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RESEARCH

Notes on the Marine Algae of the International Biosphere Reserve *Seaflower*, Caribbean Colombia X: New Records of Red Algae (Rhodophyta) from Old Providence and Santa Catalina

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Abstract
Thirteen species of red macroalgae are newly reported for islands of Old Providence and Santa Catalina in the Southwestern Caribbean Sea. Of these taxa, *Acrochaetium affine* is a new record for Colombia, *Aglaothamnion halliae*, *Chondria atropurpurea*, *Corallophila atlantica*, *Gelidiella lubrica*, *Herposiphonia secunda*, *H. pecten-veneris* and *Liagora albicans* are new records for the Biosphere Reserve *Seaflower*, while *Acrothamnion butlerae*, *Ganonema norrisiae*, *Melanothamnus sphaerocarpus*, *Perikladosporon percurrens* and *Trichogloeopsis pedicellata* are new records for both islands, being reported at other localities in the Archipelago. The algal material was collected in coral reef habitats (3–16 m depth), during the Scientific Expedition Seaflower 2019. Their morphological features are discussed. During the past decade, phycological research in the Biosphere Reserve *Seaflower* has revealed a much more diverse marine flora than historically appreciated, and recent sampling continues to add new taxa to the marine flora of the area.

Keywords *Chondria* · Colombian caribbean · *Gelidiella* · *Herposiphonia* · Old Providence · Seaflower scientific expedition

Introduction

The Caribbean Sea is considered a hotspot in marine life, with more than 12,000 species distributed in 37 phyla (Miloslavich et al. 2010). Despite the great scientific effort in the study of marine life in the Caribbean, many groups of organisms are still poorly known. Among these, red algae are a very diverse group of photosynthetic organisms, which comprise more than 50% of the marine flora in tropical environments (e.g. Duncan and Lee 2006; Bernecker and Wehrtmann 2009); however, their diversity in the region is still not thoroughly known (Miloslavich et al. 2010), and new findings as well as the description of new species is to be expected. The International Biosphere Reserve *Seaflower* is the largest marine Reserve in the Caribbean and one of the biggest in the world (CORALINA-INVEMAR 2012). It comprises the entire Archipelago of San Andres, Old Providence and Santa Catalina, where only the three main islands (San Andres, Old Providence and Santa Catalina) are permanently inhabited. Recent surveys on the marine macroalgae of the Archipelago has highlighted a great diversity which continues to provide new findings (p.e. Barrera et al. 2016; Rincón-Díaz et al. 2014, 2016, 2018; Reyes-Gómez and Gavio 2017; Reyes-Gómez et al. 2013, 2021; Gavio et al. 2022).

The country, since 2014, has implemented a scientific exploration program to improve the knowledge on the marine ecosystems of the Archipelago, with yearly oceanographic expeditions to the islands and cays of the

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Archipelago. In 2019, the expedition focused on the ecosystems of the islands of Old Providence and Santa Catalina, in the middle part of the Archipelago. We report thirteen species which are new records for these islands, and again, highlight the need to continue sampling the area.

Materials and Methods

Sampling was undertaken around the islands of Old Providence and Santa Catalina, which are part of the International Biosphere Reserve *Seaflower*, located in the southwestern Caribbean, Colombia (Fig. 1). The expedition took place in September 2019, where twenty-six sampling sites were visited, in a depth range of 3–16 m. Most sites were coral reef patches or sand plains, with some seagrass beds at depths range of 6–8,5 m. During the sampling, blooms of green (*Cladophora* spp.) and red algae (*Ceramium* sp.) were observed at some stations, where the algal bloom entirely or partially covered the substrate.

Algae were collected by hand during SCUBA diving. The algae collected were preserved in a 4% formalin/seawater solution and kept cool until their identification. The identification was carried out using an optical microscope Olympus BX51 (Olympus, Tokyo, Japan) connected to a digital camera Moticam 2300 3.0 M pixel (Motic, Hong Kong, China). Cross-sections of the specimens were made by hand with a razor blade. Images were edited using Adobe Photoshop CS6 version 13.0. (Adobe 2012). To identify the species specialized literature was used (e.g. Taylor 1960; Littler and Littler 2000; Dawes and Mathieson 2008*)*. When possible, specimens were deposited in the Herbarium JIWUKORI (JIW) of the Universidad Nacional de Colombia, in Bogotá. Information on nomenclature and taxonomy classification was obtained from AlgaeBase (Guiry and Guiry 2024).

Results

A total of thirteen new records of red algae were identified (Table 1), attached to the substrate or epiphytic on larger algae: *Aglaothamnion halliae*, *Chondria atropurpurea*, *Corallophila atlantica*, *Gelidiella lubrica*, *Herposiphonia bipinnata*, *H. pecten-veneris* and *Liagora albicans* are new records for the Archipelago (*). *Acrochaetium affine* is a new record for Colombia (**). *Acrothamnion butleriae*, *Ganonema norrisiae*, *Melanothamnus sphaerocarpus*, *Perikladosporon percurrens* and *Trichogloeopsis pedicellata* are new records for the islands, being reported at other localities in the Archipelago.

RHODOPHYTA

Order Acrochaetiales

Family Acrochaetiaceae

Acrochaetium affine* M. Howe and Hoyt*(Fig. 2A).

