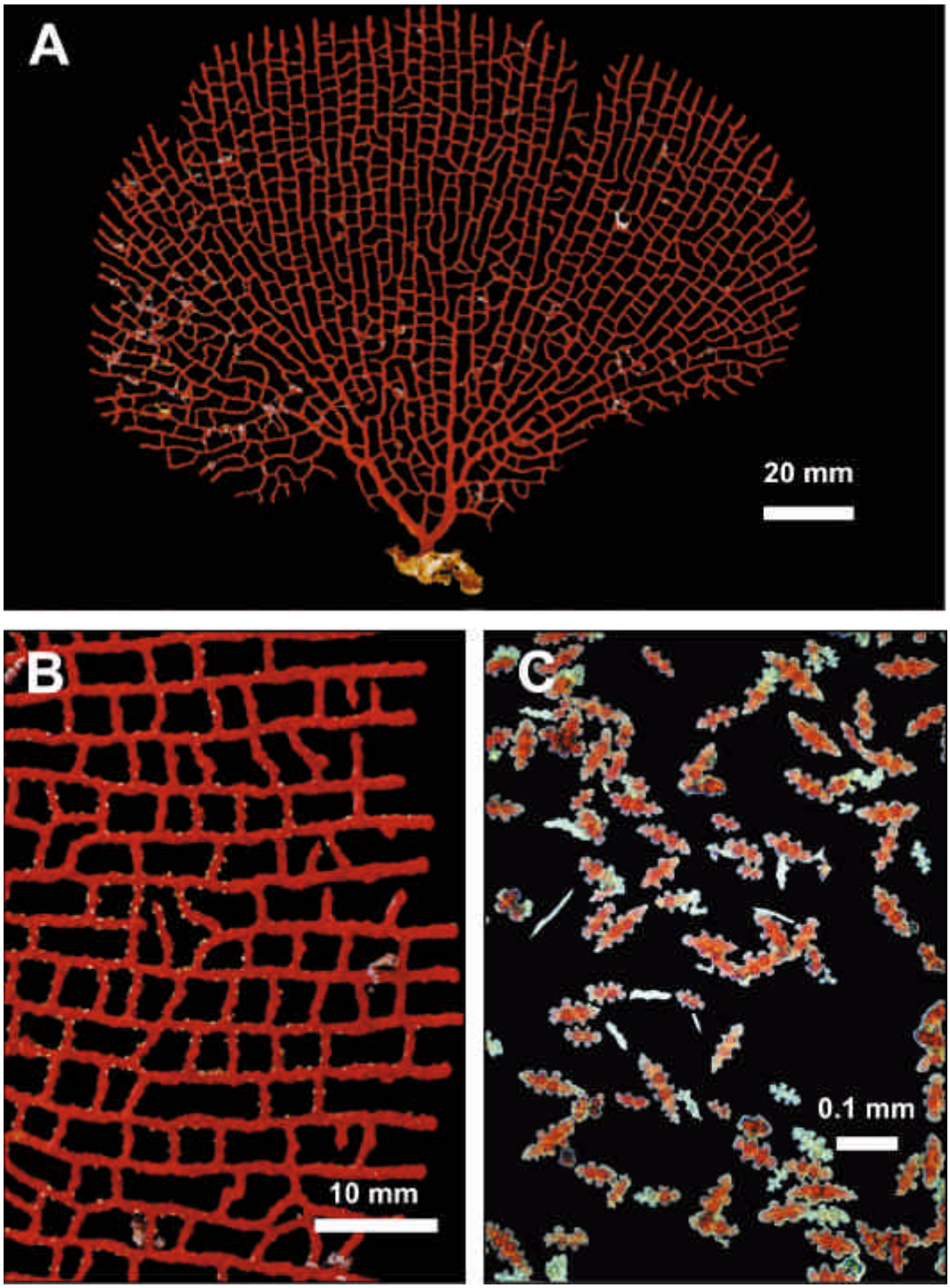

PLATE 5. *Pacifigorgia eximia* Verrill (UCR 926) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

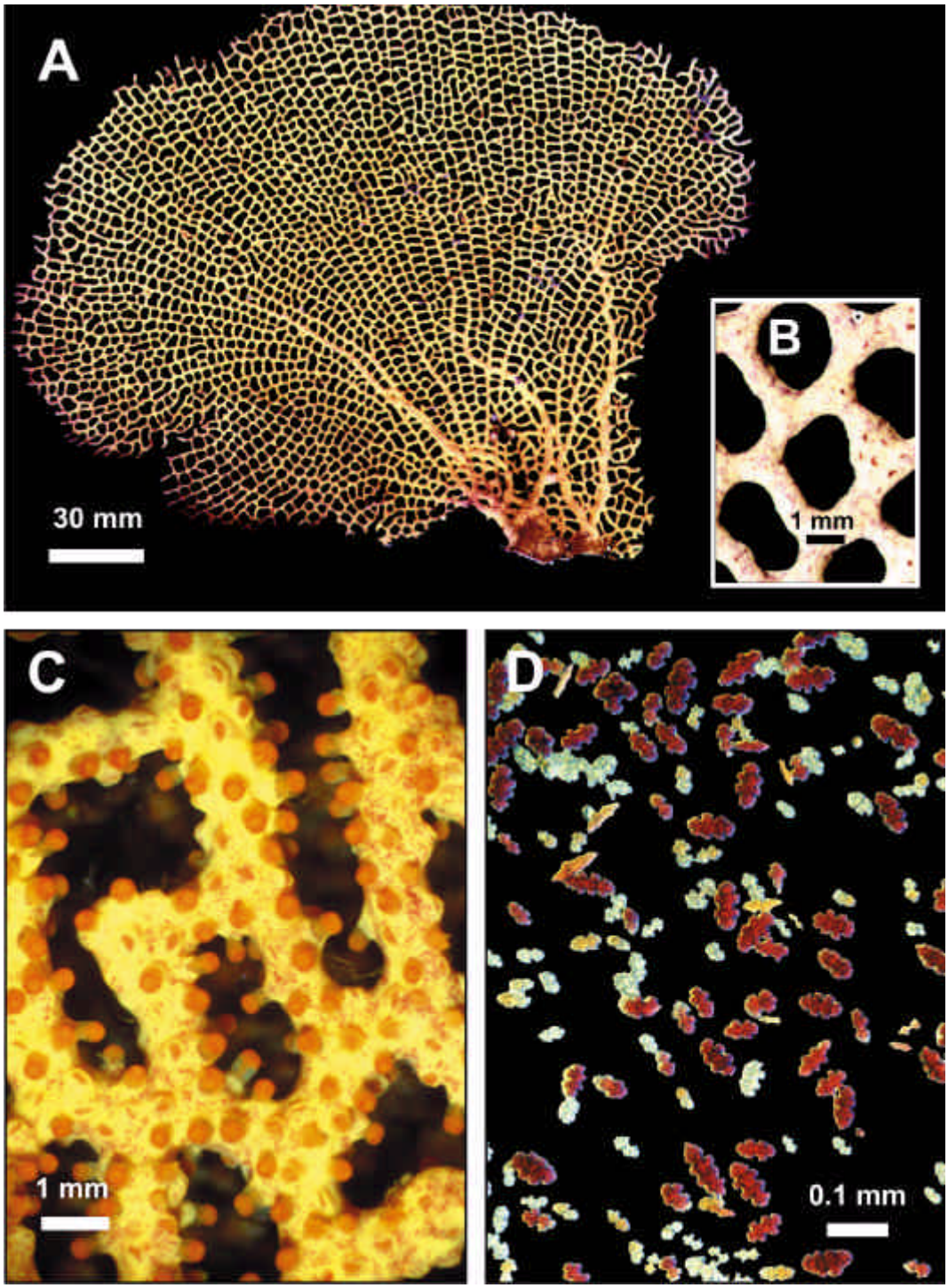

PLATE 6. *Pacifigorgia firma* new species, holotype (UCR 915) (dry specimen); A, entire colony; B, detail of the branches; C, living colony; D, photomicrograph of the sclerites.

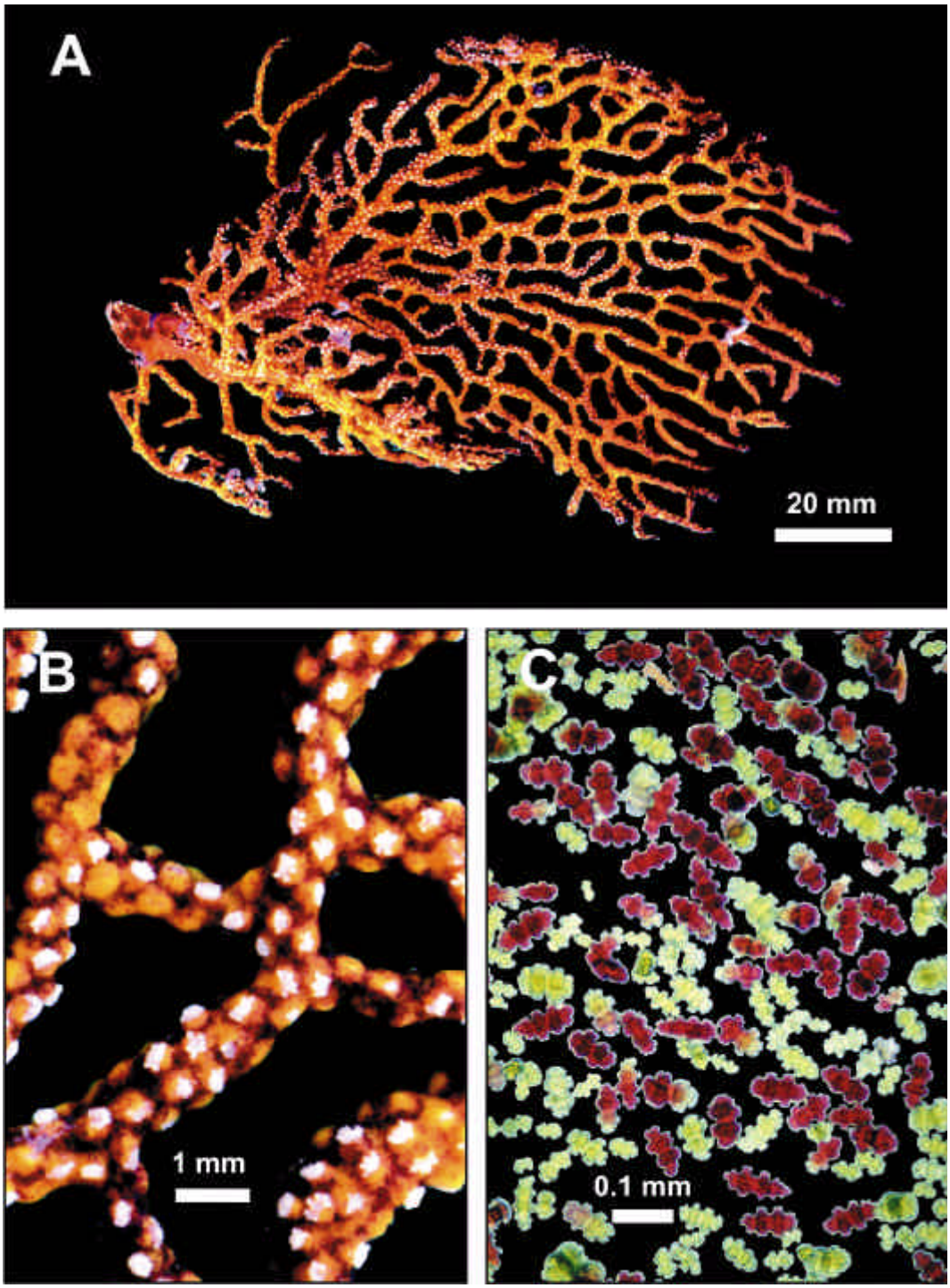

PLATE 7. *Pacifigorgia flavimaculata* new species, holotype (UCR 753) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

