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A new species of *Leptogorgia* (Coelenterata: Octocorallia: Gorgoniidae) from the shallow waters of the eastern Pacific

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Abstract

Leptogorgia cofrini, a new species of the family Gorgoniidae from Pacific Costa Rica and Panama inhabiting shallow waters (<25 m in depth) is described and illustrated. The small size, abundant, irregular branching, and the combination of long anthocodial rods, abundant large capstans, and a low occurrence of spindles in the coenenchyme are the main distinct characteristics of the new species. Mineralization of the axial skeleton is reported.

Key words: Carbonate hydroxylapatite, Cnidaria, Coelenterata, octocoral, *Leptogorgia*, biodiversity, new species, coral reef, Costa Rica, Panama, eastern Pacific

Introduction

The widespread genus *Leptogorgia* Milne Edwards & Haime, 1857, is also distributed throughout most of the eastern Pacific with about 16 nominal species (Valenciennes 1846, 1855; Duchassaing & Michelotti 1864; Verrill 1868, 1870; Hickson 1928) from shallow waters of Central America to the deeper waters (> 1900 m) of the East Pacific Rise (Bayer 2000). Six species have been reported for the shallow areas of Panama and three for Costa Rica (Verrill 1868; Hickson 1928).

Distinction among species of *Leptogorgia*, as in most gorgoniids, is based on morphological criteria, colony growth form, colour, and sclerites (Grasshoff 1992). In the chambered axial core of some gorgoniids, Bayer and Macintyre (2001) found a mineral compound, carbonate hydroxylapatite (CHAp), that is deposited as microspheres on the inner wall of the chambers and on the fine organic fibrilar meshwork filling the chambers. Some species also contain CHAp in the holdfast, filling the loculi in the layers of gorgonin. Bayer and Macintyre suggested that the skeletal mineralogy in the axes and holdfasts

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of octocorals might be related to their taxonomy, and therefore useful in octocoral systematics. Herein, we describe a new species based on the morphology of the colony and the sclerites, and examine further the characteristics of the axial skeleton.

Material and Methods

Specimens were collected by scuba diving, down to 25 m in depth, at different localities along the Pacific coast of Costa Rica and Panama. Colonies were air dried or fixed in 70% ethanol. Sclerites were prepared for light and scanning electron microscopy (SEM) following the standard techniques for structural analysis (Bayer 1961; Breedy & Guzman 2002). Anthocodial sclerites were dissected from polyps and were drawn using a camera lucida. The axial skeleton was examined with SEM following Bayer (2000), and Bayer and Macintyre (2001) protocol. The holotype is deposited in the Museo de Zoología, Universidad de Costa Rica (UCR), and paratypes are deposited in the UCR and the Museum of Comparative Zoology, Harvard University (MCZ).

Family Gorgoniidae Lamouroux, 1812

Genus *Leptogorgia* Milne Edwards & Haime, 1857

Synonymy. See Grasshoff, 1992: 54; Williams, 1992: 231; and Williams & Lindo, 1997: 500.

Type species. *Gorgonia viminalis* Pallas, 1766, by subsequent designation: Verrill, 1869: 420; Mediterranean Sea.

Diagnosis. Gorgoniids with variable branching patterns: pinnate, dichotomous, or filiform. Branch anastomosis absent; although occasionally present in two species, *L. gilchristi* (Hickson, 1904) and *L. bayeri* Williams & Lindo, 1997. Axis horny, with a cross-chambered central core containing a network of organic filaments frequently mineralized. Colonies with a simple or complex spreading holdfast, or without a holdfast and lying free on the sea floor. Coenenchymal sclerites are radiates and/or spindles, some with bent ends, with symmetrically or asymmetrically warty tuberculation. In some species, warts are fused into incomplete disks. Anthocodial sclerites usually flat rods and platelets. Colour variable: white, yellow, orange, red, violet, or brownish, and bicoloured (based on Williams 1992; Williams & Lindo 1997; Grasshoff 1988; Williams & Vennam 2001; Bayer & Macintyre 2001).

Distribution. Eastern Pacific (from southern California to Chile); western and southern Africa; western America; Caribbean Sea; Mediterranean Sea; south west Indian Ocean; and one subAntarctic species (Verrill 1868, 1870; Grasshoff 1988, 1992, 1997; Williams & Lindo 1997).