Type Locality North Carolina, U.S.A.

Specimens Observed Station 4, N 13°30'25.1'', W 81°20'07.2'', Old Providence, 10 September 2019, depth 12 m. Epiphytic on larger algae. Rather common, but easily overlooked.

Thalli up to 1 mm high, epiphytic, arising from a large globose cell (Fig. 2A), 18–22 µm diameter. Erect axes uniseriate, formed by rectangular cells, longer than wide, 8–10 µm diameter and 30–35 µm long. Branching appearing unilateral, arising from the distal end of the axial cell, numerous, giving a bushy appearance to the thallus. Branches gradually tapering toward the apices, apical cell 6–7 µm diameter. Monosporangia unilateral, abundant, ovoid to oblong, 15–17 µm diameter and 22–25 µm long, sessile or on one-celled pedicel, solitary.

Remarks The species is very small and inconspicuous, and, although it might be rather common, is easily overlooked.

Order Nemaliales

Family Liagoraceae

Ganonema norrisiae (I.A. Abbott) Huisman, I.A. Abbott and A.R. Sherwood *(Fig. 2B-C).

Type Locality Carrie Bow Bay, Belize.

Specimens Observed CMD343 Station 13, N 13°18'42.0'' W 81°22'03.4''. Old Providence, 13 September 2019, depth 3 m. Attached to calcareous rock. (JIW0004811).

Thallus white-pink, soft, mucilaginous, erect, to 8 cm tall, attached by small discoid holdfast (Fig. 2B). Branching irregular, on all sides, calcification light, in the medulla. Branches cylindrical to club-shaped, mostly 750 µm to 1 mm diameter, apices rounded. Medullary filaments colorless, longitudinal, 80–100 µm diameter, cells 350–400 µm long, cylindrical or slightly swollen (Fig. 2C). Cortical filaments radial, cells deeply pigmented, 13–20 µm diameter, apical cells cylindrical. Reproductive structures not observed.

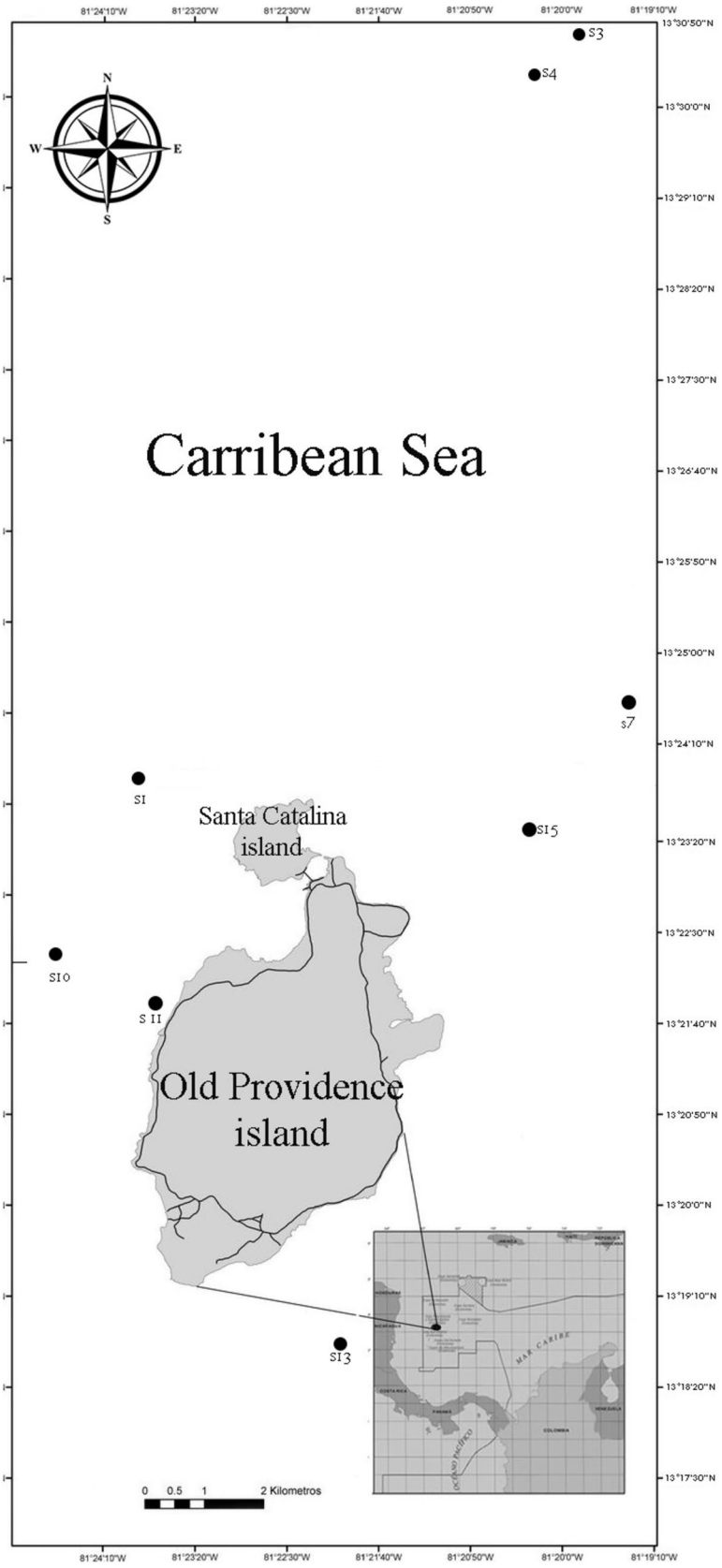


Fig. 1 Sampling site location

Table 1 List of new records of Rhodophyta and site of collection. **Denotes new records for Colombia; *Denotes new records for the Archipelago . In the reproductive stage column , indicate that the specimens were in a vegetative stage

