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# New records of the genus *Callogorgia* (Anthozoa: Octocorallia) in the western Atlantic, including the description of a new species

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*Based on material collected during oceanographic campaigns in the western Atlantic from 1958 to 2011, two species of primnoid octocorals belonging to the genus* Callogorgia *were identified:* Callogorgia americana *and* Callogorgia arawak *sp. nov. These species are described and illustrated herein and their geographic and bathymetric are given. This is the first record of the genus in the south-western Atlantic. Additionally, the elevation of* C. americana americana *and* C. a. delta *to species level is proposed, keeping* Callogorgia gilberti*,* C. delta *and* C. americana *as separate species.*

**Keywords:** Deep-water corals, octocorals, Primnoidae, south Atlantic, Cnidaria, continental slope

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## INTRODUCTION

Octocorals in the genus *Callogorgia* Gray, 1858, as other primnoid corals (family Primnoidae), are important habitat-forming organisms in the deep sea (Etnoyer & Warrenchuk, 2007; Carreiro-Silva *et al.*, 2011; Angeletti *et al.*, 2014). Their tridimensional structure allows them to shelter other species (Roberts *et al.*, 2006), creating habitat for other invertebrates and fish (Cairns & Bayer, 2009; Quattrini *et al.*, 2013). Thus, species of *Callogorgia* are considered key species in these environments (Etnoyer & Morgan 2003; Angeletti *et al.*, 2014).

The genus *Callogorgia* counts on 24 described species, distributed in the north Atlantic, Indo-Pacific (Cairns, 2010) and Mediterranean (Vafidis *et al.*, 1994), at depths ranging 37–2472 m. It is a well-established genus that in the past four decades has been the focus of two reviews: Bayer (1982) and Cairns & Bayer (2002). Bayer (1982) studied mainly species from the Indo-Pacific, and suggested that the genus could be divided in two groups, based on the sculpture of scales in the body wall. The study by Cairns & Bayer (2002) focused on western Atlantic species, with the description of two new species: *C. linguimaris* Cairns & Bayer, 2002 and *C. americana* Cairns & Bayer, 2002 (later synonymized with *Callogorgia gilberti* Nutting, 1908 by Cairns (2010)).

Here we describe a new species of *Callogorgia* and we also propose the revalidation of *Callogorgia americana*. These new records represent the first of the genus in the south-western Atlantic Ocean.

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## MATERIALS AND METHODS

The examined specimens were sampled by several collection methods during three scientific expeditions realized in the western Atlantic between the years 1958–2011, at depths ranging 137–461 m (Table 1). Specimens are preserved in ethanol (70%) and kept at the National Museum of Natural History (NMNH) in Washington, DC (USA), and in the Museu Nacional do Rio de Janeiro (MNRJ), in Brazil. Terminologies follow Bayer (1982), Bayer *et al.* (1983) and Cairns & Cairns (2002). Digital images of sclerites were obtained partly by the SEM Laboratory, Smithsonian Institution (see Bayer *et al.*, 1983 for details), and partly by the RTSC at Universidade Federal de Pernambuco, using an FEI–Aspex Express scanning electron microscope. Preparation of sclerites for imaging follow a standard protocol which is well described by Pante & Watling (2012).

### Abbreviations

Museums: USNM: United States National Museum (now the National Museum of Natural History or NMHN); MNRJ: Museu Nacional, Universidade Federal do Rio de Janeiro, Brazil.

Cruises: U.S.F.W.S.: United States Fish and Wildlife Service; P.C.A.T.C.B.P.: Projeto de Caracterização Ambiental do Talude Continental na Bacia Potiguar (Petrobras).