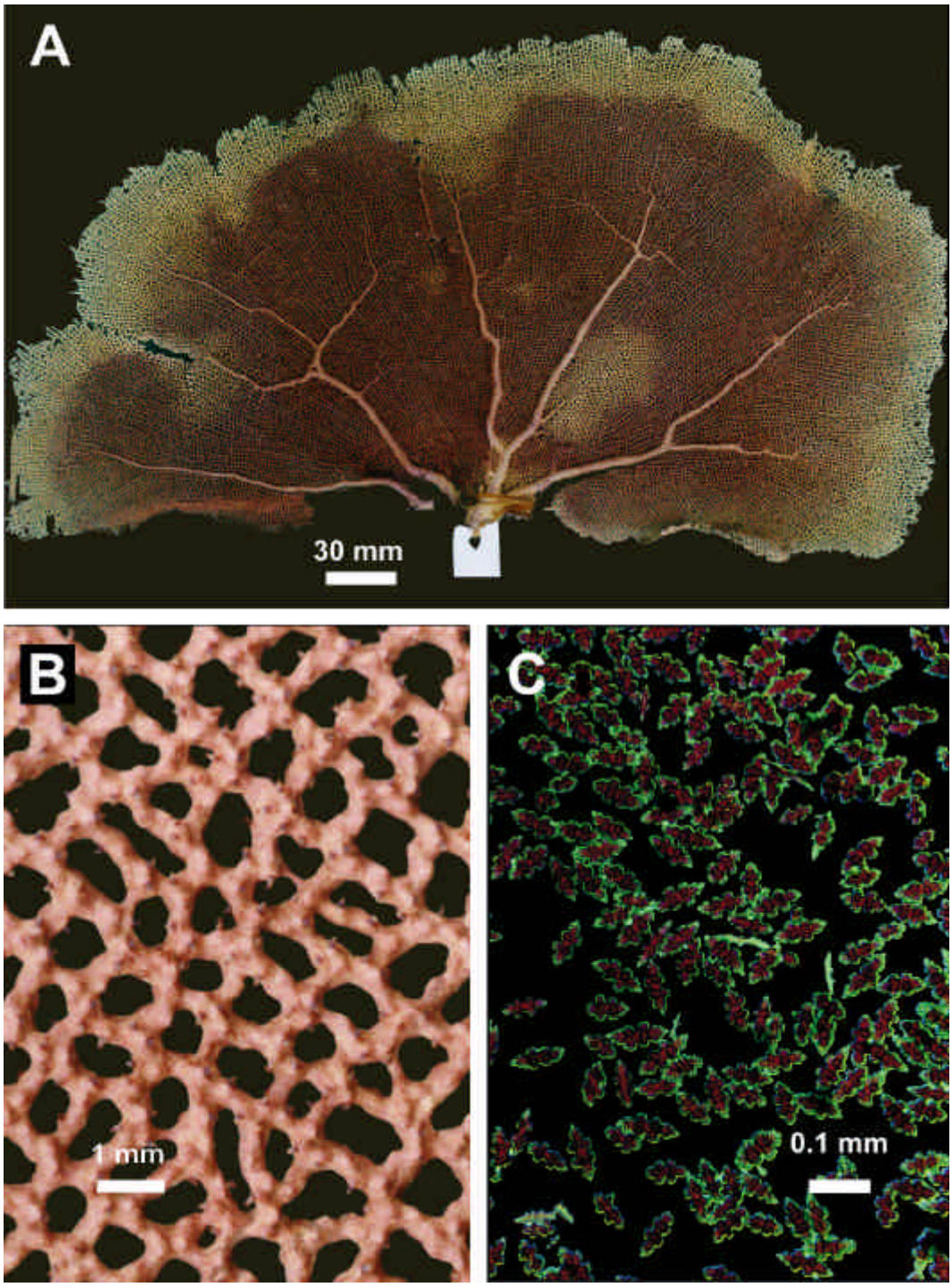

PLATE 8. *Pacifigorgia irene* Bayer (UCR 927) (dry specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

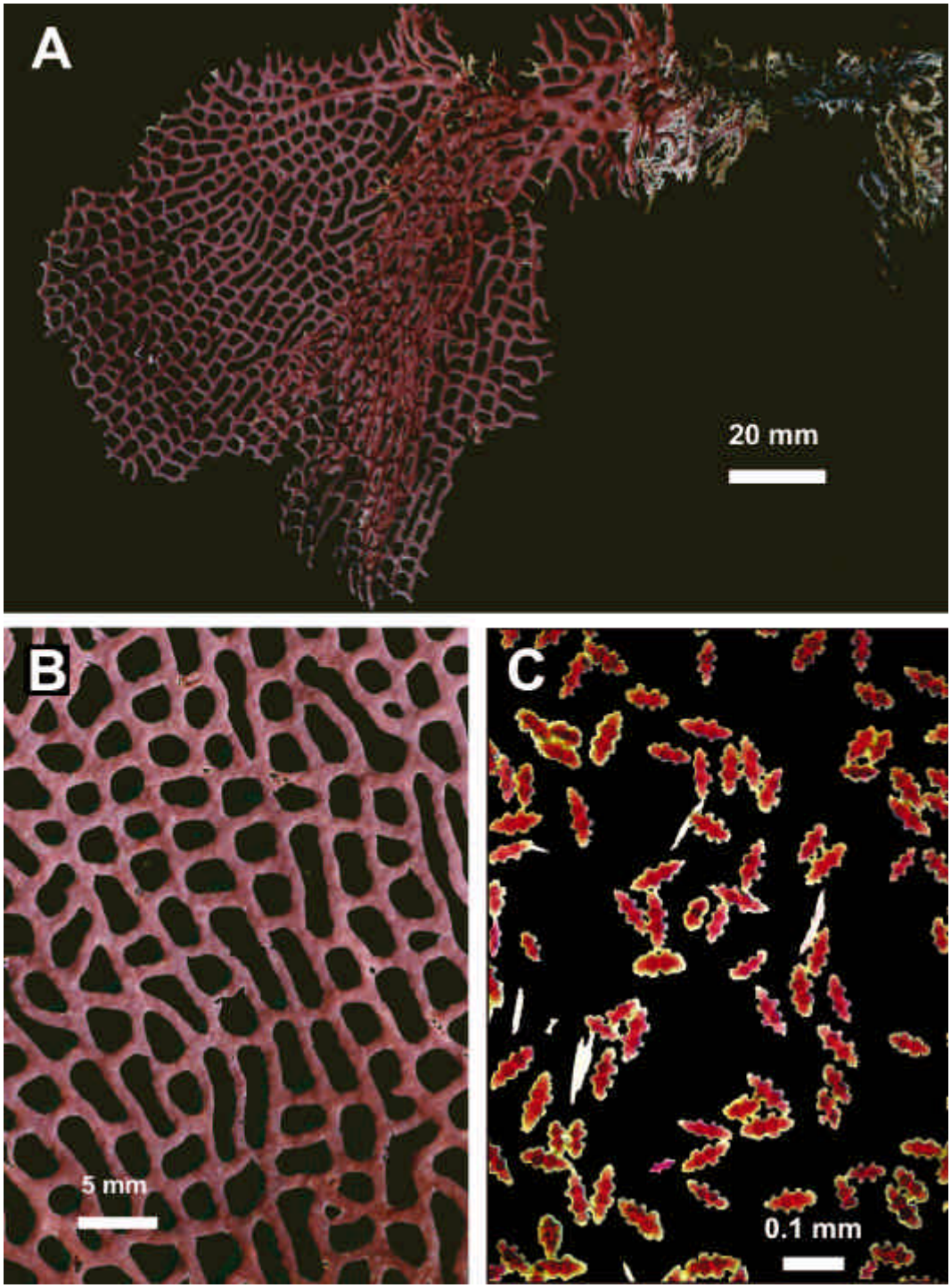

PLATE 9. *Pacifigorgia lacerata* new species, holotype (UCR 921) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

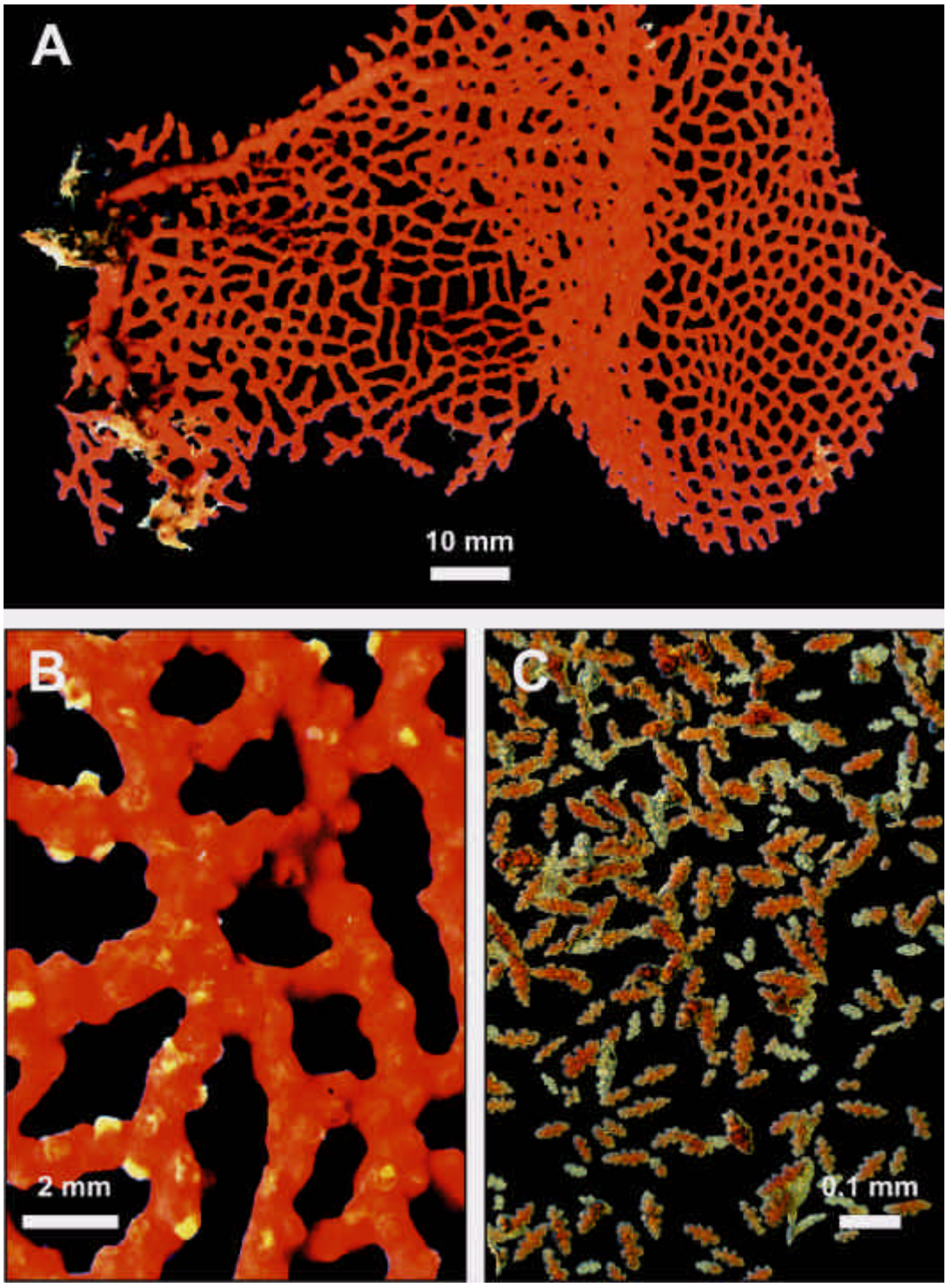

PLATE 10. *Pacifigorgia rubicunda* new species, holotype (UCR 623) (preserved specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

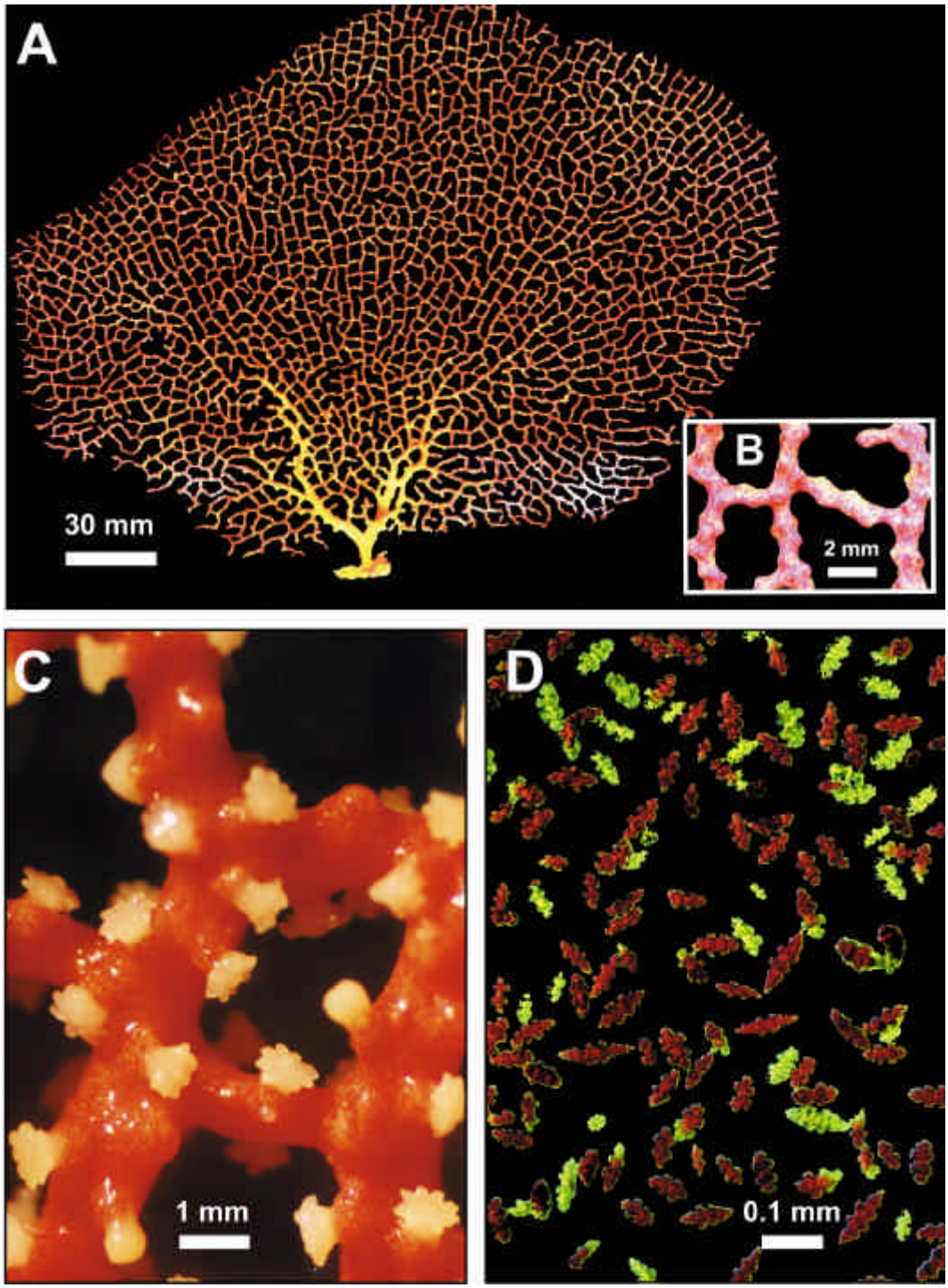

PLATE 11. *Pacifigorgia samarensis* new species, holotype (UCR 642) (dry specimen); A, entire colony; B, detail of the branches; C, living colony (paratype UCR 914); D, photomicrograph of the sclerites.