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Remarks. The taxonomic status of the Indian Ocean species of the genus *Leptogorgia* was thoroughly discussed by Williams and Lindo (1997), and Williams and Vennam (2001). Williams and Vennam (2001) decided to transfer these species of *Leptogorgia* to the genus *Pseudopterogorgia* **Kükenthal**, 1919 mainly based on the occurrence of scaphoid-like sclerites in the coenenchyme; consequently the distribution of *Leptogorgia* in the Indian Ocean could be invalid. However, more taxonomic research is needed before a zoogeographical pattern can be established.

***Leptogorgia cofrini*, sp. nov.**
(Figs. 1–6)

Material examined. ***Holotype*:** UCR 398A, preserved, Islas Tortugas, Gulf of Nicoya, Costa Rica, 1.5 m, J. Cortés, 18 July 1985.

***Paratypes*:** MCZ 62065, 2 specimens, preserved, Isla Tolinga, Gulf of Nicoya, Costa Rica, 2 m, O. Breedy, 21 August 2000; UCR 398B, as the holotype; UCR 1048, dry, Isla Canal Afuera, Gulf of Chiriquí, Panama, 3–5 m, H.M. Guzman, 10 December 2001; UCR 1319, dry, Islote, Gulf of Chiriquí, down to 11 m, H.M. Guzman, 20 April 2002; UCR 1401, 2 specimens, dry, Islote Frijol, Gulf of Chiriquí, 1–15 m, H.M. Guzman, 24 April 2002; UCR 1446, dry, Isla Otoque, Gulf of Panama, Panama, 1–5 m, H. M. Guzman, 9 May 2002; UCR 1519, 3 specimens, UCR 1532, preserved, Cabo Matapalito, Península de Osa, Costa Rica, 10 m, O. Breedy, 12 March 2004; UCR 1521, 2 specimens, preserved, Isla Jicarita SW, Gulf of Chiriqui, 15–20 m, H.M. Guzman, 19 April 2002; UCR 1522, preserved, Isla Barca, Gulf of Chiriqui, 3–9 m, H.M. Guzman, 18 April 2002; UCR 1526, preserved, eastern Islas Negritos, Gulf of Nicoya, 11 m, O. Breedy, 21 November 2002; UCR 1529, 9 specimens, preserved, western Islas Negritos, 11 m, O. Breedy, 21 November 2002; UCR 1531, 3 specimens, preserved, Archipiélago Murciélago, Costa Rica, 3–18 m, O. Breedy, 2 December 2003; UCR 1533, preserved, Bahía Salinas, Costa Rica, 10 m, O. Breedy, 9 July 2002; UCR 1569, 5 specimens, preserved, Roca Prosper, Gulf of Chiriquí, 3–15 m, H.M. Guzman, 11 December 2002; UCR 1570, 3 specimens, preserved, Cabeza de Mono, Bahía Culebra, Costa Rica, 9 m, E. Ruiz, 24 May 1997; UCR 1571, preserved, Cabeza de Mono, 10 m, O. Breedy, 27 June 1997; UCR 1572, 3 specimens, preserved, Archipiélago Murciélago, 15 m, O. Breedy, 16 October 1999; UCR 1573, 2 specimens, preserved, Isla del Caño, Costa Rica, 20 m, O. Breedy, 13 September 1996.

Diagnosis. Dwarf, white colonies, up to 7 cm in length, and 5 cm in width. Axis cylindrical. Growth form upright, branching abundant, and bushy, with a single stem reaching up to 3 mm in height before branching, or multiple stems (up to 4). Anastomosis absent. Polyps sparsely placed all around branches, fully retractile. Sclerites colourless, and mostly capstans up to 0.09 mm in length, spindles few and up to 0.12 mm in length, and long anthocodial rods up to 0.14 mm in length.