**Table 1.** Sample stations of *Callogorgia* spp. in south-western Atlantic Ocean. U.S.F.W.S.: United States Fish and Wildlife Service; P.C.A.T.C.B.P.: Projeto de Caracterização Ambiental do Talude Continental na Bacia Potiguar (Petrobras).

| Cruise/Vessel | Station number | Latitude | Longitude | Depth (m) | Date |
|---|---|---|---|---|---|
| Gerda | G-898 | 21°04′N | 86°19′W | 330–365 | 10/09/1967 |
| Gerda | G-898 | 20°55′N | 86°28′W | 220–175 | 10/09/1967 |
| U.S.F.W.S./Oregon | 2289 | 07°25′N | 54°35′W | 137–146 | 08/09/1958 |
| U.S.F.W.S./Oregon | 4305 | 07°28′N | 55°11′W | 137 | 24/03/1963 |
| P.C.A.T.C.B.P./Seward Johnson | MT54-2 | 04°37′S | 36°46′W | 137–215 | 22/05/2011 |
| P.C.A.T.C.B.P./Seward Johnson | MT61 | 04°47′S | 36°11′W | 423–461 | 08/05/2011 |

Morphological: BW: body wall; OL: outer lateral; IL: inner lateral; H:W: ratio between height and width.

## RESULTS

### SYSTEMATICS

Order ALCYONACEA Lamouroux, 1812
Suborder CALCAXONIA Grasshoff, 1999
Family PRIMNOIDAE Milne Edwards, 1857
Genus *Callogorgia* Gray, 1858

#### DIAGNOSIS

Colonies uniplanar, branchlets usually alternate pinnate in arrangement, but may also be opposite pinnate and dichotomous. Polyps arranged in whorls, the polyps facing upward. Polyps protected by eight longitudinal rows of scales, the rows decreasing in number of scales in the abaxial to adaxial direction, such that adaxial side may be largely naked. Outer surface of body wall scales smooth, granular, or ornately ridged, the ridges sometimes continuing to inner proximal side of scale. Marginal scales fixed, not folding over operculars, the latter bearing keels or ridges on their inner surface. Coenenchymal scales elongate and usually granular (Cairns, 2010).

#### TYPE SPECIES

*Gorgonia verticillata* Pallas, 1766, by monotypy.

#### REMARKS

Five species of *Callogorgia* are currently recorded for the western Atlantic, including the new species described herein (Figure 1). Previously to this study, *Callogorgia* was only known in the north-west Atlantic, Indo-Pacific and Mediterranean Sea. This study extends the latitudinal range of the genus to south Atlantic waters.

*Callogorgia arawak* sp. nov.
(Figures 2A, B, D, 3A–D & 4)
*Callogorgia verticillata*: Bayer, 1961: 297 (in part: USNM 51257)

#### TYPE MATERIAL

Holotype: USNM 51257, 07°25′N 54°35′W, Surinam, 137–146 m (main stem 11 cm tall with 3 major lateral branches and part of holdfast) (Figure 2A).


**Fig. 1.** Distribution map of *Callogorgia* spp. in Western Atlantic, based on Cairns & Bayer (2002), Quattrini *et al.* (2013) and present study. Filled circles: *C. americana*; open circles: *C. gracilis*; triangle: *C. linguimaris*; filled square: *C. delta*; open square: *C. arawak* sp. nov.