Taxon	S1	S3	S4	S7	S10	S11	S13	S15	Reproductive stage
Acrochaetiaceae									
Acrochaetium affine M. Howe and Hoyt**			x						Monosporangia
Liagoraceae									
Ganonema norrisiae (I.A. Abbott) Huisman, I.A. Abbott and A.R. Sherwood							x		Vegetative stage
Liagora albicans J.V. Lamouroux*							x		Carposporophyte
Trichogloeopsis pedicellata (M. Howe) I.A. Abbott and Doty							x		Carposporophyte
Gelidiellaceae									
Gelidiella lubrica (Kützing) Feldmann and Hamel*			x						Vegetative stage
Callithamniaceae									
Aglaothamnion halliae (Collins) Aponte, D.L. Ballantine and J.N. Norris*						x			Vegetative stage
Ceramiaceae									
Acrothamnion butlerae (Collins) Kylin*								x	Vegetative stage
Corallophila atlantica (A.B. Joly and Ugadim) R.E. Norris*	x								Vegetative stage
Perikladosporon percurrens (E.Y. Dawson) Athanasiadis				x					Vegetative stage
Rhodomelaceae									
Chondria atropurpurea Harvey*		x							Vegetative stage
Herposiphonia secunda (C. Agardh) Ambronn*	x			x				x	Vegetative stage
Herposiphonia pecten-veneris (Harvey) Falkenberg*					x				Vegetative stage
Melanothamnus sphaerocarpus (Børgesen) Díaz-Tapia and Maggs		x							Vegetative stage

Remarks The red algal genus *Ganonema* (Liagoraceae) currently includes 13 species that are distributed primarily in tropical and warm-waters (Ballantine and Aponte 2002; Huisman 2002, 2006; Huisman et al. 2004; Lin et al. 2014). The genus was established by Fan and Wang (1974) based on vegetative and reproductive features. Wynne (2022) reported five species of *Ganonema* for the western Atlantic: *G. farinosum*, *G. megagynum*, *G. norrisiae*, *G. pinnatum* and *G. vermiculare*. Of these, two species, *G. farinosum* and *G. norrisiae* are reported for Colombia (Díaz-Pulido and Díaz-Ruiz 2003). Despite the lack of reproductive structures, the vegetative features match the description of the taxon. The species has been reported for Serrana key, in the northern portion of the Archipelago (Díaz-Pulido and Bula-Meyer 1997).

Liagora albicans J. V. Lamouroux (Figs. 2D-F and 3A-C).

Type Locality East Indies.

Specimens Observed CMD 340, Station 13, N 13°18'42.0'' W 81°22'03.4''. Old Providence, 13 September 2019, depth 3 m (JIW 0004810).

Thallus white to light pink, erect, bushy, stiff, 6 cm tall, attached by small discoid holdfast (Fig. 2D-E). Calcification heavy. Branching abundant, widely dichotomous, sometimes appearing cervicornis. Medullary filaments longitudinal, colorless, 20–25 µm diameter, cells 90–120 µm long (Fig. 2F). Cortical filaments radial, formed by cylindrical to swollen pigmented cells, 6–10 µm diameter, di- or trichotomously branched several times (Fig. 3A). Apical cells round to pear-shaped, 8–10 diameter. Carpogonial branch incurved, formed by 3 cells near middle of cortical filaments (Fig. 3B). Carposporophytes abundant, appearing as red dots on the surface of the thallus (Fig. 2E) terminal on cortical filaments, hemispherical, 180–220 µm diameter (Fig. 3C).

Remarks A cosmopolitan species in tropical seas, it has been reported, in Colombia, for Tayrona National Park (Díaz-Pulido and Díaz-Ruíz 2003).

Trichogloeopsis pedicellata (M. Howe) I.A. Abbott and Doty (Fig. 3D-F).

Type Locality Cockburn Harbor, South Caicos, Caribbean Sea.

Specimens Observed CMD 342, Station 13, N 13°18'42.0'' W 81°22'03.4''. Old Providence, 13 September 2019, depth 3 m, attached to calcareous rock (JIW00005032).

Thallus erect, attached to hard substrate (coral rubble or calcareous rock) by a small holdfast, soft and gelatinous in texture, 10–12 cm tall, pyramidal in outline, light pink to white in color (Fig. 3D). Calcification moderate. Branching irregularly alternate. Cortex formed by dichotomously

branched filaments of small cylindrical cells, round and moniliform near tips (Fig. 3E). Medullary filaments longitudinal, cylindrical, 30–100 µm diameter (Fig. 3E). Carposporophytes on outer cortical cells, 90–220 µm diameter. Cystocarps round, without involucre, with descending rhizoids at the base (Fig. 3F).