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Description. The holotype is a small, bushy, white colony 3.4 cm in height and 3.0 cm in width, arising from a laminar holdfast covered by coenenchyme but devoid of polyps (Fig. 1B). When it was alive, the holdfast spread over a rocky substrate, and other colonies were growing in close proximity (Fig. 1A). There are three main stems arising from a small holdfast producing profuse irregular branching in many directions. The main stems are 1.5–2.0 mm in diameter, and the terminal twigs about 1.0 mm. Terminal twigs are pointed, up to 15 mm in length, and curved at the ends. Polyps are colourless, and are sparsely distributed on all sides, fully retractile into the coenenchyme, which is almost flat around the apertures (Fig. 1B–C). Sclerites of the coenenchyme are colourless (Fig. 1D). The few longer ones are tuberculate spindles, some slightly curved, up to 0.12 mm in length and 0.04 mm in width, with warts in girdles. The shorter ones are blunt tuberculate capstans, 0.09 mm in length, and 0.04 mm in width, with two whorls of complex tubercles and terminal clusters (Figs. 1D, 2A). A small number of crosses are also present, up to 0.07 by 0.07 mm in size (Fig. 2A, bottom left). The anthocodiae mostly contain long, narrow, somewhat flattened rods, up to 0.14 mm in length, and 0.01 mm in width, with some lobe-like marginal projections, and also, smaller rods with branching projections (Figs. 2B, 3). The anthocodial rods are arranged vertically below the polyp tentacles. The combination of long anthocodial rods, abundant large capstans, and a low occurrence of spindles are distinct characteristics of the new species (Fig. 1D).

Axis and holdfast. The axis of the terminal branches is pale yellow, with a clearly visible narrow white chambered central core, becoming darker amber in the larger branches and main stems. Layers of mineralized gorgonin, the axial cortex, surround the central core. After maceration in sodium hypochlorite, the axis shows longitudinal strands of CHAp, leaving dark grooves where gorgonin was removed (Fig. 4A). This arrangement of mineralized strands has been observed in other species of *Leptogorgia* (Lewis *et al*. 1992, Bayer 2000, Bayer & Macintyre 2001). The chambers of the axial core of *L. cofrini* sp. nov. are filled with organic filaments mineralized with CHAp (Figs. 4B, 5A–B). The filaments are coated with microspheres of CHAp that fuse to produce branching extensions that partially anastomose. Microspheres that are isolated, or have different degrees of fusion are also found (Fig. 5). In this new species the meshwork of filaments is not dense, anastomosis is open, and mineralization consists of mostly large microspheres (up to 0.90 µm).

The holdfast consists of thin layers of gorgonin with mineralized loculi (Fig. 6A). Loculi are filled with organic filaments (Fig. 6B–C) that are also mineralized. Longitudinal fractures of the surface expose the filaments coated with microspheres of CHAp fused to form column-like arrangements (Fig. 6C–D). After partial removal of the organic matter by maceration in sodium hypochlorite, some microspheres show a hollow core where the organic filaments were dissolved (Fig. 6D), thus, a concentric deposition process around the filaments has occurred.