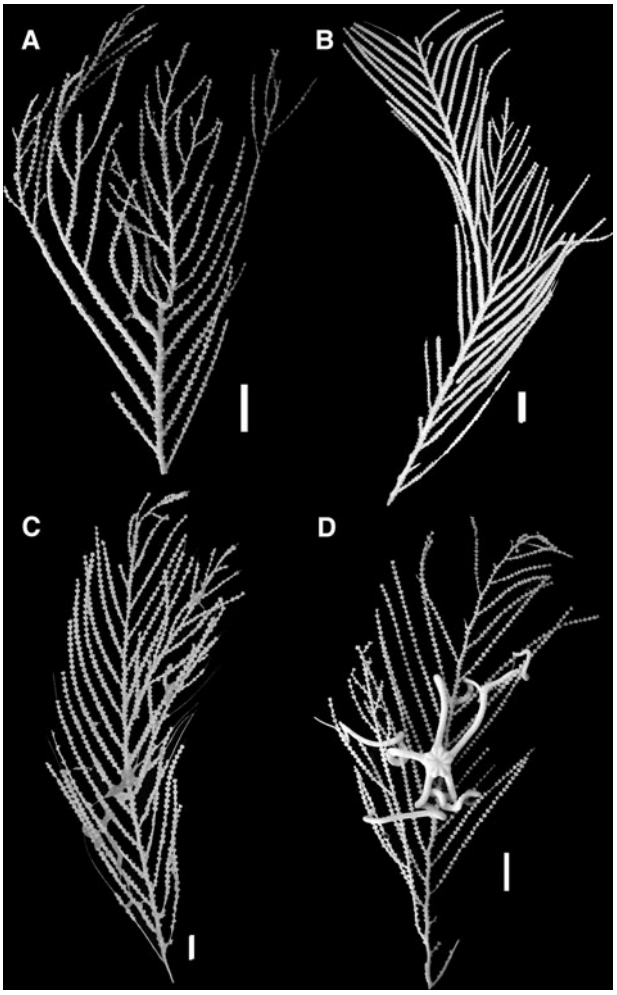


**Fig. 2.** Colonies of *Callogorgia* spp. from Western Atlantic. (A) *C. arawak* sp. nov. (USNM 51257, holotype); (B) *C. arawak* sp. nov. (MNRJ 8563, paratype); (C) *C. americana* (MNRJ 8564); (D) *C. arawak* (USNM 52945, paratype). Scale bar: 10 mm.

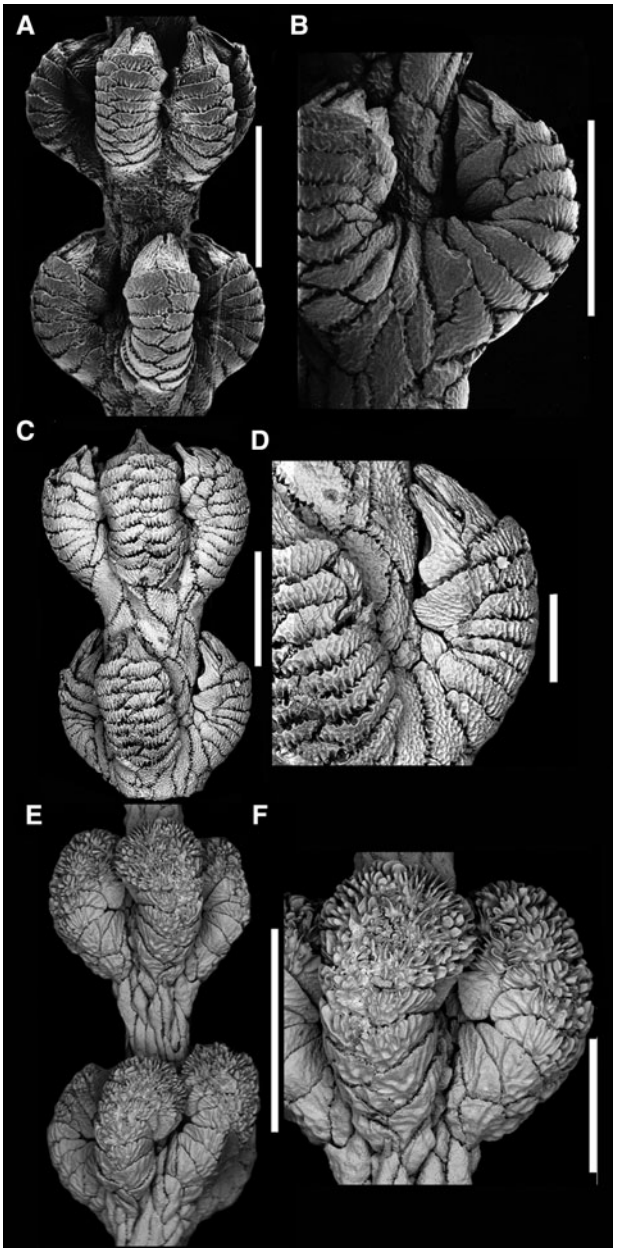


**Fig. 3.** Whorls and polyps of: (A–B): *Callogorgia arawak* sp. nov. (USNM 51257, holotype); (C–D): *C. arawak* sp. nov. (MNRJ 8563, paratype); E, F: *C. americana* (MNRJ 8564). Scale bars: A–C, E–F, 1 mm; D, 0.5 mm.