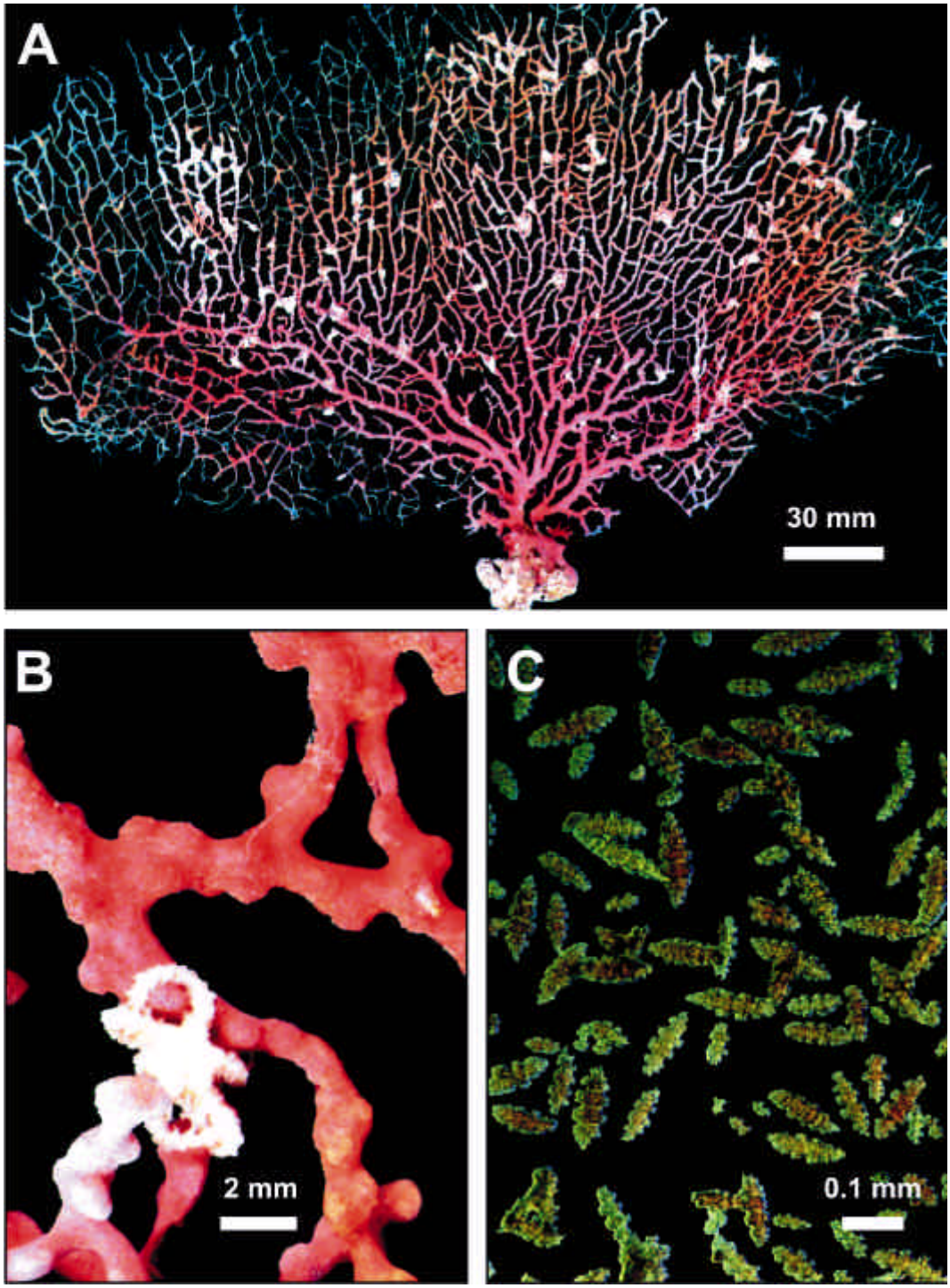

PLATE 12. *Pacifigorgia senta* new species, holotype (UCR 923) (dry specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

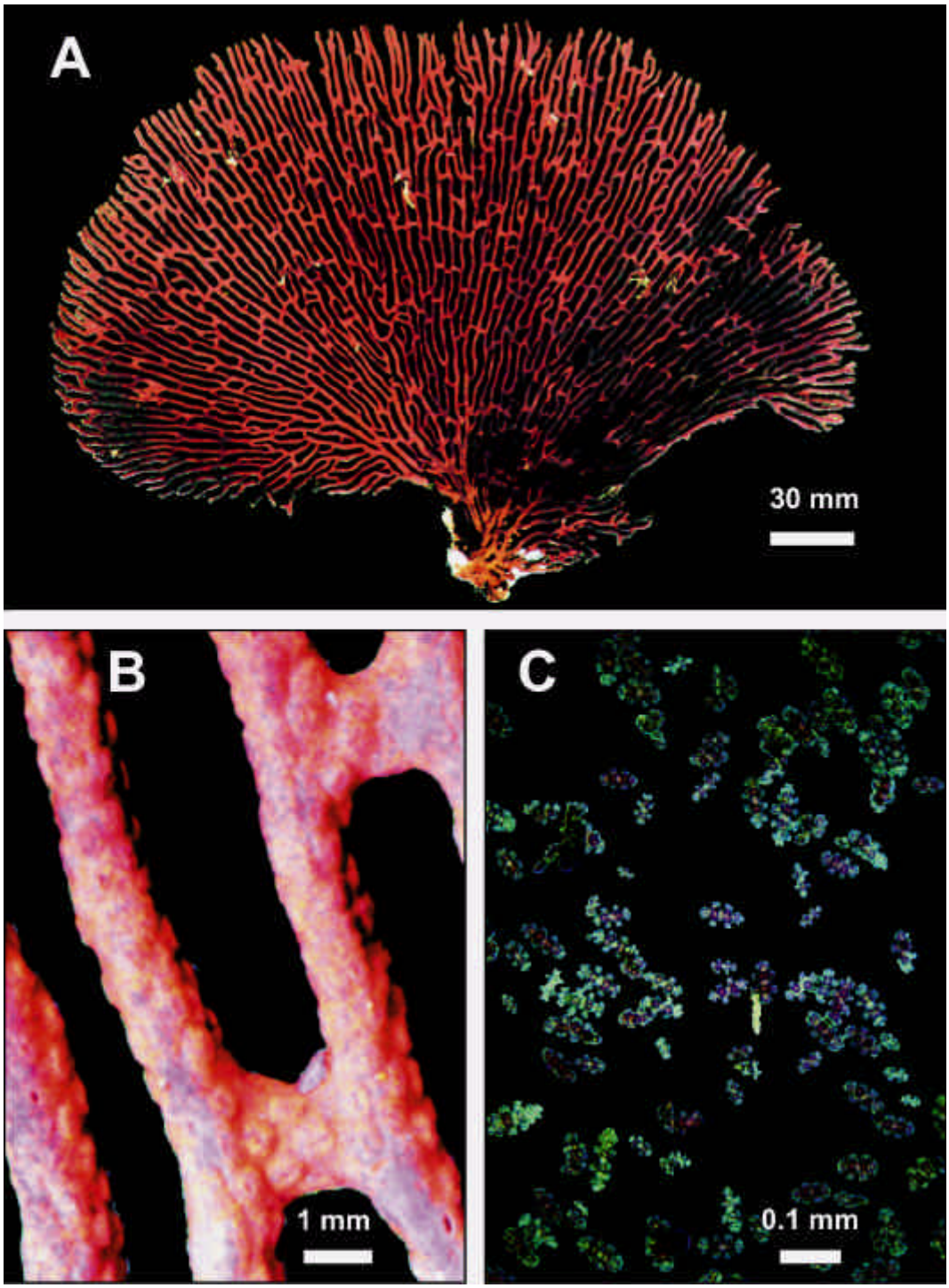

PLATE 13. *Pacifigorgia stenobrochis* Valenciennes (UCR 831) (dry specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

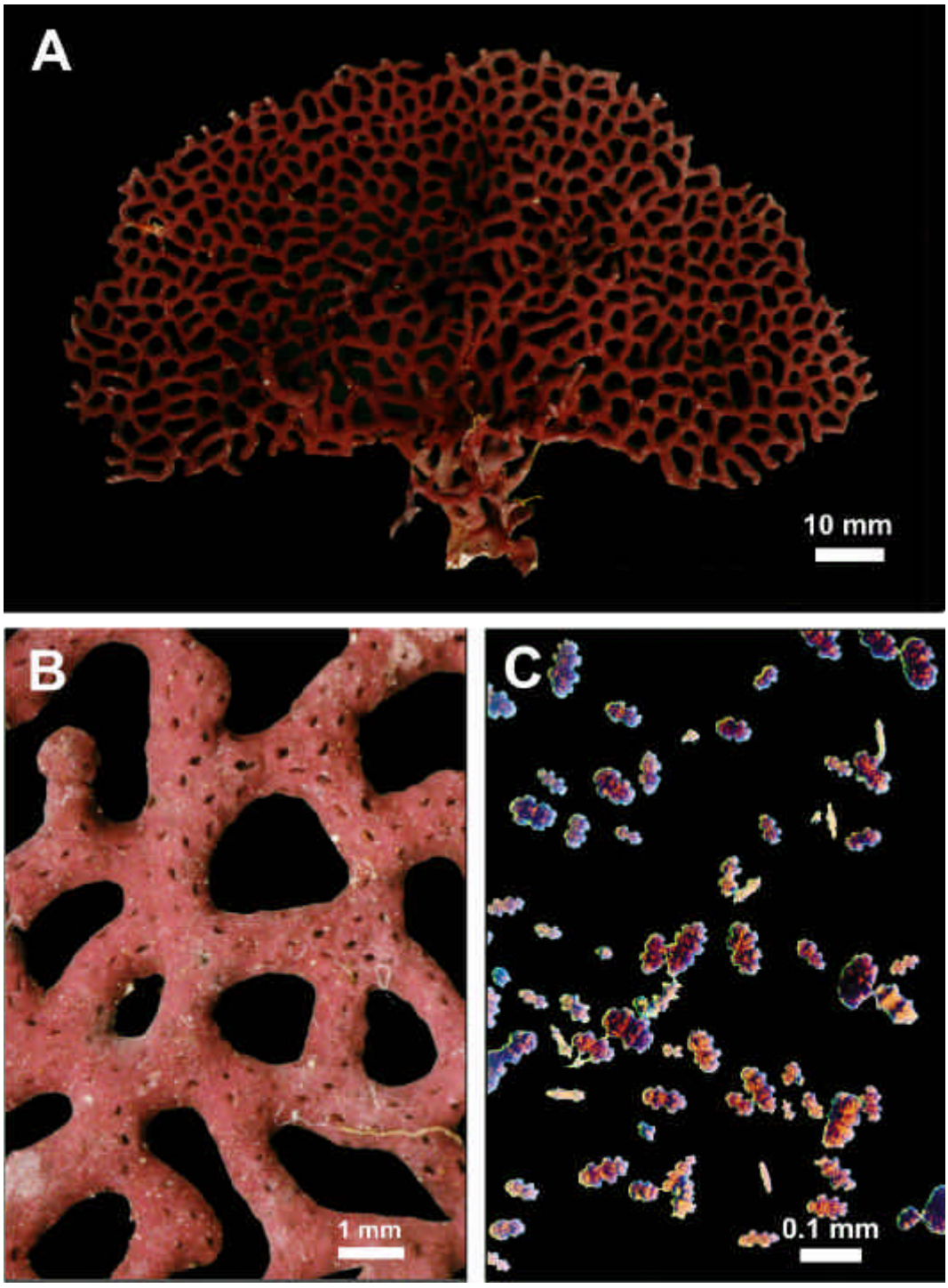

PLATE 14. *Pacifigorgia tupperi* new species, holotype (UCR 920) (dry specimen); A, entire colony; B, detail of the branches; C, photomicrograph of the sclerites.