Remarks Recently, Gavio et al. (2022) reported an extensive bloom of *T. pedicellata* after hurricane Iota in the island of San Andrès. The bloom receded naturally after few months. Our specimen matches the description of the taxon. It is not a common species, and it is found occasionally attached to hard substrate, such as calcareous rock or coral rubble.

Order Gelidiales

Family Gelidiellaceae

Gelidiella lubrica (Kützing) Feldmann and Hamel* (Fig. 4A-D).

Type Locality Napoli, Italy.

Specimens Observed VH050, Station 4, N 13°30'25.1'', W 81°20'07.2'', Old Providence, 10 September 2019, depth 12 m.

Thallus burgundy red to red-brown, prostrate and spreading to 3,5 mm high (Fig. 4A). Erect axes not branched, long, terete to compressed, 90–127 µm diameter, with or without unicellular hyaline hairs on the apex (Fig. 4B). Prostrate axes bearing many unicellular rhizoids that may remain individual or form a peg-like structure (Fig. 4C). Apical cell single, dome-shaped, protruding. In cross section, medulla formed by polygonal cells (Fig. 4D). Rhizoidal filaments absent.

Remarks The genus *Gelidiella* was proposed by Feldmann and Hamel (1934) to include small to medium-sized species typical of warm waters and are characterized by the absence of internal rhizoidal filaments, a protruding apical cell and cortical cells in irregular longitudinal rows.

Since then, there has been considerable change in the genus: Santelices (2004) proposed the genus *Parviphycus*, to accommodate three species of *Gelidiella*. Over time, a few other species of *Gelidiella* have been transferred to the genus. More recently, Boo et al. (2016) have proposed three additional genera to accommodate some members of the family: *Huismaniella*, *Millerella* and *Perronella*. Among these genera, only *Huismaniella* and *Gelidiella* have a decussate division of the subapical cell; the main difference between these two genera is the disposition of the tetrasporangial branches.

To date, four species of *Gelidiella* are reported for the western Atlantic (Wynne 2022): *Gelidiella acerosa*, *G. flabella*, *G. hancockii* and *G. lubrica*. In Colombia, two species have been reported, *G. acerosa*, rather widespread, and *G. lubrica*. The latter taxon has been reported for the continental coast of Colombia by Schnetter (1980) and Bula-Meyer (1986). These have been the only records of the species in the Western Atlantic until 2005, when Shneider and Lane reported the species for Bermuda. *Gelidiella lubrica* is characterized by having unicellular hyaline hairs at the tip of some branches, as shown by Feldmann and Hamel (1934). In our specimens, not all tips had hairs, but still they were present. Overall, the morphology of our sample fits well the description of the taxon. The alga is probably more widespread, but may be confused with other species of the family, especially when they are not tetrasporic.

Order Ceramiales

Family Callithamniaceae

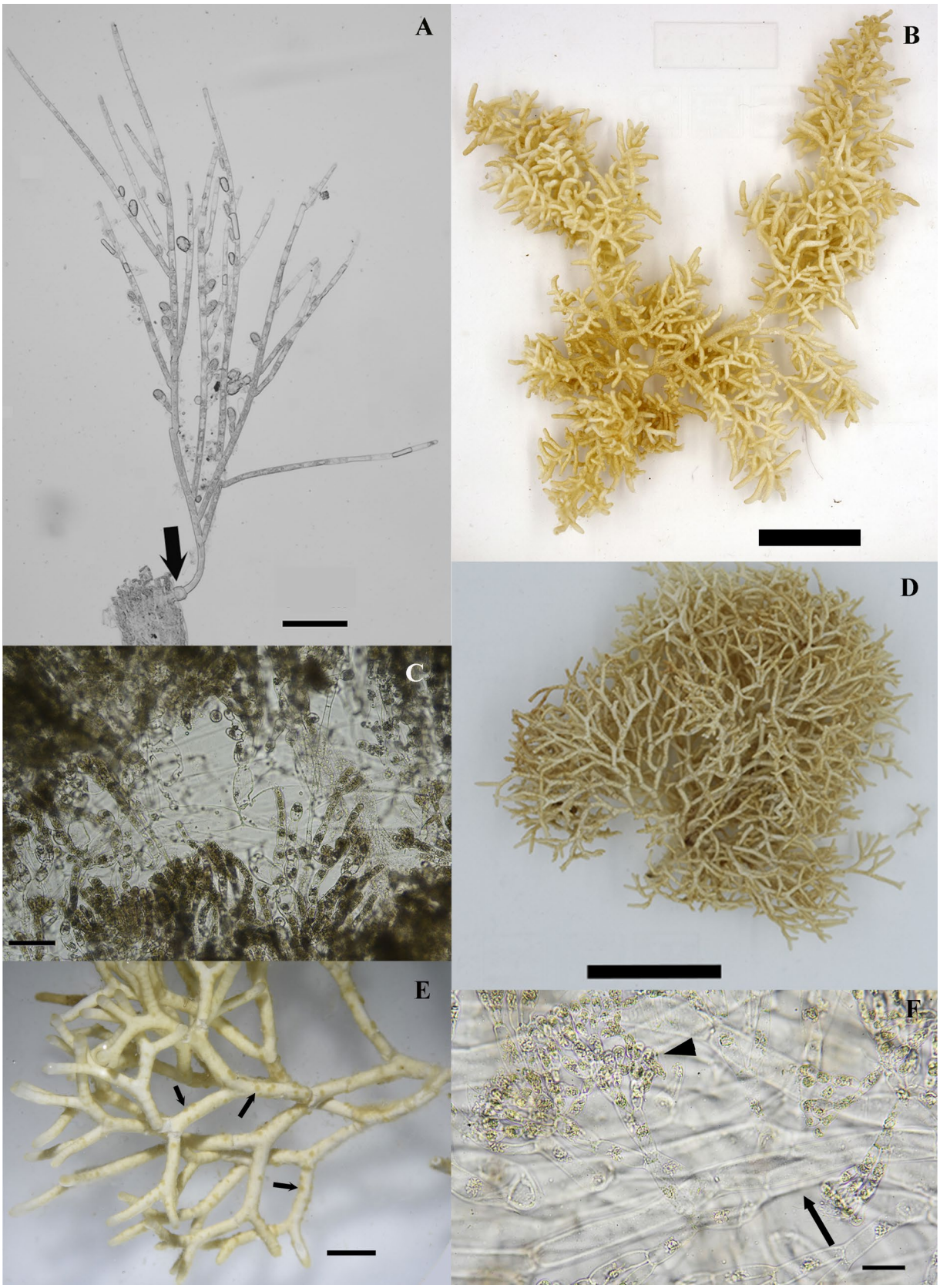
Aglaothamnion halliae (Collins) Aponte, D.L. Ballantine and J.N. Norris* (Fig. 4E).