Paratypes: USNM 52945, 21°04′N 86°19′W, Yucatán, 330–365 m (a main trunk lacking holdfast, with two major branches and numerous pinnate branchlets) (Figure 2D); USNM 52939, 20°55′N 86°28′W, Yucatán, 220–175 m (one pinnate branch 6 cm long with 3 branchlets on each side); USNM 52936, 07°28′N 55°11′W, Surinam, 137 m; MNRJ 8563, 04°45′S 36°11′W, Potiguar Basin (Rio Grande do Norte State), 423–461 m (one branch with a terminal bifurcation) (Figure 2B).

## DIAGNOSIS

Alternately pinnate colonies with sometimes one but commonly two scales in outer-lateral row on one or both sides, 8–11 scales in abaxial rows, inner laterals always absent; body scales externally sculptured by radial wrinkles strongest along proximal edge and not anastomosing.

Description of the holotype: Colony of the general aspect of *Callogorgia gracilis* Milne Edwards & Haime, 1857, alternately pinnate, the major axis bending only slightly away from the origin of branchlets, hence nearly or quite straight; the branchlets are mostly 40–50 mm long when fully developed, 6–12 mm apart on each side of the stem (11 cm tall) (Figure 2A, B). Polyps are about 1 mm tall or slightly less, arranged in whorls of 3–5, of which 7–9 occur in 1 cm of axial length. The abaxial scale rows have 8–11 scales each, sculptured with moderately prominent radial wrinkles that are strongest and ridgelike where the scale is overlapped by the one below, interlocking with the radial ridges of its overlapping distal margin (Figure 3A–D). The outer-lateral rows always are present and commonly represented by two scales, but occasionally 0–2 are missing on one or both sides of a polyp (Figure 3A–D); they are not so strongly sculptured as the abaxials and the external ridges are confined to that part of the scale that is covered by the edge of the adjacent abaxials. A small, discoidal marginal (Adax-1) is present in both adaxial rows (Figure 3A–C). The operculars are smaller than those of other western Atlantic species of *Callogorgia*, at most about 0.4 mm tall, apically pointed but not projecting as a