***Pacifigorgia irene* Bayer, 1951**
(Plate 8, Fig. 7)

Synonymy. See Breedy & Guzman 2002: 825.

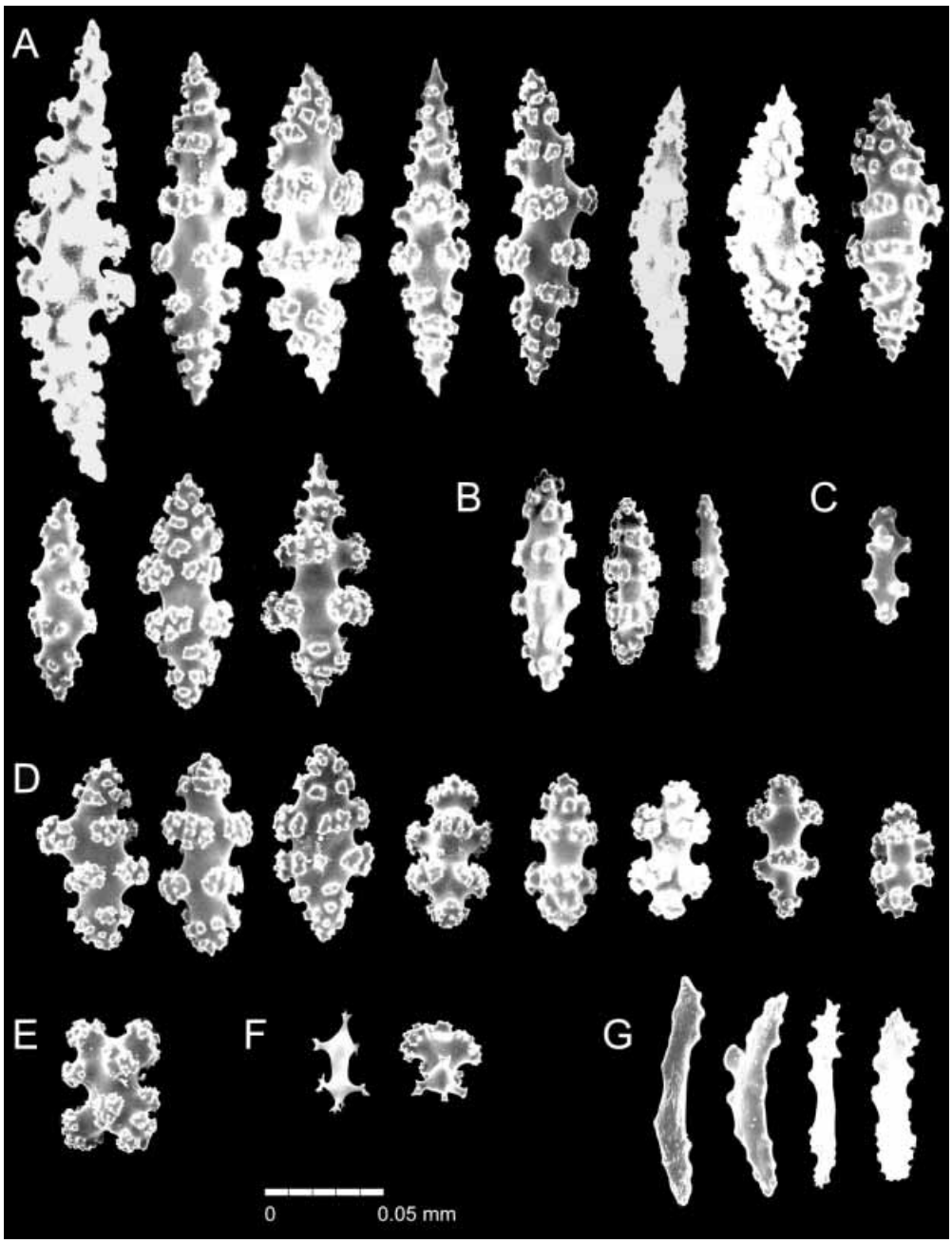

FIGURE 7. *Pacifigorgia irene* Bayer (UCR 927), SEM-micrographs of the sclerites: A-B, spindles; C, immature sclerite; D, capstans; E, four-radiate; F, spindly capstans; G, anthocodial rods.

Material examined.

***Holotype*:** USNM 49365, Punta Pajarón, Panamá, P. S. Galtsoff, 11 March 1948.

Paratypes: USNM 33611, 49379, Gulf of Nicoya, M. Valerio, March 1927.

Other material: UCR 413, Punta Mala, Dominical, 15 m, M. Murillo, 24 January 1984; UCR 476, Punta Uvita, Puntarenas, Costa Rica, 14 m, J. Cortés and M. Murillo, 24 February 1984; UCR 488, 493, Dominical, Puntarenas, 13 m, J. Cortés, 23 January 1984; UCR 487, Punta Conejo, Herradura Bay, Costa Rica, 10 m, J. Cortés, 2 September 1983; UCR 506, Caño Island, 17 m, H. Guzman, 24 February 1984; UCR 643, Sámara Bay, 10 m, J. Cortés, 25 April 1992; UCR 906, Archipelago Murciélago, Costa Rica, J. Jiménez, October 1997; UCR 927, 964, 965, Punta sureste, Caño Island, 17 m, O. Breedy and J. Cortés, 14 September 1996; UCR 966, Sámara Bay, picked up in the beach, A. Chaverri, January 2000; UCR 968, Isla Chora, Sámara Bay, 12 m, O. Breedy and H. Guzman, 31 March 1998; UCR 987, Bajo Tiburones, Caño Island, 20 m, O. Breedy, 13 September 1997; UCR 993, Punta Matapalito, Osa Peninsula, 18 m, O. Breedy and A. Fonseca, 15 March 1998.

Diagnosis. Colonies large, erect, and broad (up to 800 mm long by 900 mm wide) of one or several fans (Plate 8A). Colonies when alive are dark purple with greenish borders; fading when preserved or dry to a dark pink with greenish to yellowish edges; some specimens retain darker colours. Colonies finely and regularly reticulate (32 meshes/cm^2). Branches slender (0.5–0.7 mm thick). Network of small, squarish meshes, up to 2 mm in diameter. Fans crossed by several very stout, flattened midribs and with strong, wide holdfasts. End-branchlets very short, less than 1 mm. Calyces bilabiate, small, slightly raised and very crowded, distributed evenly along outer edges of branches producing a rough warty surface. Polyps light orange, when alive, and about 0.7 mm long when fully expanded. Coenenchymal sclerites red, lemon yellow, and bi-coloured: spindles long (up to 0.15 by 0.04 mm, some reaching 0.2 by 0.05 mm), with 2–4 whorls of warty tubercles and acute, long, warty ends (Fig. 7A); spindles (up to 0.09 by 0.04 mm) with blunt, warty ends (Fig. 7B); immature sclerites (up to 0.06 by 0.03 mm) with short, low tubercles (Fig. 7C); capstans (up to 0.06 by 0.03 mm) (Fig. 7D); and four-radiates (around 0.05 by 0.06 mm) with warty ends (Fig. 7E). Anthocodial sclerites flat rods, light pink or colourless (up to 0.10 by 0.02 mm) with broadly scalloped edges (Fig. 7G), and slender, spiny capstans (up to 0.05 by 0.02 mm) (Fig. 7F).

Remarks. This species is easily recognized because of its characteristic morphology and colour which is very different from all the others. These features remain constant regardless of the size, depth or location. The dried specimens from Panamá are of a more intense reddish colour than the ones from Costa Rica.

Habitat. Colonies were found 12–33 m in depth and were attached to rocky bottoms or vertical walls. They are common in most of the places sampled where they show a very marked distribution and in some rocky reefs they are the dominant species.

Distribution in Costa Rica. Found all along the coast and the explored islands.

Published records. From Bayer (1951): Punta Pajarón, Panamá; Gulf of Nicoya, Costa Rica.

***Pacifigorgia lacerata*, new species**
(Plate 9, Fig. 8)

Material examined.

***Holotype*:** UCR 921, Plataforma sureste, Caño Island, 18 m, O. Breedy, 16 February 2000.

***Paratypes*:** UCR 948, 984(2), Los Arcos, Caño Island, 20 m, O. Breedy, 18 February 2000; MCZ 51921, Bajo Diablo, Caño Island, 20 m, O. Breedy, 17 February 2000.

Diagnosis. Colonies erect, lobed, various shades of pink to dull violet, up to 180 mm in height, and 100 mm in width. Network stiff, of mostly square and oblong meshes up to 8 by 3 mm in size (12.5 meshes/cm²). Branches cylindrical, up to 1 mm in diameter with a smooth surface. End-branchlets up to 11 mm in length. Very few free-twigs. Midribs short, not prominent. Polyps white. Calyces almost flat, closely arranged in pairs on both surfaces of the branches, absent on the inner sides of the meshes. Coenenchymal sclerites red with lemon-yellowish halos; spindles (up to 0.12 by 0.04 mm); capstans (up to 0.10 by 0.05 mm); and immature capstans (up to 0.060 by 0.04 mm). Anthocodial rods very long and conspicuous (up to 0.14 by 0.02 mm), almost colourless or with a slight pink tint, with warty ends and smooth or serrated margins.

Description. The holotype is a preserved colony measuring 180 by 95 mm, and is formed from three fans, part of which have been ripped off (Plate 9A). Some branches spread from the primary fan and form the two perpendicular secondary fans. Branches are cylindrical, ranging from 0.8–1 mm in diameter. Network consists of mostly square and oblong meshes ranging from 2–3mm by 2–3 mm and 6–8 mm by 1–1.5 mm in diameter. Two, not very prominent midribs (2–4 mm diameter), arise from the small holdfast and can be followed for a short distance before they merge into the fan. Free-branchlets are from 1–11 mm long. Coenenchymal sclerites are red with a lemon-yellowish halo: spindles (0.09–0.12 by 0.03–0.04 mm) with acute ends and 3–4 whorls of tubercles (Fig. 8A); some are tapered at one end (0.09–0.1 by 0.03–0.04 mm) (Fig. 8B); abundant capstans (0.05–0.10 by 0.04–0.05 mm) with warty whorls of tubercles (Fig. 8C); and immature sclerites (0.04–0.06 by 0.02–0.04 mm) with low tubercles, and acute or blunt, rounded ends (Fig. 8D). Anthocodial sclerites are conspicuous, very long rods (0.09–0.14 by 0.01–0.02 mm) with smooth or dentate margins and with warty ends (Fig. 8E). Some of these are colourless, while others have a slight pink tint to them.

Remarks. Colonies of this species were generally found in very bad condition, mostly torn with just small living fragments (40–50 mm) (Plate 9A). Colonies are not abundant and live close together on the same rocks. The colour and network of the new species resemble that of *Pacifigorgia tupperi* new species, however, the sclerites of that species

are very different, especially the anthocodial rods, which are finger-biscuit-like, shorter, and light purple (Table 2). The sclerites of *P. lacerata* are somewhat similar to those in *P. cairnsi*, however, the colour is darker and more spindles with acute ends are observed on preparations of this species than in *P. cairnsi*. Also, the anthocodial rods in *P. cairnsi* are shorter and yellow although similar in shape (Table 2).