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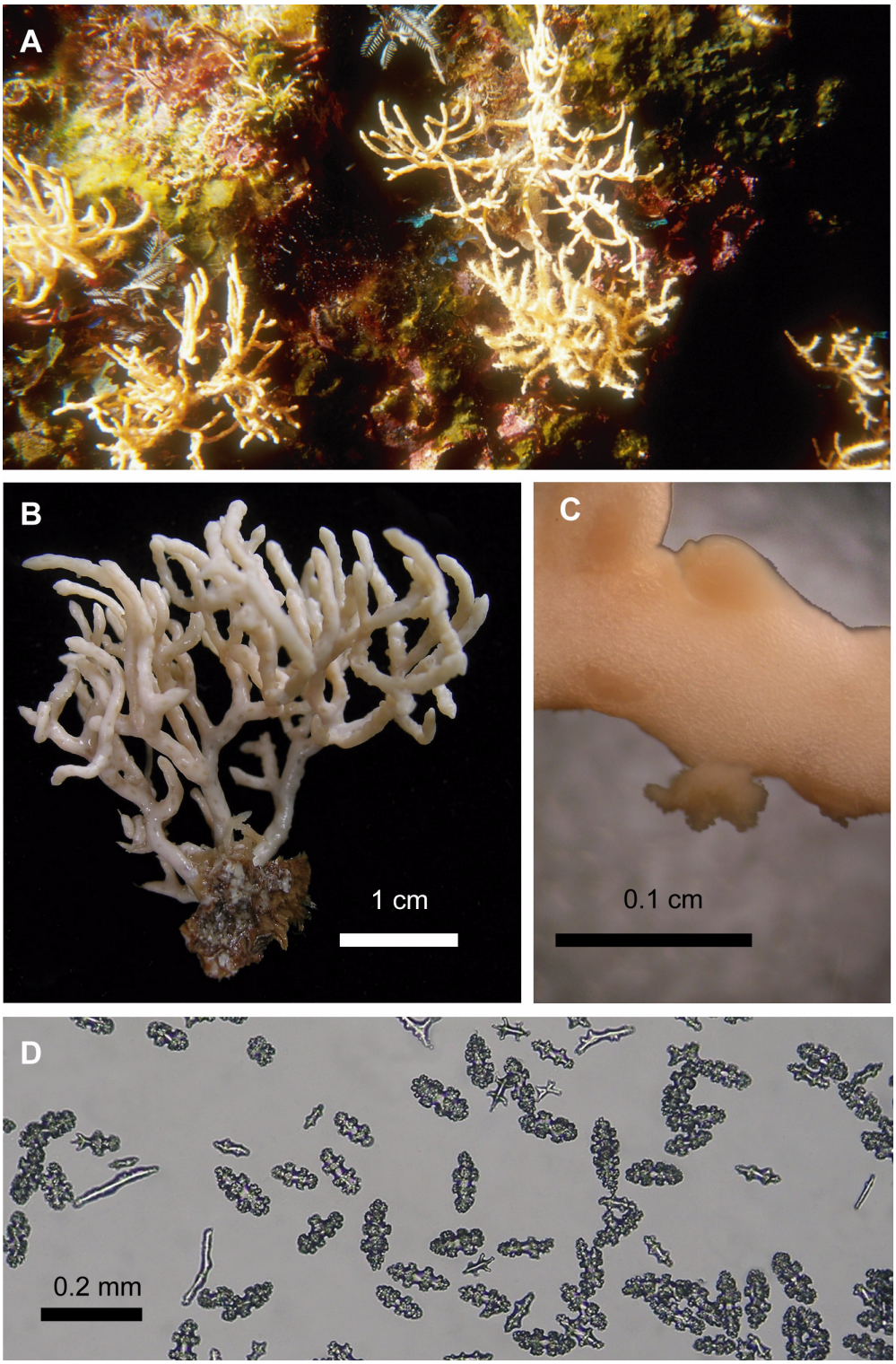

FIGURE 1. *Leptogorgia cofrini* sp. nov.: **A**, living colonies photographed 4 m depth by H.M. Guzman; **B**, holotype (UCR 398A); **C**, detail of colony branch; **D**, light micrograph of sclerites.

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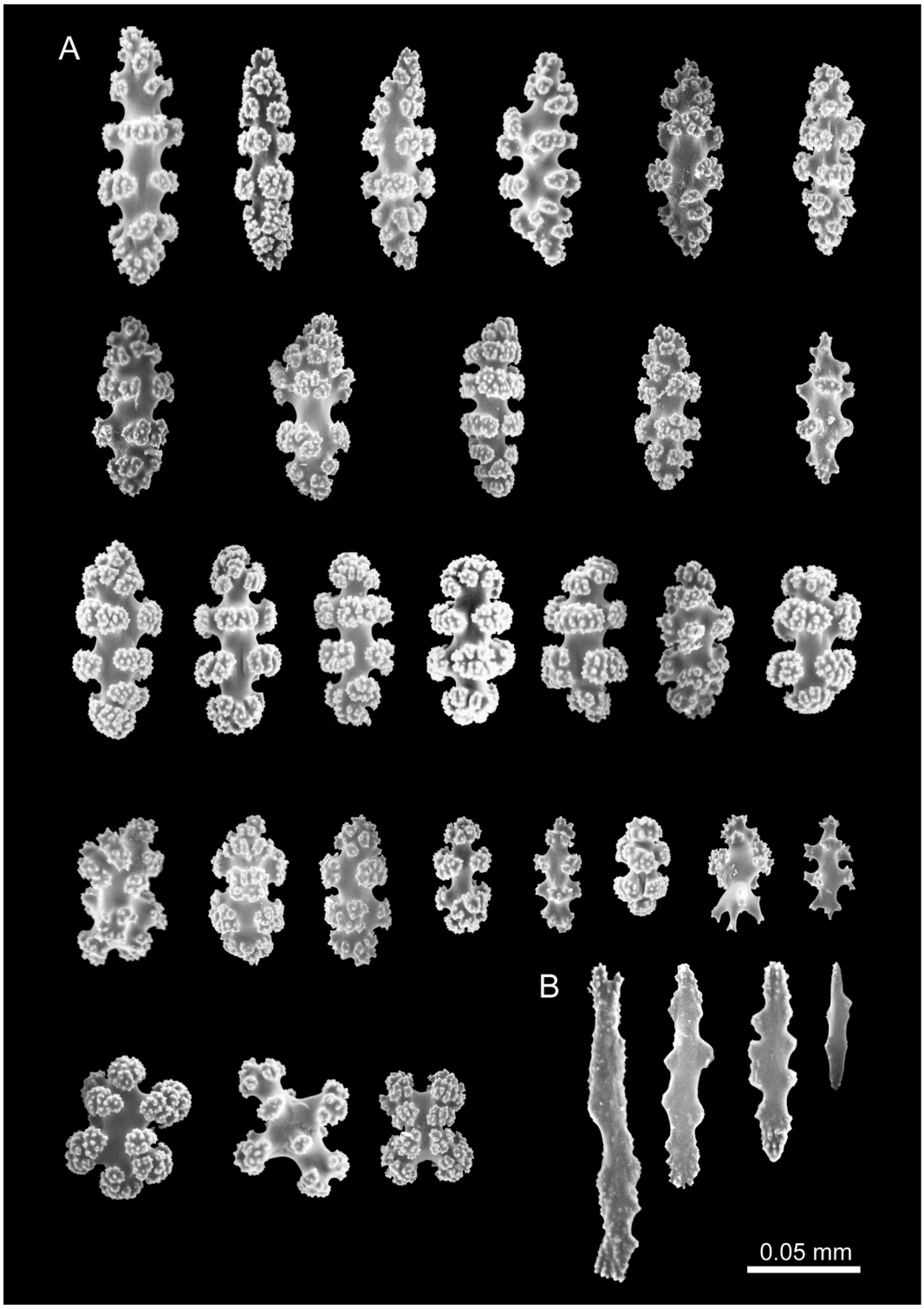