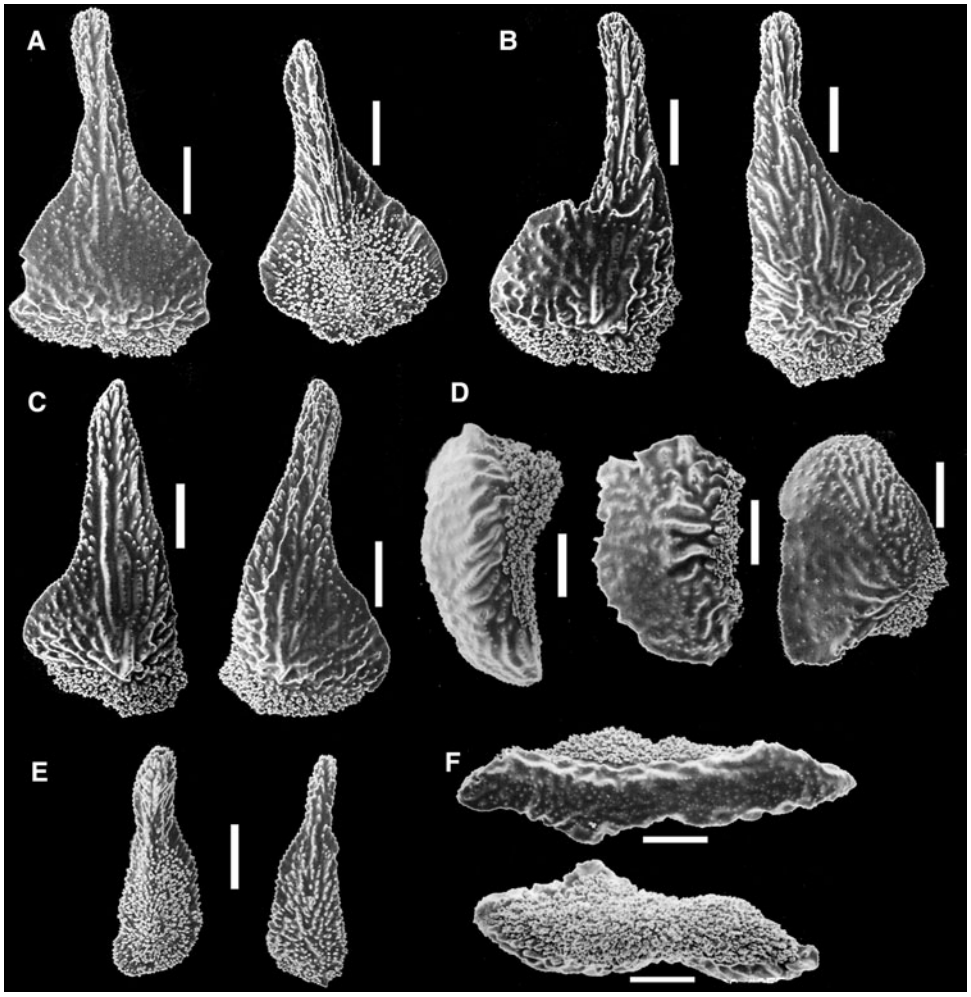


**Fig. 4.** Sclerites of *Callogorgia arawak* sp. nov. (USNM 51257, holotype). (A–C, E): opercular scales; (D): body wall scalles; (F): coenenchymal scales. Scale bars: 0.1 mm.

distinct stout tooth (Figure 4A–C), the inner surface of the abaxials and laterals with a rather low keel having two or three finely serrate ridges, the outer surface with an indistinct apical groove having two or three serrate ridges along the bottom, the margin finely serrate, and the base tuberculate (Figure 4D). The coenenchymal sclerites are thick, elongate, irregularly polygonal plates closely fitted together by their serrate margins, their outer surfaces glossy but sculptured by low to moderate reticulating ridges, their inner surfaces closely covered by complex tubercles (Figure 4F). Sclerites are glassy clear but the inner surfaces appear frosted because of the crowded tuberculate sculpture.

The axis is strongly calcified, irregularly grooved longitudinally, with a pale bronze or golden lustre that is paler in the branchlets, where it resembles mother-of-pearl, darker in the proximal parts of the axis. The holdfast is thickened by opaque white secondary calcareous deposits.

### ETYMOLOGY

Arawak, the name of an Amerindian Neolithic people of the Guyanas and northern South American. A noun in apposition.

### VARIATION

The two colonies from the coast of Surinam and the one from Brazil correspond rather closely. However, two specimens from near Arrowsmith Bank off the east coast of Yucatan agree in most salient points but have somewhat larger opercular scales, and somewhat more strongly sculptured abaxial scales. In Yucatan specimens, radial wrinkles of abaxials, apparently, not always reach the distal margin, unlike the Brazilian specimen. The abaxial opercular scales of this have an apical tooth with ridges slightly more prominent. It seems likely that Yucatan specimens represent the same species as those from Surinam and Brazil, but they may constitute a subspecifically distinct northern population. Unfortunately, the amount of material available for study is so small that it is undesirable to formalize subtaxa at this time.

### COMPARISON

*Callogorgia arawak* sp. nov. differs from all other western Atlantic species in the large number of scales (8–11) in the abaxial rows, the presence of two scales in the outer-lateral rows of many if not most polyps, the external sculpture of radial wrinkles showing little or no anastomosis, and the smaller opercular scales with poorly developed apical tooth. The species virtually more similar to *C. arawak* sp. nov. is *C. gracilis*, which however, besides the differences mentioned above, have the outer face of abaxial scales with radially anastomosed sculpture (honeycombed aspect). A comparison between characters of *Callogorgia* spp. in the western Atlantic is given in Table 2.