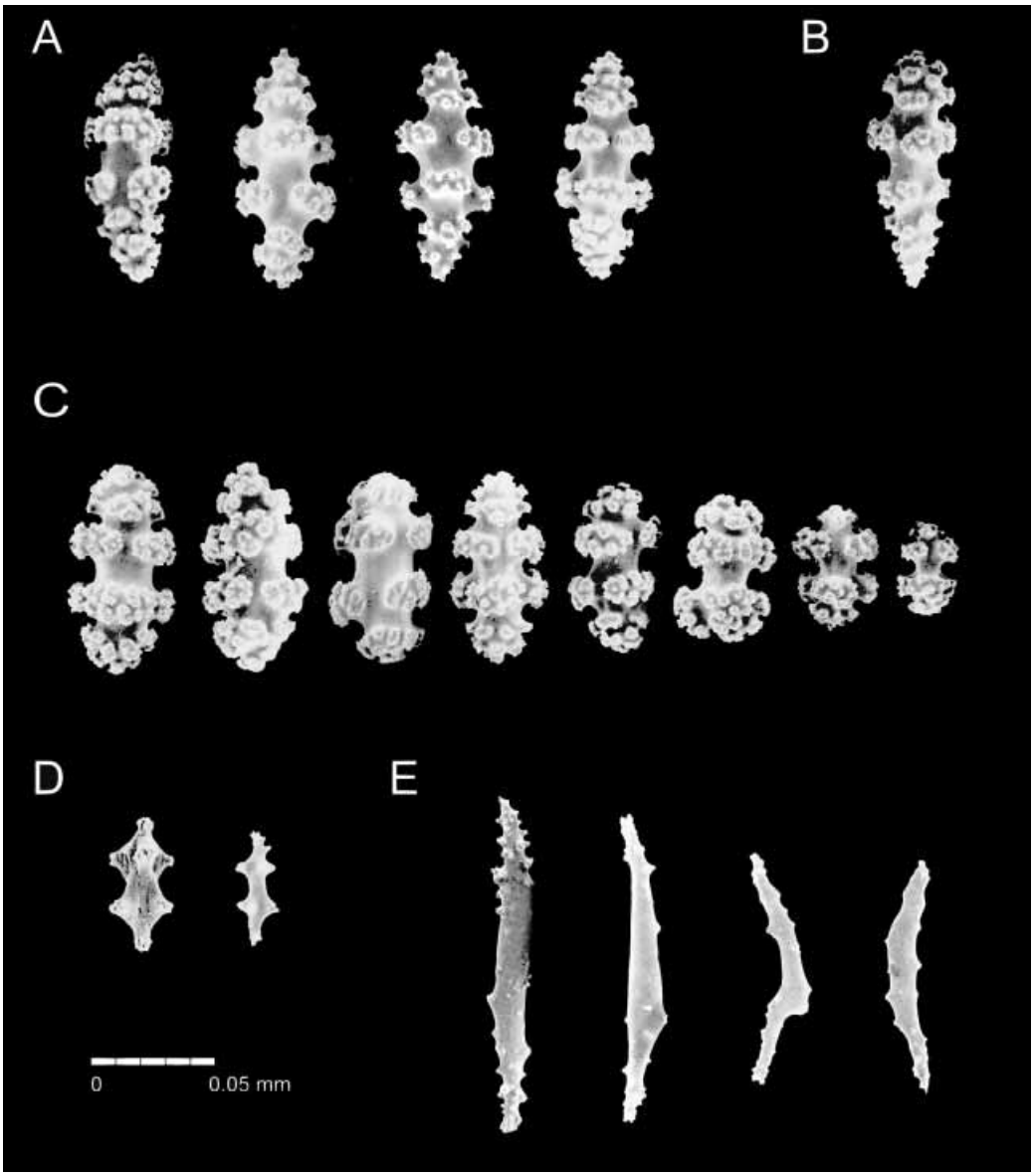

FIGURE 8. *Pacifigorgia lacerata* new species, holotype (UCR 921), SEM-micrographs of the sclerites: A–B, spindles; C, capstans; D, immature sclerites; E, anthocodial rods.

Habitat. The specimens were found at a depth of 18 m deep and live together with colonies of *P. cairnsi* and *Pacifigorgia rubicunda* new species, attached to rocky substrates together with sponges, algae and bryozoans.

Etymology. An adjective (L), *laceratus* = torn to pieces, mutilated, from *lacero* = tear to pieces, cut up or mutilate.

Distribution in Costa Rica. Caño Island.

Pacifigorgia rubicunda, new species
(Plate 10, Fig. 9)

Material examined.

Holotype: UCR 623, Isla Chora, Sámara Bay, 20–23 m, H. Guzman, 18 March 1984.

***Paratypes*:** UCR 496, Caño Island, 22 m, 11 February 1994; UCR 503, 504, Ana Bay, Caño Island, 17 m, H. Guzman, 10 February 1984; UCR 907, Archipelago Murciélago, J. Jiménez, October 1999; UCR 930, Plataforma sureste, Caño Island, 18 m, O. Breedy, 16 February 2000; UCR 932, 937 to 939, Bajo Diablo, Caño Island, 24 m, O. Breedy, 17–18 February 2000; UCR 944, Caño Island, 20 m, O. Breedy, 13 November 1997; UCR 955, 956, Punta Catedral, Archipelago Murciélago, 23 m, O. Breedy, 14 October 1999; UCR 983, Caño Island, 15–18 m, O. Breedy, 26 April 1997; UCR 991, 992, Caño Island, 20 m, O. Breedy, 13 September 1997; UCR 1043, Frailes Islet, Chiriquí Gulf, 30–35 m, H. Guzman, 9 December 2001; UCR 1067, 1072, 1073, 1075 to 1082, MCZ 51917, Santa Cruz Islet, Chiriquí Gulf, 5–14 m, H. Guzman, 10 December 2001; UCR 1106, Roca Prosper, Chiriquí Gulf, 20–25 m, H. Guzman, 11 December 2001; UCR 1141, 1143, 1146, 1148, Farallón Island, Chiriquí Gulf, 25–30 m, H. Guzman, 12 December 2001.

Diagnosis. Colonies large, oblong, wider than high, up to 150 mm in height and 60 mm in width; deep orange when alive or preserved and a conspicuous burnt sienna colour when dry. Colonies thick and stiff, of one or several fans. Network closed, and regular (17 meshes/cm^2) consisting of square meshes (1.2–5 by 0.9–2.5 mm). Free-twigs absent or very small. End-branchlets short. One midrib prominent, usually parallel to the substratum. Branches up to 1.3 mm in diameter with a warty surface. Calyces raised, with oval opening, densely distributed around the branches, few and distant on the midribs and the holdfast. Polyps from pale orange to yellow. Coenenchymal sclerites orange, yellow, almost colourless or bi-coloured: spindles (up to 0.12 by 0.04 mm) with acute, warty ends, some with sinuous axes; blunt spindles (up to 0.10 by 0.04 mm) sinuous and conspicuous; capstans (up to 0.09 by 0.04 mm) with blunt or elongated warty ends; and immature sclerites (up to 0.06 by 0.03 mm) with low tubercles. Anthocodial rods pale yellow (up to 0.14 by 0.02 mm) with lobed or scalloped margins.

Description. The holotype is a small, 50 by 90 mm, oblong colony, wider than high composed of a principal fan divided at right angles producing two perpendicular second-

ary fans that spread as a peacock tail. It is a dry colony, but pictures in Plate 10A, B were taken when it was preserved. A small portion of a large holdfast remains. Branches (0.8–1.3 mm in diameter) arise directly from the holdfast and anastomose to form a thick and stiff regular network of square and oblong meshes (2.2 by 1.4 mm, 5 by 0.9 mm, 1.2 by 1 mm, 2.5 by 2.5 mm). A prominent midrib extends laterally for a short distance (running along the substratum in *in-situ* colonies), and then radiates in an obtuse angle up the end of the fan. There are very short end-branchlets (0.5 to 4 mm). The sclerites of the coenenchyme are conspicuous spindles (0.09–0.12 by 0.02–0.04 mm) with acute ends, and with 4–5 whorls of tubercles and sometimes a sinuous axis (Fig. 9A); sinuous spindles (0.09–0.10 by 0.03–0.04 mm) with 2–3 whorls of tubercles and acute or blunt, warty ends (Fig. 9B); capstans (0.04–0.09 by 0.02–0.04 mm) symmetric, with two whorls of wide, warty tubercles, or asymmetric, with one elongated end (Fig. 9C); and abundant immature sclerites (0.05–0.06 by 0.02–0.03 mm) with low tubercles, and warty ends (Fig. 9D). There are also a few four-radiates like crosses (around 0.07 by 0.07 mm). Anthocodial rods are pale yellow (0.05–0.14 by 0.01–0.02 mm) with lobed or scalloped margins, either smooth or with small warts (Fig. 9E).

Variability. The fans of this species are either simple and extending in one plane, or composed of several fans like the paratypes from Panamá. The secondary fans sprout from the main fan at a right angle and spread perpendicular to form new fans. Several fans can reunite, adhere together and produce square arrangements like beehives. The midrib in this species is very characteristic; it extends from the holdfast on one side along the substrate, but never attaches to it. In some specimens the midribs either merge into the network or can be traced up to the end of the fan forming an obtuse angle, like in the paratype UCR 496.

Remarks. Dry colonies of *P. rubicunda* acquire a particular burnt sienna colour, very different from the colour of other species. The species resembles *Pacifigorgia rutila* (Verrill, 1868), however, *P. rutila* has a more erect, larger, and thicker fan, with closer knitted meshes and no midribs. The coenenchymal sclerites of *P. rubicunda* are similar in colour, but different in shape and size to those of *P. rutila*, e.g. the anthocodial rods are shorter (up to 0.11 mm) and darker in colour than those in *P. rubicunda*. This new species is found together with *P. cairnsi*, and when alive their colours look very similar. However, in *P. cairnsi*, the meshes are more open, the surface smoother, the midribs cross the fan, and the polyps look greenish (Table 1). Apart from the discussed similarities, this species does not agree with any of the other *Pacifigorgia* species that have been described.

Habitat. The colonies were collected between 20–25 m depth. They grow on the vertical walls of rocky reefs or on big individual rocks covered mainly by algae, sponges and bryozoans. They also live in crevices and outcrops where they achieve their maximum size. This species is found together with *P. irene* and *P. cairnsi*, but also has been found alone on deep rocky reefs.

Etymology. An adjective (L), *rubicundus* = orange, yellowish red.

Distribution in Costa Rica. Caño Island; Sámara Bay; and Murciélago Archipelago.

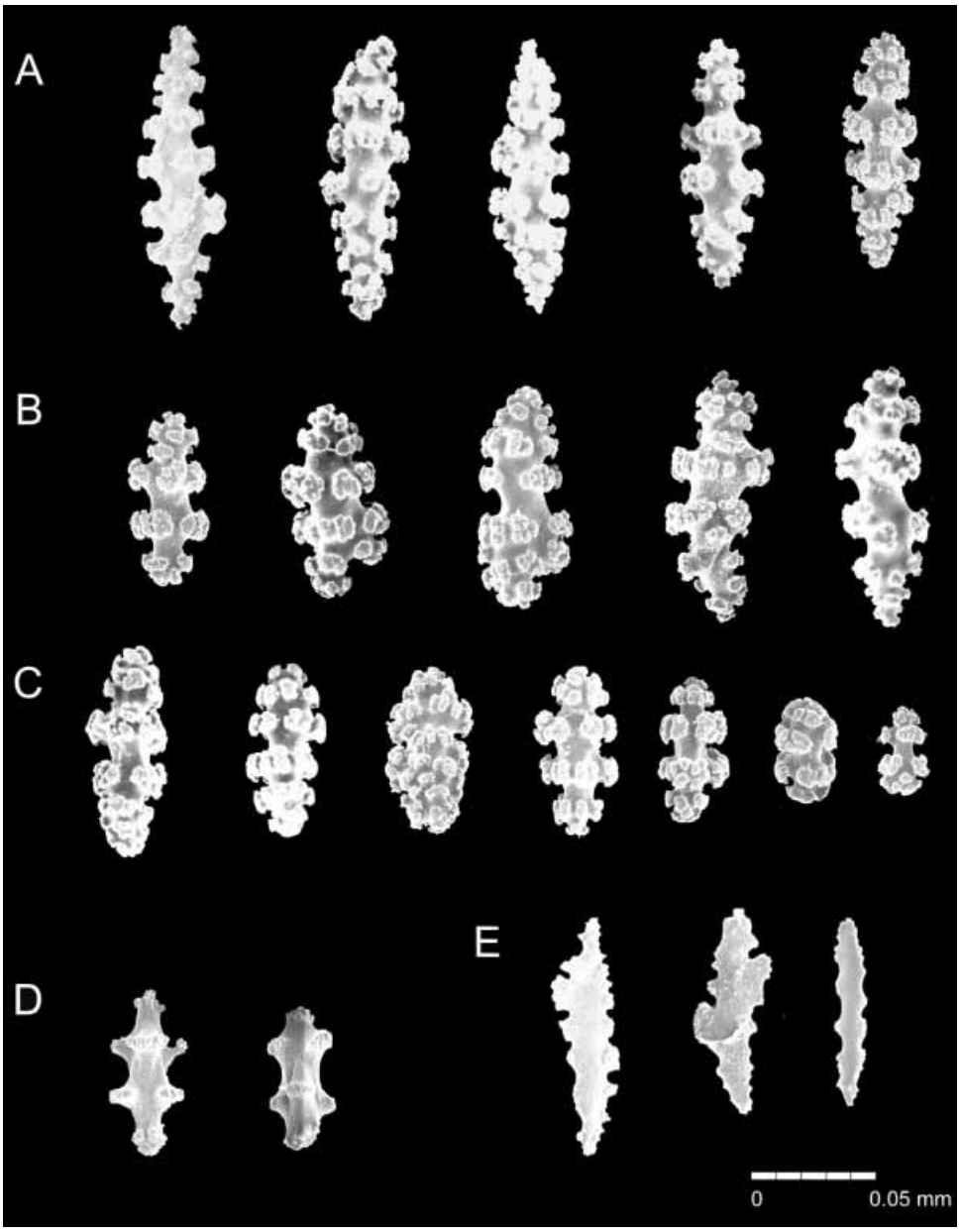

FIGURE 9. *Pacifigorgia rubicunda* new species, holotype (UCR 623), SEM-micrographs of the sclerites: A–B, spindles; C, capstans; D, immature spindles; E, anthocodial rods.