Type Locality Key West, Florida Keys, U.S.A.

Specimens Observed CMD062, Station 11, N 13°21'54.2'', W 81°23'48.7''Old Providence Island, September 12th 2019, 4 m depth.

Thallus small, to 26 mm height, epiphytic, pale rose in color. Main axis uniseriate, ecorticated, 60 µm diameter, cells cylindrical, up to 220 µm long. The main axis is alternately branched, on one plane, almost on every cell (Fig. 4E). The first-order lateral branches are also alternately branched, in one plane. The first two to three cells of the first-order branches usually are not ramified, then branches are produced from every cell. The ultimate branchlets are slightly incurved toward the apices.

Remarks There are ten species of *Aglaothamnion* reported for the western Atlantic Ocean (Wynne 2022). *A. halliae* is easily differentiated from the other species because it has no cortication (in contrast with *A. collinsii*, *A. felipponei* and *A. herveyi*), its branching is distichous (it is radial in *A. boergesenii*, *A. cordatum* and *A. flexibile*) and the apical cells are not pointed (as in *A. uruguayense*, (Littler et al. 2008). *A. priceanum* has a very different branching pattern, as well as *A. tenuissimum*. Of the 10 species of *Aglaothamnion* reported for the Western Atlantic (Wynne 2022), four taxa are recorded on the Colombian coasts: *A. boergesenii*, *A. cordatum*, *A. herveyi* and *A. halliae*; the latter has been reported, until now, only for Tayrona National Park (Díaz-Pulido and Díaz-Ruíz 2003).


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◂**Fig. 2** **A**. *Acrochaetium affine*. Habit, with basal cell (arrow). Scale bar: 100 µm. **B-C**. *Ganonema norrisiae*. **B**. Habit. Scale bar: 2 cm. **C**. Medullary filaments. Scale bar: 100 µm. **D-F**. *Liagora albicans*. **D**. Habit. Scale bar: 2 cm. **E**. Detail of branches with carposporophytes (arrow). Scale bar: 2 cm. **F**. Medullary (arrow) and cortical filaments (arrowhead). Scale bar: 25 µm

Order Ceramiales

Family Ceramiaceae

Acrothamnion butlerae (Collins) Kylin* (Fig. 4F-G).

Type Locality Kingston, Jamaica.

Specimens Observed VH071, Station 15, Pinnacles, N 13°23'26.7'', W 81°20'19.6'', 8,5 m depth. 14 September 2019.

Thallus very small, filamentous, pinkish red, to 1,5 mm high, uniseriate, ecorticated (Fig. 4F). Erect axes bipinnate (Fig. 4F), not very branched at base and profusely branched in the upper half of the thallus. Cells of main axes up to 10–12 µm diameter, producing 1–2 short lateral branches, opposite, distichous, conferring a pinnate habit. These lateral branches bear unilateral or opposite two-three celled branchlets. Apical cells of branches and branchlets tapered, dome-shaped. Gland cells roundish to flattened on apical cells of branches, 12–15 µm diameter, refractive (Fig. 4G). Reproductive structures not observed.

Remarks This tiny beautiful alga is very easy to identify due to its branching pattern and the apical position of gland cells. The genus is composed of only two species, *A. butlerae* and *A. preissii*, a much more conspicuous alga, native to Australia, that since the 1960s has invaded the Mediterranean Sea (Parente et al. 2018) and is included in the 100 worst non-indigenous species list (Streftaris and Zenetos 2006) as well as in the Black List of Marine Invasive Species (Otero et al. 2013). *A. butlerae* has been reported for the continental coast of Colombia and for Roncador key, in the Archipelago (Díaz-Pulido and Bula-Meyer 1997; Díaz-Pulido and Díaz-Ruíz 2003). Possibly much more widespread, but overlooked for its size.