FIGURE 2. *Leptogorgia cofrini* sp. nov., holotype (UCR 398A), SEM sclerites: **A**, from the coenenchyme; **B**, from the anthocodia.

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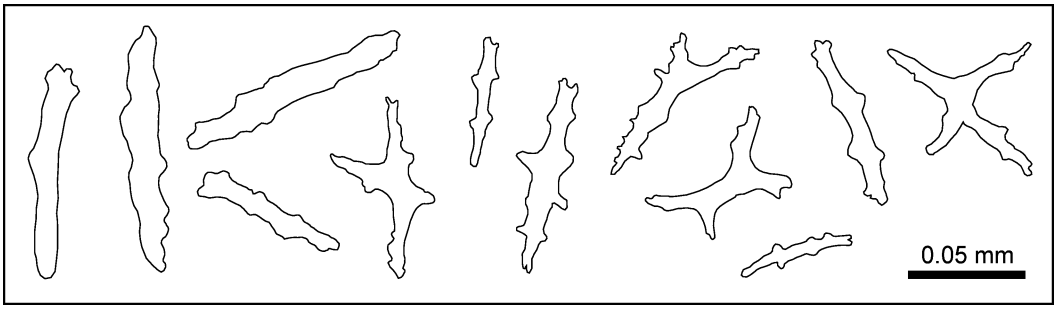

FIGURE 3. *Leptogorgia cofrini* sp. nov., holotype (UCR 398A), anthocodial sclerites.