Pacifigorgia samarensis, new species
(Plate 11, Fig. 10)

Material examined.

***Holotype*:** UCR 642, Isla Chora, Sámara Bay, 8–10 m, J. Cortés, 25 April 1992.

Paratypes: UCR 480, Punta Conejo, Herradura Bay, 9 m, J. Cortés, 2 September 1983; UCR 511, Sámara Bay, 13 m, J. Cortés, 3 June 1983; UCR 590, Punta Concavas, Costa Rica, 12 m, J. Cortés, 14 June 1991; UCR 641, Sámara Bay, 10 m, J. Cortés, 25 April 1992; UCR 914, UCR 975 to 978, Isla Chora, Sámara Bay, 10–12 m, O. Breedy and H. Guzman, 27–30 July 1999; UCR 959, Caño Island, 18 m, O. Breedy and H. Guzman, 25 April 1997; UCR 986, Punta Matapalito, Osa Peninsula, 18 m, O. Breedy and A. Fonseca, 15 March 1998; UCR 1021, 1022, Ballena Marine National Park, 20 m, O. Breedy and J. Cortés, 26 April 2002; MCZ 51916, Isla Chora, Sámara Bay, 15 m, O. Breedy and H. Guzman, 31 March 1998.

Diagnosis. Fans wider than high, up to 150 mm in height and 250 mm in width, with one or several fans growing parallel. Colonies deep red to orange when alive or preserved, and light orange speckled with pink, when dry. Network closed (14 meshes/cm²), consisting of square and rectangular meshes (up to 7 by 3 mm) with short free-twigs. Midribs very short. Branches up to 0.8 mm in diameter with a warty surface. Calyces raised, rounded, alternately in two rows on both sides of the branches. Polyps white or yellowish (paratype UCR 914, Plate 11C). Coenenchymal sclerites red, yellow or bi-coloured: spindles (up to 0.12 by 0.05 mm); capstans (up to 0.10 by 0.04 mm); and immature capstans (up to 0.06 by 0.03 mm). Anthocodial rods yellow, long and pointed (up to 0.10 by 0.02 mm) with smooth or lobed margins.

Description. The holotype is composed of a single fan measuring 128 by 168 mm (Plate 11A). It was attached to the substratum by a small circular holdfast. It is a dry colony. A short stem divides close to the holdfast forming two very short midribs that subdivide immediately and merge into the fan. Thin branches (0.5–0.8 mm thick) form a close and regular network of mostly square and rectangular meshes (3.0 by 2.0 mm, 4.0 by 2.5 mm, 7 by 2.5 mm). End-branchlets range from 2.0–6.0 mm, and the long free-twigs range from 0.5–2.0 mm. Coenenchymal sclerites are red or yellow, or a combination of both. In most of the specimens these colours are bright. These sclerites are long spindles (0.08–0.12 by 0.03–0.05 mm) with acute warty ends and four whorls of tubercles (Fig. 10A); blunt spindles (0.06–0.09 by 0.03–0.04 mm) with four whorls of tubercles and warty ends (Fig. 10B); numerous capstans (0.04–0.10 by 0.02–0.04 mm) with wide warty tubercles and elongated warty ends; smaller forms with tuberculate, short ends (Fig. 10C); and immature sclerites (0.04–0.06 by 0.02–0.03 mm) with low tubercles (Fig. 10D). The anthocodial sclerites are yellow, pointed rods with smooth margins (0.08–0.10 by 0.003–0.02 mm) or lobed margins (0.05–0.06 by 0.01–0.02 mm) (Fig. 10E), and spindly crosses (Fig. 10F).

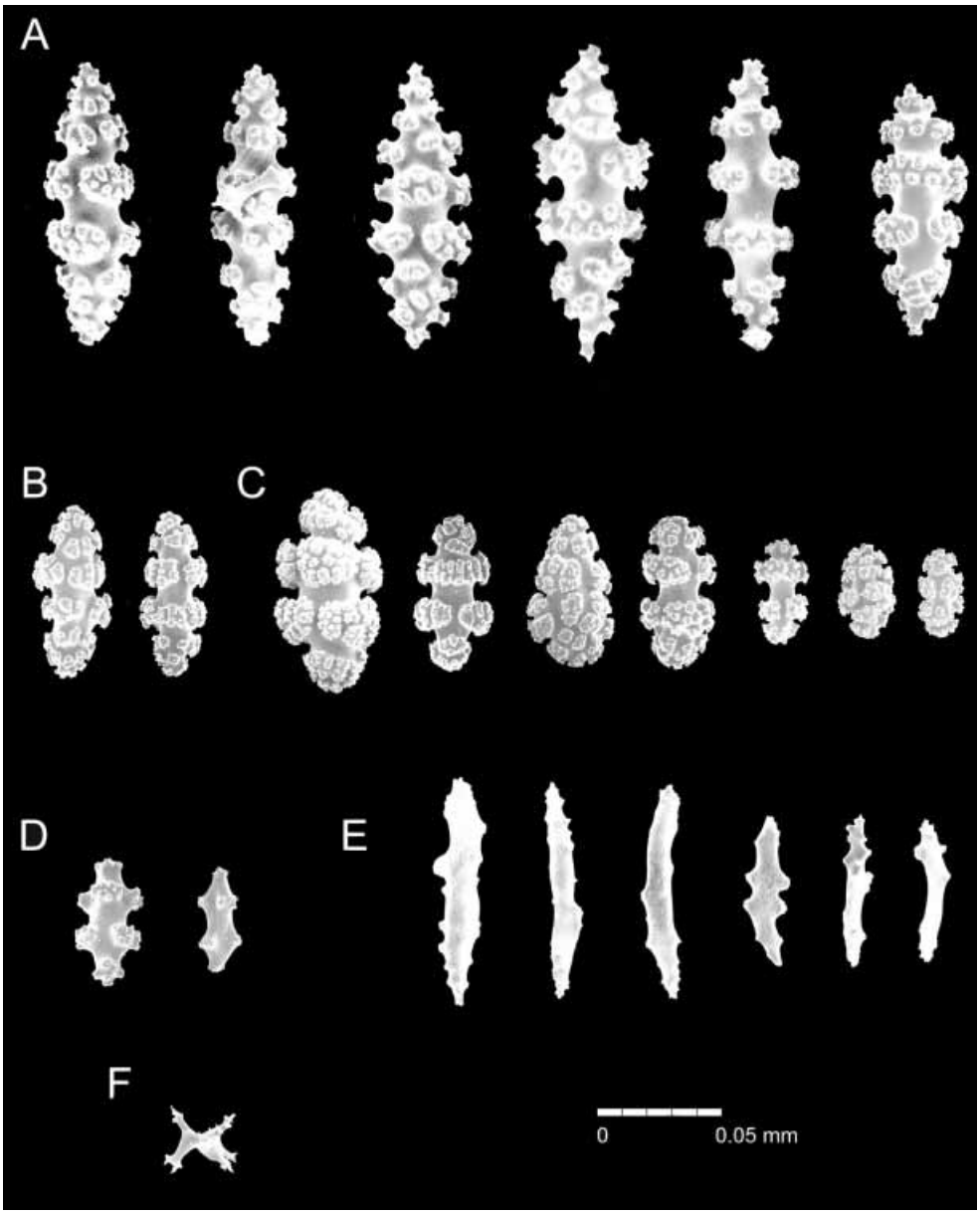

FIGURE 10. *Pacifigorgia samarensis* new species, holotype (UCR 642), SEM-micrographs of the sclerites: A–B, spindles; C, capstans; D, immature sclerites; E, anthocodial rods; F, spindly capstan.

Remarks. Similarity with *P. cairnsi* was discussed above. This new species also should be compared with *P. eximia*, *Pacifigorgia pulchra* (Verrill, 1870) and *Pacifigorgia exilis* (Verrill, 1870), however, the thin network of the new species, mainly of square meshes, distinguishes it at first glance from the other species. Also, *P. eximia* forms bigger

colonies, with larger mostly rectangular meshes (1–30 mm by 2–3 mm); it has larger sclerites, mainly spindles with acute ends and, with the exception of the yellow anthocodial rods, all sclerites are red. With respect to *P. pulchra*, the warty surface, absence of midribs, and colour and size of coenenchymal sclerites match *P. samarensis*. However, *P. pulchra* shows many more secondary fans than *P. samarensis* and the anthocodial rods are specifically orange, not yellow as in the new species, and are also larger (0.14 by 0.03 mm). *P. exilis* is different from *P. samarensis* in regard to: the branches which are thicker (1.0–2.5 mm); the meshes, which are smaller (0.5–3 mm) with spaces totally filled in with coenenchyme; and the short flat midribs, which are absent in the new species. Additionally, the new species has polyps arranged in two rows instead of four as in *P. exilis* (Plate 11C). Sclerites of both species are similar in colour and size. Although anthocodial rods in both species are yellow and of similar shapes, they are longer in *P. exilis* (0.12 mm).

Habitat. The specimens were found 8–12 m deep on basaltic walls and on mudstone slabs and also weakly attached to rocky bottoms, small stones or debris. They are commonly found in zones of turbid waters and swept by currents, such as in Sámara Bay where they represent the dominant species at a depth of 10–12 m, and at Piedra de Corcovado where they are the sole species of fans found from 8–10 m deep.

Etymology. This species is named in allusion to Sámara Bay. Even though this species is very common along the Pacific coast of Costa Rica, Sámara Bay is the first place where a *Pacifigorgia* species is being studied in terms of population dynamics (work in progress).

Distribution in Costa Rica. Found all along the coast and the explored islands.

***Pacifigorgia senta*, new species**
(Plate 12, Fig. 11)

(?)*Gorgonia eximia* Hickson, 1928: 386–387; Stiasny, 1943: 74–76, Plate 6.

Material examined.

***Holotype*:** UCR 923, Cuaginiquil, Santa Elena Bay, Costa Rica, 40 m, obtained on a fishing line, donated by the fishermen of Cuaginiquil to G. Bassey, no date.

***Paratypes*:** UCR 929, Murciélago Archipelago, 36 m, no collector, no date; MCZ 47802, Gorda Bank, Baja California, Gulf of California, Mexico, "Zaca" Exped., Sta. 150, D8D10, W., 91 m, 1.2 m dredge, Beebe, 22 April 1936; MCZ 51923, Ballena Bay, Gulf of Nicoya, 36 m, collected by dredging, Expedition Victor Hensen, 2 December 1993; CASIZ 103217, Isla Cerralvo, NW end, small islet 360 m offshore from Carpenteria Canyon, Baja California Sur, Gulf of California, 9 m, collected by CASIZ 12 Jul 1979; CASIZ 103218, Los Frailes Bay, Baja California sur, Gulf of California, 36–40 m, collected by CASIZ, 10 July 1979.