Corallophila atlantica (A.B. Joly and Ugadim) R.E. Norris* (Fig. 5A-B).

Type Locality Ilha Anchieta, Ubatuda, Sao Paulo State, Brazil.

Specimens Observed PAFM183, Station 1, N 13°23'52.1'', W 81°23'46.9'', 6,3 m depth. 9 September 2019.

Thallus prostrate and erect, up to 5 mm high (Fig. 5A), attached to the substrate by rhizoids, which are 180–650 µm long and 35–38 µm diameter. The rhizoids arise from the nodes, 1 to 3 per node. Postrate axes 130–165 µm diameter, with axial cells to 185 µm long. Erect branched not ramified, arising from the prostrate axes, 110–120 µm diameter. Six pericentral cells. Cortical cells in surface view are 20–25 µm wide and 7,5–17,5 µm high (Fig. 5B). Apices of erect axes and adventitious branches curved, with one protruding large apical cell.

Remarks Mostly a genus of the Indopacific, of the eleven species described only two are reported for the Western Atlantic: *C. atlantica* and *C. verongiae*. The difference between these two species resides mainly in size, being *C. atlantica* more robust than *C. verongiae* (Ardito et al. 2009). The specimen observed fits the description of *C. atlantica*, which has been reported in Venezuela and in the Tayrona National Park on the continental coast of Colombia (Guiry and Guiry 2024; Díaz-Pulido and Díaz-Ruíz 2003).

Perikladosporon percurrens (E.Y. Dawson) Athanasiadis (Figs C-D).

Type Locality Eniwetok Atoll, Marshall Islands.

Specimens Observed VH096, Station 7, N 13°24'41.6'', W 81°19'20.5'', 14,2 m depth. 11 September 2019.

Thallus filamentous, very small, epiphytic, 0,6 mm high, uniseriate, light pink (Fig. 5C). Main axes 15–18 µm diameter, branched distichously, pinnate. Lateral branches are branched adaxially (Fig. 5D). Gland cells and reproductive structures not observed.

Remarks The specimen found was a small fragment. The characteristic branching pattern makes it easy to identify it. Possibly much more widespread, but due to its small size it is easily overlooked.

Family Rhodomelaceae

Chondria atropurpurea Harvey* (Fig. 5E-H).

Type Locality Charleston, South Carolina, and Florida, U.S.A.

Specimens Observed CMD 254, Station 3, N 13°30'43.0'', W 81°19'47.8'', Old Providence, 10 September 2019, depth 10.3 m. Mixed in an underwater bloom dominated by *Cladophora* spp. (JIW0004729)

Thallus large, 15–25 cm tall, pink to dark red, erect (Fig. 5E). Axes cylindrical with faint banding, arising from discoidal holdfast. Branches sparse, irregular, 3–5 mm diameter. Branchlets 1,5 –2 mm diameter, constricted at base (Fig. 5F). Apex pointed and tapered or blunt (Fig. 5G-H),