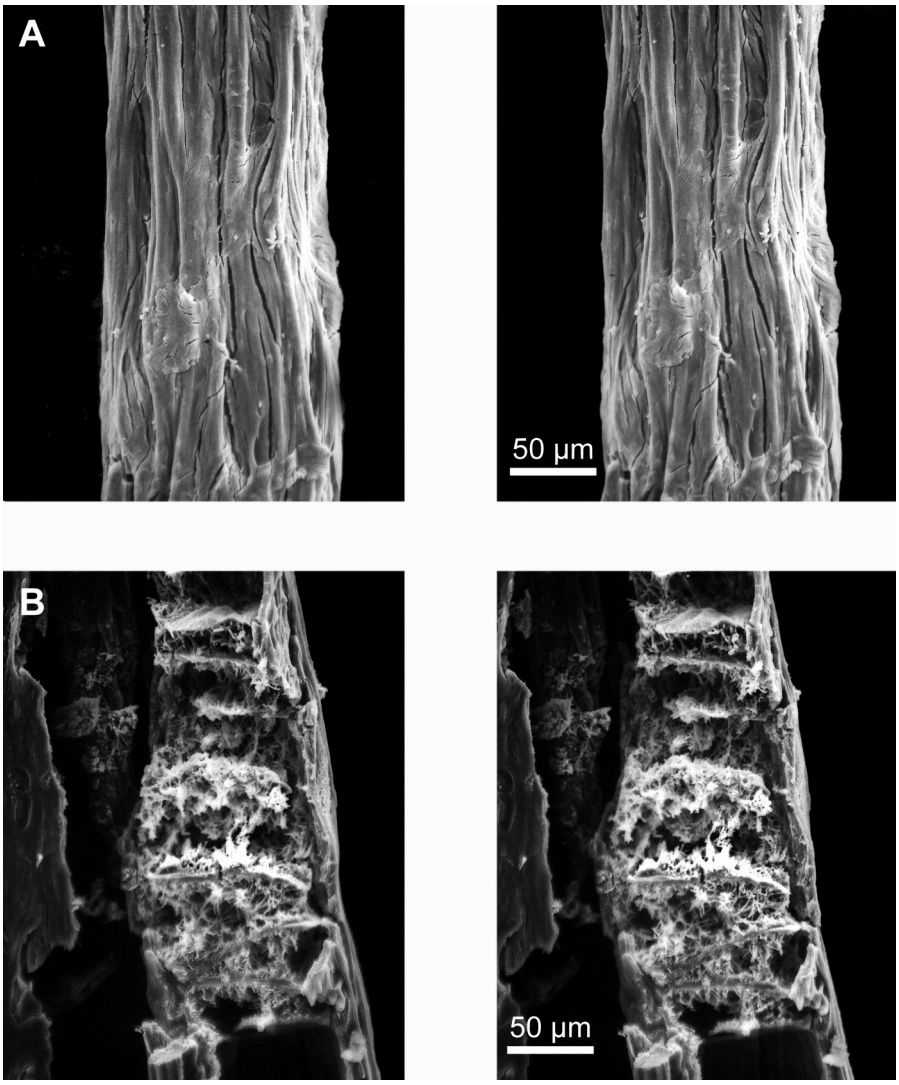

FIGURE 4. *Leptogorgia cofrini* sp. nov., holotype (UCR 398A), axis mineralisation, SEM-micrograph stereo pairs of longitudinal sections of terminal twig after maceration in sodium hypochlorite: **A**, longitudinal strands of CHAp in the axial cortex; **B**, chambered core with mineralized filaments.

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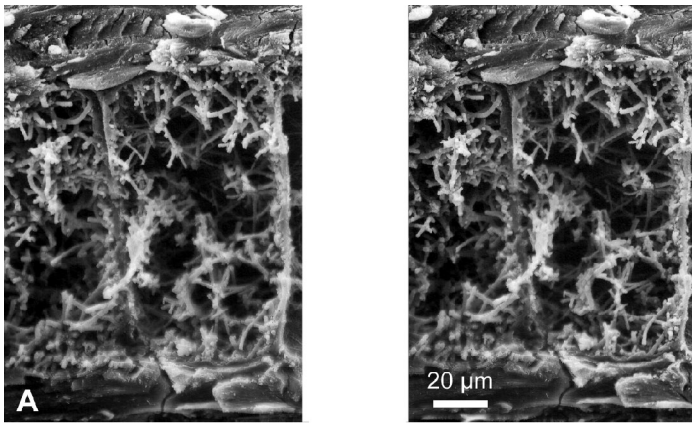

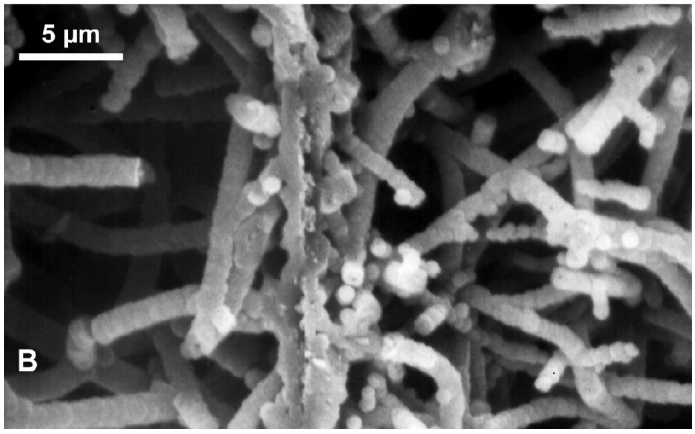

FIGURE 5. *Leptogorgia cofrini* sp. nov., holotype (UCR 398A), axis mineralisation, SEM-micrograph of longitudinal sections of terminal twig after maceration in sodium hypochlorite: **A,** central chamber showing filaments coated with CHAp (stero pair); **B**, detail of CHAp microspheres coating filaments.