**Table 2.** Distinguishing characters of the Western Atlantic Callogorgia. BW: body wall; OL: outer lateral; IL: inner lateral; H:W: ratio between height and width.

| **Characters** | ***Callogorgia americana* Cairns & Bayer (2002)** | ***Callogorgia delta* Cairns & Bayer (2002)** | ***Callogorgia gracilis* (Milne Edwads & Haime, 1857)** | ***Callogorgia linguimaris* Cairns & Bayer (2002)** | ***Callogorgia arawak* sp. nov.** |
|---|---|---|---|---|---|
| Colony shape; axis shape | Plumose, flexible; quasi-sympodial main branch (zig-zag) | Plumose, flexible; quasi-sympodial main branch (zig-zag) | Plumose, stiff; straight main stem | Plumose, flexible; quasi-sympodial main branch (zig-zag) | Alternate pinnate; straight main stem (slightly bended away from the origin of branchlets) |
| Branchlets: length and further branching | 5–15 cm, occasional bifurcation | 5–12 cm, presence of bifurcations | 3.5–17 cm, presence of bifurcations | ?–6 cm, presence of bifurcations | 4.0–9.0 cm, presence of bifurcations |
| Internode distance on one side of branch | 7–15 mm | 4–14 mm | 4.5–11 mm | 10–12.5 mm | 3.5–12 mm |
| Polyps shape and length | Strongly clavate, 1.3–1.5 mm | Clavate, 1.3–1.4 | Cylindrical; 0.9–1.1 mm | Cylindrical or clavate; 1.1 mm | Cylindrical; 1.0–1.8 mm |
| Polyps/Whorl | 2–7 | 2–5 | 2–6 | 1–3 | 3–5 |
| Whorls/cm | 4–5 | 4–6 | 4–8 | 4 | 7–9 |
| Sculpture of outer surface of abaxial BW scales; scale thickness | Tall, complex, finely serrate ridges covering entire exposed surface | Less tall, simple ridges on proximal half surface | Prominent, radiating reticulate sculpture (anastomosed); thin | Variable: smooth on branchlets; highly ridged on main stem; thin | Prominent radial wrinkled sculpture; thin |
| Number of scale pairs in abaxial BW rows | 7–11 | 8–11 | 5–8 | 5–7 | 8–11 |
| Number of scale pairs in abaxial OL BW rows | 2–4 | 2–4 | 0–2 | 1–2 | 0–2 |
| Number of scale pairs in abaxial IL BW rows | 1–2 | 1–2 | 0 | 1–2 | 0 |
| Number of scale pairs in adaxial BW rows | 1–2 | 1–2 | 0–1 | 1 | 1 |
| Operculum height; H:W of abaxial operculars | Low; 1.60–1.80 | Tall; 1.9–2.4 | Slightly concave outer surface; 1.6–1.9 | Tall; 2.1–2.8 | Low (slightly concave outer surface); 1.8–2.1 |
| Other distinctive characters | Widely spaced branchlets, prominent whorls | Reduced adaxial sculpture (less complex) | Scales sculptured with ridges, forming small polygonal cells (honeycomb) | Body wall scales flared outward | Scale wrinkles with little or no anastomosis; smaller opercular scales with poorly developed apical tooth |
| Distribution | Straits of Florida; Gulf of Mexico; Lesser Antilles; 183–732 m | Northern Gulf of Mexico; 366–914 m | Lesser Antilles, Bahamas; Northern Gulf of Mexico; 82–514 m | Bahamas; 1116 m | Yucatan, Surinam and northern Brazil; 101–365 m |

DISTRIBUTION

Western Atlantic, including Yucatan, Surinam and northern Brazil 137–365 m. No records in intermediate localities.