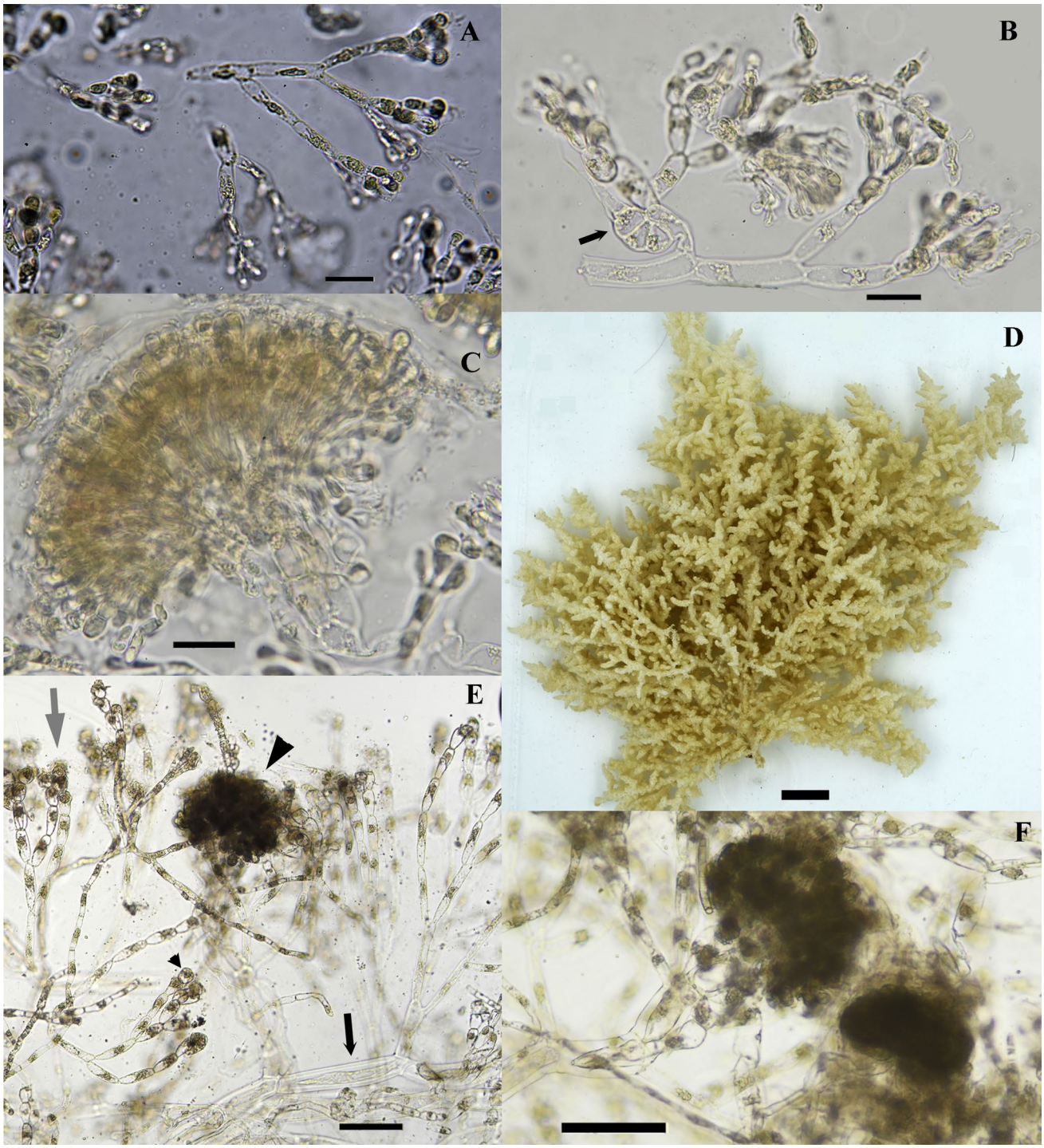


Fig. 3 **A-C** *Liagora albicans*. **(A)** Cortical filaments. Scale bar: 25 µm. **(B)** Carpogonial branch (arrow). Scale bar: 25 µm. **(C)** Compact carposporophyte. Scale bar: 25 µm. **D-F**. *Trichogloeopsis pedicellata*. **(D)** Habit. Scale bar: 1 cm. **(E)** Cortical (grey arrow) and medullary (black arrow) filaments and carposporophyte (arrowhead). Scale bar: 100 µm. (F) Carposporophyte with descending filaments. Scale bar: 100 µm

with apical cell exposed, but not always visible due to the presence of a dense trichoblast tuft. Cortical cells 110–150 µm high and 20–30 µm wide. In cross section, axial cell 160–170 µm diameter, surrounded by five very large periaxial cells, 250–360 µm diameter. Cortical cells in cross Sects. 60–100 µm diameter.