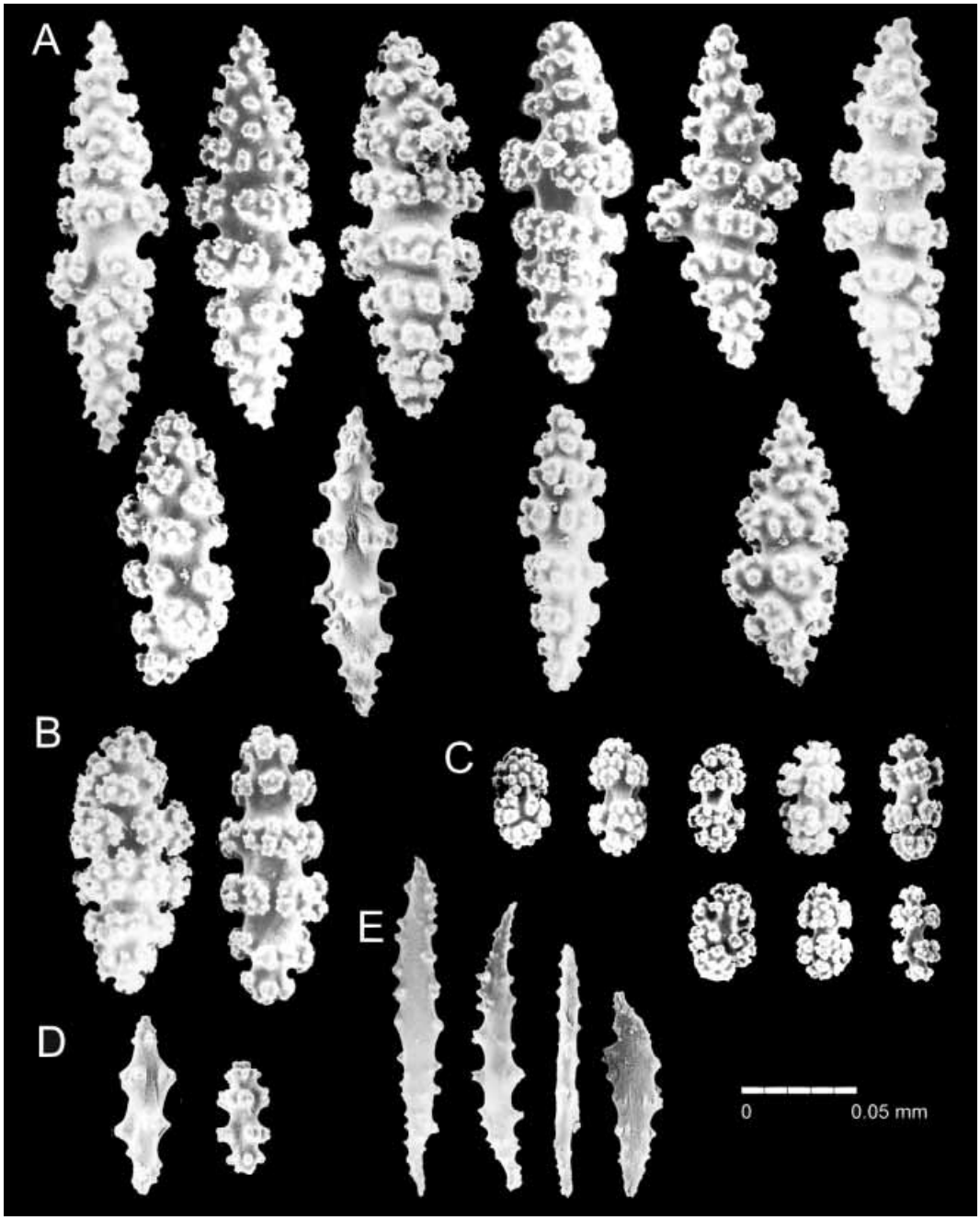

FIGURE 11. *Pacifigorgia senta* new species, holotype (UCR 923), SEM-micrographs of the sclerites: A–B, spindles; C, capstans; D, immature sclerites; E, anthocodial rods.

Diagnosis. Colonies erect, from light orange, to pink, to almost white. Fans wider than high, up to 200 mm in height, and 350 mm in width. Network irregular, of open meshes up to 24 by 7 mm (4 meshes/cm²). Holdfast strong. Midribs cylindrical and thick. Branches

up to 1.5 mm in diameter with a warty surface. Free-twigs abundant. End-branchlets long. Calyces prominent, dome-shaped, mostly alternating in about four rows on the midribs and in a single row on both sides of the branches. Sclerites large, and very conspicuous. Coenenchymal sclerites from brownish pink colour to almost colourless: mostly warty spindles (up to 0.22 by 0.06 mm) with acute ends; blunt spindles (up to 0.14 by 0.06 mm); and capstans (up to 0.06 by 0.04 mm). Anthocodial rods thorny and colourless (up to 0.14 by 0.02 mm) with acute ends and serrated margin.

Description. The holotype measures 180 by 310 mm (Plate 12A). It is a brittle, dry colony with a very loose network of irregular meshes (8–23 mm by 3–5 mm) and with many free-twigs projecting into them. Several cylindrical, thick midribs (3–8 mm in diameter) arise from a bulky holdfast. They can be traced for one third of the colony where they become thinner (1–1.5 mm in diameter). There are distinct longitudinal grooves along the midribs. End-branchlets are long and range from 10–16 mm. The colony is so brittle that the sclerites are easily dislodged leaving bare axes, which are black at the base and of a straw colour at the tips. Coenenchymal sclerites consist of mostly long spindles (0.15–0.22 by 0.02–0.06 mm) with acute ends, 6–10 whorls of warty tubercles and commonly a bare mid-section (Fig. 11A). There are few blunt spindles (0.11–0.14 by 0.05–0.06 mm) with 4 whorls of tubercles and warty ends (Fig. 11B); small capstans (0.04–0.06 by 0.02–0.04 mm) (Fig. 11C); and immature sclerites (0.05–0.08 by 0.02–0.03 mm) with low tubercles and pointed or blunt ends (Fig. 11D). Anthocodial rods are either thorny with acute ends (0.09–0.14 by 0.01–0.02 mm long) or flat with few tubercles and wavy margins (0.06–0.09 by 0.01–0.02 mm long) (Fig. 11E).

Remarks. This species resembles *P. pulchra* in its colonial morphology, however, the meshes of the latter are smaller and more symmetrical (6–18 mm by 5–6 mm) and the colony is multiplanar. It is also similar to *P. eximia* but the sclerites are very different. The conspicuous pointed spindles in *P. senta*, are very large, wide and thick, which is not the case in *P. eximia* or in the other species studied. This kind of spindle resembles those found in *Leptogorgia*. Curiously enough, the sclerites of this species very closely agree with the ones in *Gorgonia eximia*, as illustrated and described by Stiasny (1943). Although his drawings are not detailed, it is still possible to notice the similarity in the shape and the size of the sclerites. Stiasny pointed out that his specimen, a fragment from Rey Island (Gulf of Panamá) sent to him by Hickson, presented long slightly curved spindles with 8 to 12 warty girdles and measuring 0.16 to 0.20 mm long. These sclerites are not present in Verrill's type specimens of *Leptogorgia eximia* Verrill, 1868 (see Breedy & Guzman 2002), where the maximum size of the pointed spindles is 0.14 mm, and their morphology is clearly different. Hickson (1928) could not find a regular pattern in the sclerites of the specimens he analyzed, collected at the Islands of Rey and San José, Panamá or in Verrill's co-type (BM 1961.6.16.202), which was sent to him. Therefore, he classified all of the specimens as *G. eximia*, based entirely on the size of their network mesh rather than on the size and character of their sclerites. This is quite evident from his slide collection, where

slides holding different sclerite forms are labelled as one species: *G. eximia*. Actually only one, BM 1961.6.16.202, matches the lectotype of *P. eximia* (YPM 1550a) and Verrill's description in 1868b. The slide BM 1961.3.9.282, represents a different yet undescribed species; the slide BM 1961.2.6.113 is probably *P. media*, and the slides BM 1961.2.6.114 and BM 1961.2.6.115 agree with *P. senta*. Consequently, part of the material identified by Hickson as *P. eximia*, and the fragment of that from Rey Island studied by Stiasny, probably belong to *P. senta*.

We found a specimen in the MCZ labelled by E. Deichmann as *Leptogorgia zacae* "nov. nom.", from the "Zaca" Expedition, Baja California, which perfectly match this new species. Since this species was never published, we assigned those specimens to the species under study, *P. senta*.

Habitat. Two of the specimens of this species come from the same area; the holotype came from a depth of about 40 m entangled in a fishing line, and the paratype UCR 929 was growing on basaltic walls 36 m deep and collected by divers. The latter specimen belongs to the Guanacaste Conservation Area exhibit in San José Island (Archipelago Murciélago).

Etymology. An adjective (L), *sentus* = thorny, rough.

Distribution in Costa Rica. Murciélago Archipelago; Cuaginiquil, Santa Elena Peninsula; Ballena Bay, Gulf of Nicoya.

Further records. Baja California, Mexico; and probably Gulf of Panamá (Hickson 1928; Stiasny 1943).

Pacifigorgia stenobrochis (Valenciennes, 1846)

(Plate 13, Fig. 12)

Synonymy. See Breedy & Guzman 2002: 833.

Material examined.

Holotype: MNHN OCT.S.2000.03, (?) New Zealand, M. A. du Petit-Thouars, Voyage Autour du Monde, La Venus, 1839.

Other material: UCR 477, Dominical, 13 m, J. Cortés, 23 February 1984; UCR 498, Caño Island, 22 m, H. Guzman, 11 February 1984; UCR 771, Montezuma, Costa Rica, 10 m, L. Mena, 25 April 1993; UCR 831, Los Pedrones, Cabo Blanco, Costa Rica, 7 m, L. Mena, 18 April, 1994; UCR 905, Archipelago Murciélago, J. Jiménez, October 1997; UCR 962, 1005(2) Punta Matapalito, Osa Peninsula, 18 m, O. Breedy and A. Fonseca, 15 March 1998; UCR 963, Caño Island, 18 m, O. Breedy, 26 April 1997; UCR 1004 Caño Island, 20 m, O. Breedy and A. Fonseca, 13 November 1997; UCR 1020, Bajo Viuda, Ballena Marine National Park, 20 m, O. Breedy, 26 April 2002.

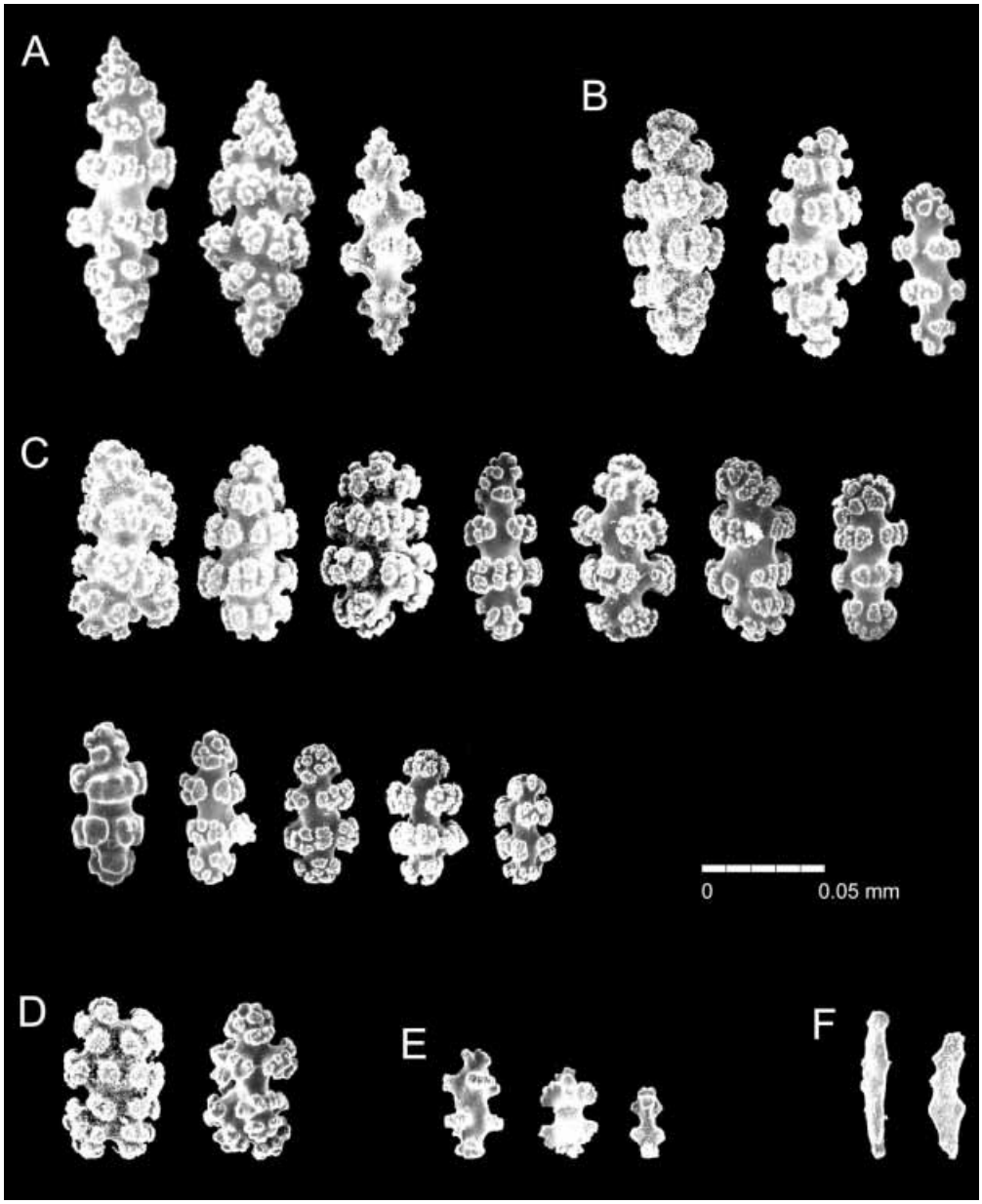

FIGURE 12. *Pacifigorgia stenobrochis* Valenciennes (UCR 831), SEM-micrographs of the sclerites: A–B, spindles; C, capstans; D, six-radiates, E, immature sclerites; F, anthocodial rods.