COMMENSALS

Both specimens from Surinam (USNM 51257, 52936) and the larger one from Yucatan (USNM 52945) have ophiuroid commensals (Figure 2D).

*Callogorgia americana* Cairns & Bayer (2002) (Figures 2C, 3E, F & 5)

*Callogorgia americana americana* Cairns & Bayer, 2002: 845–852, Figures 1A & 2–4, Table 1 (synonymic list); 2009a: 29, Table 4 (listed); 2009b: 329 (listed). –Quattrini *et al.*, 2013: 4129, Figure 2D–F.

*Non Callogorgia americana delta* Cairns & Bayer, 2002: 852–856, Figures 1B & 4–6; 2009a: 29, Table 4 (listed); 2009b: 329 (listed).

MATERIAL

MNRJ 8564, 04°37′S 36°46′W, Potiguar Basin (Rio Grande do Norte State), 137–215 (2 fragments) (Figure 2C).

DESCRIPTION

Fragments of plumose, slightly flexible, uniplanar and pinnate colonies, up to 19.5 cm in height. Main stem with 1–2 mm in diameter. Branchlets up to 8 cm in length and distances between branchlets in one side 9–15 mm (Figure 2C). Polyps arranged in whorls or isolated on the main stem (Figure 3E, F). Whorls usually in 5/cm with 3–5 polyps (commonly 4), 1 mm in length each (Figure 3E, F). Eight opercular scales, 0.37–0.61 mm high and apical tooth slightly projecting (Figure 5B). Presence of 7–10 abaxial pairs, 2–4 OW, 1–2 IL and 1–2 pairs less developed in adaxial row (Figures 3E, F & 5A). Body wall scales (0.27–0.48 mm in larger width) with highly projected ridges, mostly on distal portion of polyp, near to the operculum (Figure 5C). Coenenchymal scales 0.35–0.83 mm long (Figure 5D).