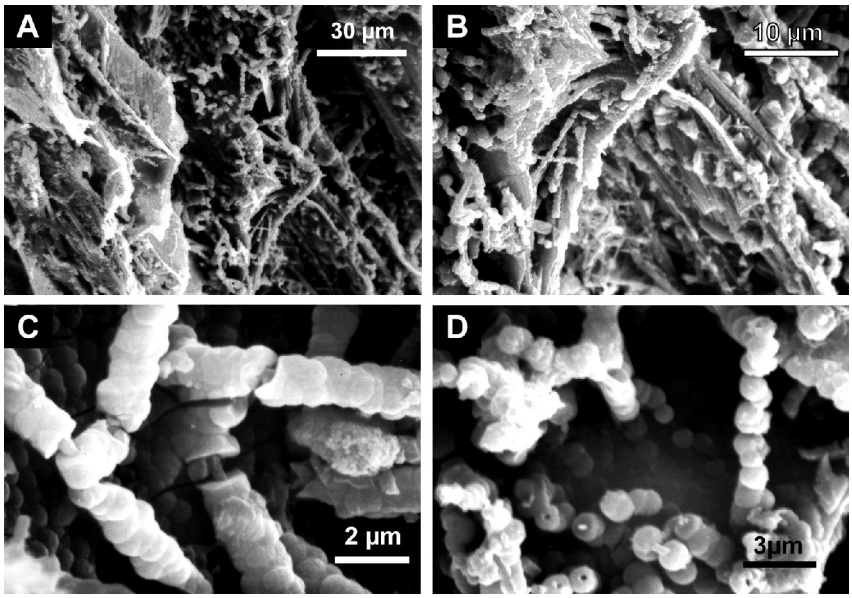

FIGURE 6. *Leptogorgia cofrini* sp. nov., holotype (UCR 398A), holdfast mineralisation: **A**, fractured surface showing layers of gorgonin and mineralized loculi; **B,** mineralized filaments of loculi (a close view of the right bottom section of A); **C**, microspheres of CHAp on organic filament; **D**, microspheres of CHAp coating filaments that were partially removed after maceration.

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Etymology. This species is named in honor of Dr. David A. Cofrin, a physician, philanthropist and visionary science-enthusiast who has contributed to the advancement of research in biology. Dr. Cofrin's interest in the rise of the Isthmus of Panama and its influence over the last 12 million years on the evolution of life's diversity in the Americas is encouraging the development of extensive research on marine biology and paleobiology.

Habitat. The new species was found inhabiting shallow waters, from 1 m to 25 m in depth on rocky communities exposed to strong waves and currents. It is very common between 10 and 15 m where it appears in patches together with other octocorals species, but being the dominant species.

Distribution. Various localities along the Pacific coast of Costa Rica and Panama, under contrasting oceanographic and hydrological conditions (e.g., upwelling and non-upwelling regimes).

Remarks. *Leptogorgia cofrini* sp. nov. is allied to a group of *Leptogorgia* that could be called the *Leptogorgia alba* Duchassaing & Michelotti, 1864 group. They all are white with various branching patterns and different abundances of sclerite types. Excluding *Leptogorgia styx* Bayer, 2000, that was properly described and characterised, the rest of this group needs revision and redescription. However, *Leptogorgia cofrini* sp. nov. presents a characteristic small size, branching pattern, and sclerites that clearly differentiate it.
The arrangement of CHAp in layers along the axis of *L. cofrini* sp. nov. matches *L. styx* (Bayer 2000), but the CHAp mineralization of the filaments in the core chambers showes some similarity to that found in *Leptogorgia cardinalis* (Bayer, 1961) by Bayer & Macintyre (2001), having a looser mesh of filaments, and larger microspheres.

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