Diagnosis. Colonies large, up to 200 mm in height and 580 mm in width, and stiff (Plate 13A). Colour of the colonies varies from deep pink, reddish-purple, dark yellow, to brown, sometimes intermingled with orange. Fans open reticulate, with a single fan or subdivided into 2–5 lateral fans. Stem very short or absent; holdfast wide and strong. Branches mostly compressed, around 2–5 mm thick, and nearly round in cross-section at the tips. No

distinct midribs present. Network of long, oblong, or rectangular meshes around 10–35 mm by 1–4 mm in size (2 meshes/cm²). End-branchlets up to 30 mm long. Calyces low, oval, distributed on both sides of the branches, not very crowded, leaving the branches with a smooth texture. Polyps orange, reaching about 1.5 mm in diameter when fully expanded, possessing collaret-like masses of pale yellow sclerites arranged vertically, and projecting slightly into the base of each tentacle. Coenenchymal sclerites pink, grey, and yellowish: a few long spindles (up to 0.12 by 0.04 mm) with warty, acute ends, and four whorls of tubercles (Fig. 12A), blunt spindles (up to 0.1 by 0.05 mm) with four whorls of tubercles (Fig. 12B) some with one elongated end; capstans very abundant (up to 0.10 by 0.05 mm) with different arrangements of tubercles, and most of them with elongated warty ends (Fig. 12C); six-radiates (up to 0.06 by 0.04 mm) (Fig. 12D), and immature sclerites (up to 0.05 by 0.04 mm) with low tubercles (Fig. 12E). Anthocodial sclerites yellow rods (up to 0.09 by 0.02 mm) with scalloped or short lobed edges, weakly serrated at both ends (Fig. 12F).

Remarks. Although the morphology of this species is very constant, the dominance of different sclerite-forms and also the colour of both colonies and sclerites vary among different specimens. This variation was pointed out by Hickson (1928) in colonies collected from the same place at the same time. In different sites in Costa Rica, we have observed both yellow and reddish-purple varieties together and some colonies have both yellow and reddish-purple sections. UCR 771 presents a dominance of spindles with sharp ends. In UCR 498, we found six-radiates (around 0.05 by 0.03 mm) with warty blunt ends (Fig. 12D) which were not reported for the holotype.

Habitat. Found between 15–30 m deep on rocky bottoms or vertical walls. Very few colonies of this species are found scattered in environments dominated by other species like *P. irene*. Specimens from Pearl Islands and Zorritos (Perú) were collected in shallower waters, between 12 and 16 m deep (Verrill 1868c). Recent field observation showed that they also live at a depth of 8 m (Cortés, pers. comm. 2000).

Distribution in Costa Rica. Murciélago Archipelago; Cabo Blanco; Gulf of Nicoya; Sámara Bay; Caño Island; Ballena Marine National Park; and Punta Matapalo, Osa Peninsula.

Published records. From Verrill (1868c): Acapulco, México; San Salvador, El Salvador; Corinto, Punta Arenas, Nicaragua; Pearl Islands, Panamá; Zorritos, Perú. Type locality, New Zealand, is probably erroneous.

Pacifigorgia tupperi, new species
(Plate 14, Fig. 13)

Material examined.

***Holotype*:** UCR 920, San Pedrito Islets, Murciélago Archipelago, 25–28 m, C. Jiménez, Oct 1996.

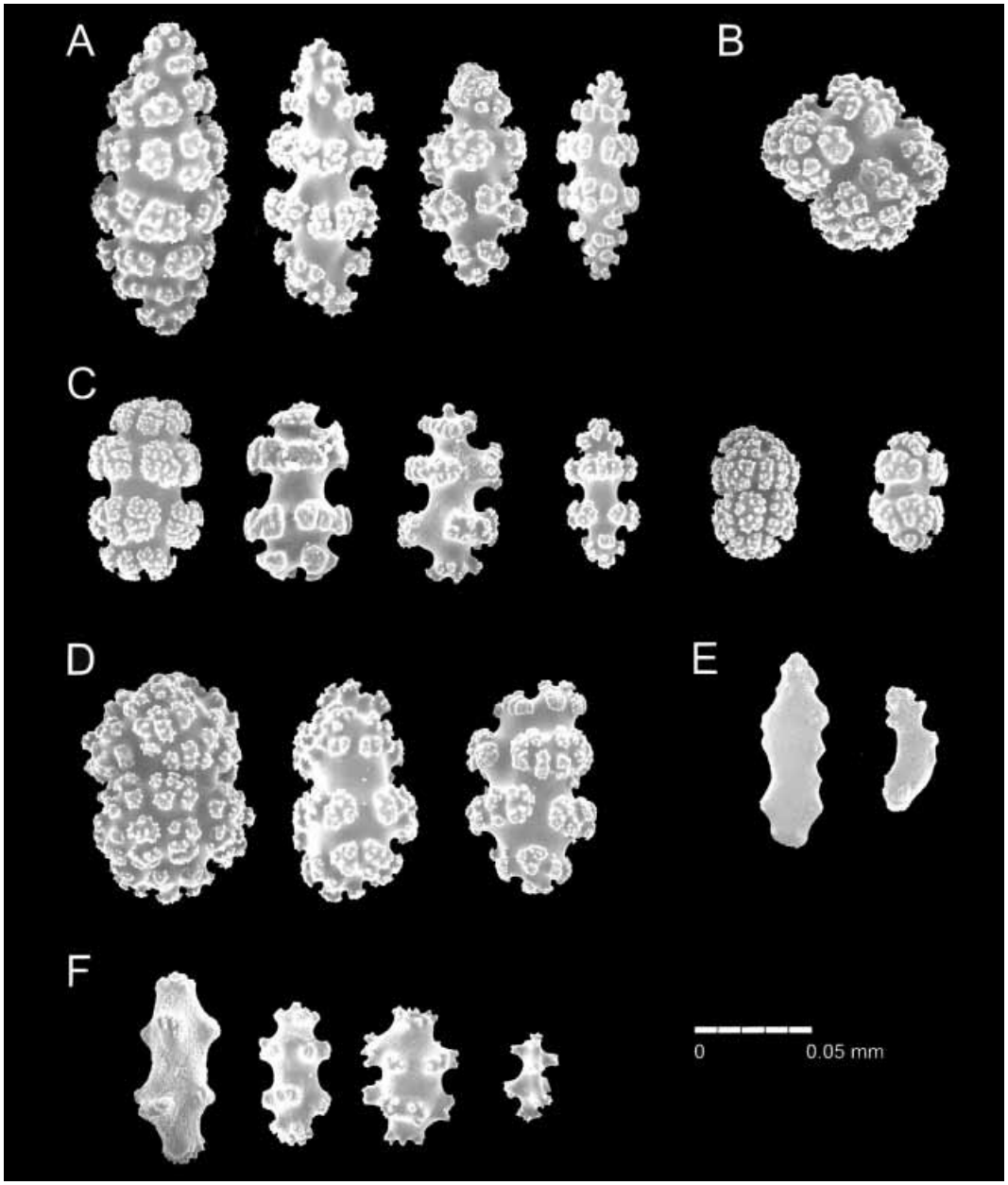

FIGURE 13. *Pacifigorgia tupperi* new species, holotype (UCR 920), SEM-micrographs of the sclerites: A, spindles; B, four-radiate; C–D, capstans; E, immature sclerites; F, anthocodial rods.

***Paratype*:** MCZ 51920, data as for the holotype.

Diagnosis. Colonies small, oval, with short stems and no trace of midribs. Colour wine red when preserved and dark pink when dry. Networks regular and closed with oval and almost circular meshes around 2–5 mm in diameter (13 meshes/cm²). End-branchlets short. Free-twigs absent or very short. Branches cylindrical in section, 1.0–1.5 mm in

diameter with smooth surface. Calyces almost flat, not very crowded, arranged all around the branches. Coenenchymal sclerites dark red; few spindles with acute ends (around 0.10 by 0.04 mm); blunt spindles (up to 0.13 by 0.05 mm) abundant; capstans wide, conspicuous (up to 0.13 by 0.08 mm), and small (up to 0.08 by 0.05 mm); and four-radiates (around 0.07 by 0.07 mm). Anthocodial rods pink (up to 0.07 by 0.02 mm) with smooth, scalloped, or lobed margins.

Description. The holotype is an erect, small fan, 76 by 120 mm, with a short stem composed of some interlaced branches (Plate 14A). It is a dry specimen. Midribs absent. Branches are cylindrical (1–1.5 mm thick) and smooth. Some of them spread at right angles and form a small secondary fan, which grows parallel to the primary. End-branchlets are very short (0.5–2 mm). Coenenchymal sclerites consist mostly of blunt spindles (0.09–0.13 by 0.04–0.05 mm) with four whorls of tubercles (Fig. 13A) and a few spindles (around 0.10 by 0.04 mm) with acute ends and 4–5 whorls of tubercles. There are four-radiates (around 0.07 by 0.07 mm) with warty, rounded ends (Fig. 13B). The capstans are very conspicuous: small (0.04–0.08 by 0.03–0.05 mm), having heavy warty tubercles to a few short warts (Fig. 13C), and large and very wide (0.09–0.13 by 0.05–0.08 mm) with a very short and almost absent median space (Fig. 13D); and immature forms (0.04–0.05 by 0.02–0.03 mm) with short low tubercles (Fig. 13F). Anthocodial sclerites are light purple rods (0.06–0.07 by 0.01–0.02 mm), finger biscuit-like, with smooth margins, or with scalloped or lobed margins (Fig. 13E).

Remarks. Only four specimens, all of similar size, were seen during the time of collection, but only two of them were collected, the holotype and the paratype. This species is similar to *P. lacerata* new species, but in the latter: the branches are thinner; the meshes are mostly square and oblong; the end-branchlets are longer (Table 1); the sclerites are purple, but with a lemon-yellowish halo; and the anthocodial rods are longer and colourless, and of a different form to the ones in *P. tupperi* (Table 2). The wide blunt spindles and capstans distinguish *P. tupperi* from the other species in the collection and also from the species of *Pacifigorgia* already described (Breedy & Guzman 2002). However, the description and the illustration given by Hickson (1928) for *P. tabogae* somewhat resemble this species, but the sclerites of the holotype (Breedy & Guzman 2002) are different enough to consider *P. tupperi* a different species.

Habitat. The colonies were found in just one site, growing alone on basaltic walls 25–28 m deep.

Etymology. This species is named after Mr. Mark Tupper in recognition of his interest and valuable collaboration in the development of marine science in the tropics.

Distribution in Costa Rica. Only reported for the type locality, San Pedrito Islets, Murciélago Archipelago.

Final remarks

Thus far, thirteen species of *Pacifigorgia* have been found along the Pacific coast of Costa Rica including the offshore islands. Even though the collection is fairly complete, some areas have not been covered thoroughly or at all, e.g. the central Pacific coast (Plate 1). Several of the species occur frequently and have a wide geographic distribution, such as *P. irene*, *P. stenobrochis* and *P. firma*. Others occur at only one locality, e.g. *P. flavimaculata* at the southern part of Osa Peninsula and *P. curta* at the north side of Cocos Island. Few specimens of these species have been collected and minimal field observations have been recorded. *Pacifigorgia lacerata* was found only at Caño Island where it is abundant. Sámara Bay and Caño Island are the sites with a higher diversity, but they are also better explored. We expect to find more species in places such as Murciélago Archipelago, Santa Elena Bay and Cocos Island when a more extensive survey is done. This will probably not be the case in the other places (e.g. Culebra Bay, Gulf of Nicoya, Golfo Dulce) where we have observed that the octocoral fauna is composed mainly of species of the genera *Leptogorgia* and *Muricea*. The central Pacific, from Playa Herradura to Playa Dominical, needs to be better explored.

Tables 1, 2 show the most important comparative features used in the identification of the species of *Pacifigorgia*. The colony colour, size of the meshes, and the presence or absence of midribs are the first diagnostic characteristics that can be observed in the field. The surface of the colony varies depending on the degree of expansion of the polyps in living colonies and on the state of the colony after preservation. This character is better observed in dry specimens. The colony sclerite content, especially the kind and abundance of spindles and anthocodial rods, made possible the definitive diagnoses in most of the species (Table 2).

Variation in the morphology of the colony and sclerites of gorgoniids according to environmental pressures has been acknowledged (Bayer 1961, Lasker & Coffroth 1983, Prahl et al. 1986, Brazeau & Lasker 1988, Yoshioka & Yoshioka 1989, Mitchell et al. 1993, West et al. 1993, Weinbauer & Velimirov 1995). Nevertheless, with the exception of some difference in the size of the colonies, observations on *P. irene* in Costa Rica have shown that both sclerites and growth forms keep the same morphology in spite of being taken from different sites and depths. In several species, the meshwork of small colonies is looser than that in fully-developed ones, but there is no difference in the sclerites, e.g. *P. samarensis*, and *P. rubicunda*. Field observations of specimens of *P. firma* show that this species displays a variety of colony forms and lives in diverse habitats, but the sclerites remain constant. Genetic and future field studies will help to understand the phenotypic plasticity that seems to play an important role in octocorals.

The recognition of nine new species of this genus in such a small coastline (1000 km) indicates a potentially high octocoral diversity.

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List of colour plates

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