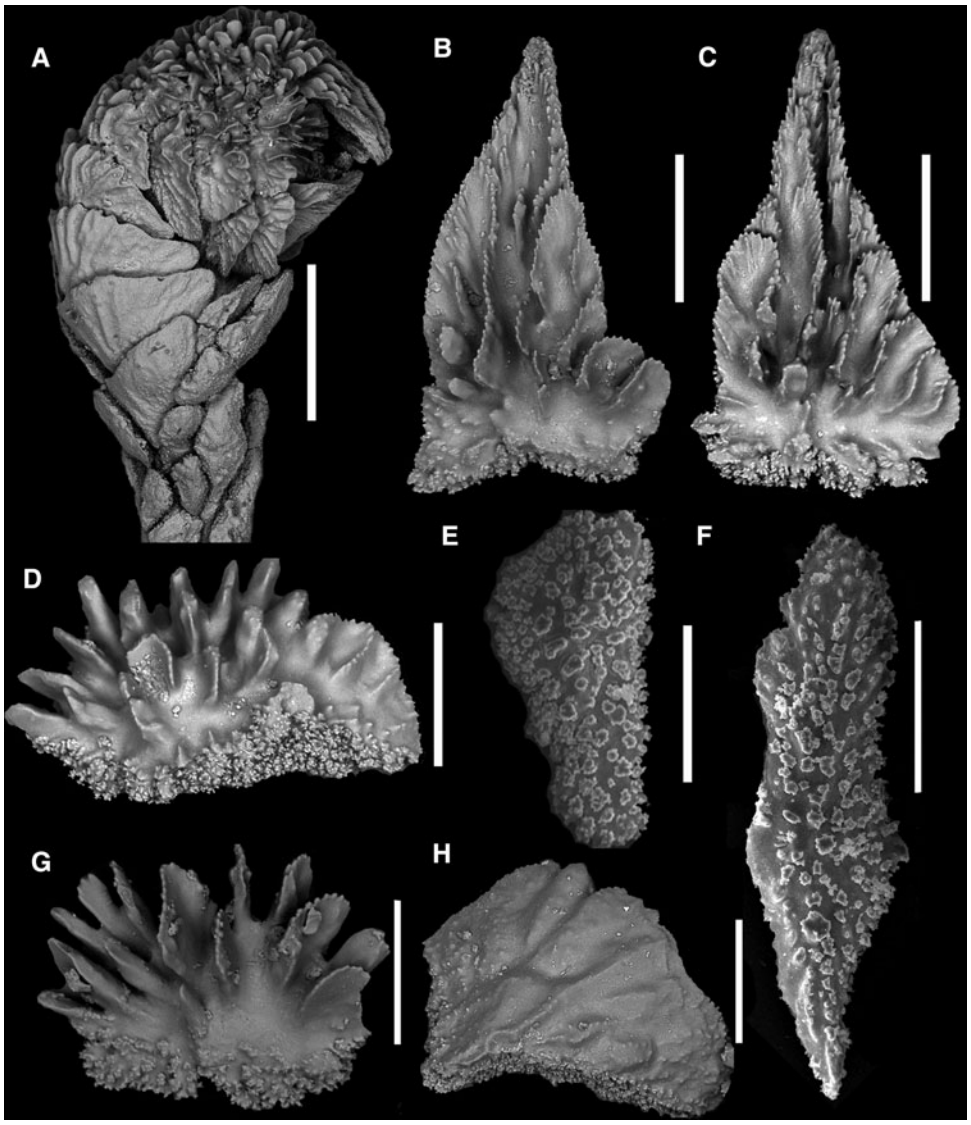


**Fig. 5.** Polyp and scales of *Callogorgia americana* (MNRJ 8564). (A) lateral view of polyp; (B, C) opercular scales; (D, G–H) body wall scales; (E, F) coenenchymal scales. Scale bars: A, 0.5 mm; B–C, 0.16 mm; D, G–H, 0.13 mm; F, 0.1 mm.

### REMARKS

Cairns (2010) considered *Callogorgia americana* Cairns & Bayer, 2002 a junior synonym of *Callogorgia gilberti* (Nutting, 1908) based on an overlap of characters observed in these two species. Based on the study by Quattrini *et al.* (2013), we opted for considering *C. americana* as a separate species.

The molecular mitochondrial markers (cox1 + igr + mtMutS) used by Quattrini *et al.* (2013) revealed small but consistent differences between these two species, which occupy distinct ocean basins (Cairns, 2010). Furthermore, Quattrini *et al.* (2013) found ecological niche differences between the Atlantic *C. americana* (as *C. a. americana*) (339–384 m, 10.2–12.4°C, 35.3–35.5 salinity) and *Callogorgia delta* Cairns & Bayer, 2002 (as *C. a. delta*) (403–914 m, 4.3–9.8°C, 34.9–35.1 salinity), showing that it is not ideal to keep them as a single species, as stated by Cairns (2010).

According to McFadden *et al.* (2011), although the distinction between species using DNA barcode is more reliable if the divergence is >1%, it is possible to safely distinguish taxons with a <1% divergence if the distinction is well supported by morphology. Quattrini *et al.* (2013) found a divergence of 0.82% (cox1 + igr1 + mtMutS) between *C. gilberti* and *C. americana* (*C. a. americana*), which when associated to nuclear markers (28S) becomes 1.12%. This result, associated to a biogeographic and ecological context, seems to suggest that *C. americana* and *C. gilberti* are in fact two different species, as indicated by Cairns & Bayer (2002).

Quattrini *et al.* (2013) conclude that *C. gilberti*, *C. americana* (*C. a. americana*) and *C. delta* (*C. a. delta*) are different species. Therefore, three nominal species are considered valid: *C. gilberti* Nutting, 1908, *C. americana* Cairns & Bayer, 2002 and *C. delta* Cairns & Bayer, 2002 (Table 2).

### DISTRIBUTION

Straits of Florida, northern Gulf of Mexico, Yucatan Peninsula, Nicholas Channel, Lesser Antilles from Puerto Rico to Tortuga, Venezuela and northern Brazil; 183–732 m.

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