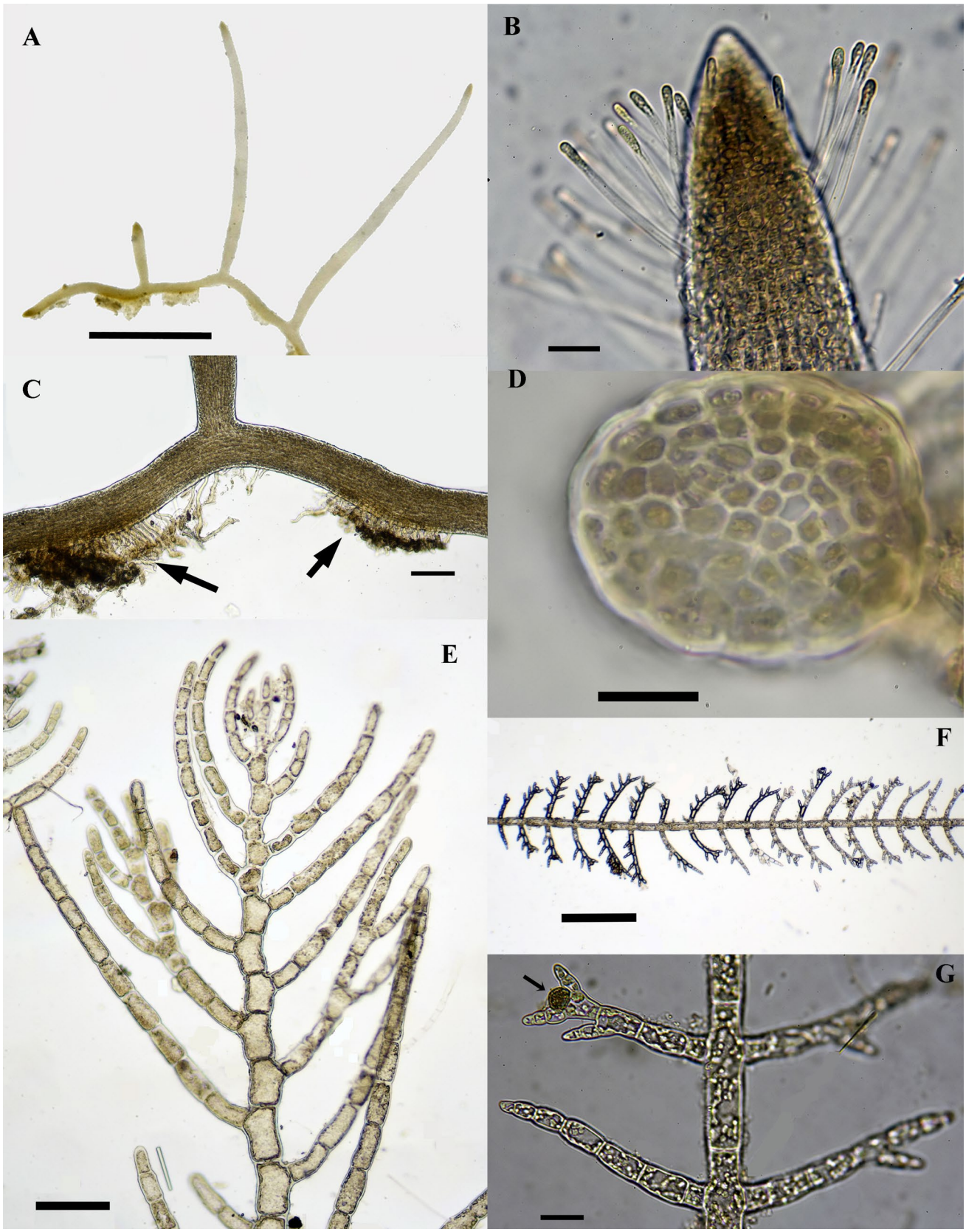
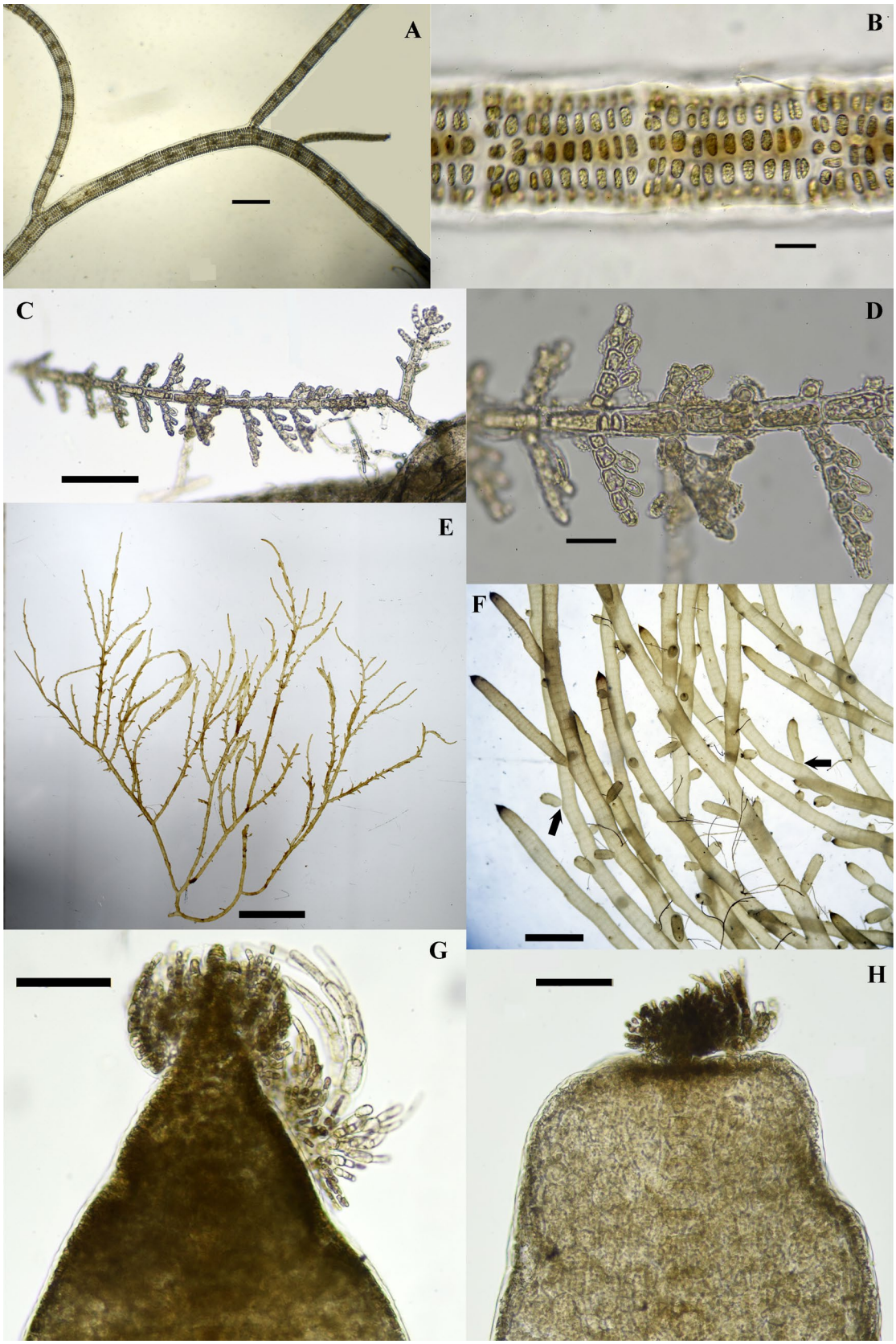


Fig. 4 **A-D** *Gelidiella lubrica*. **(A)** Habit. Scale bar: 1 mm. **(B)** Apex with hyaline hairs. Scale bar: 25 µm. **(C)** Rhizoids (arrows). Scale bar: 100 µm. **(D)** Cross section. Scale bar: 25 µm. **E**. *Aglaothamnion halliae*. Detail of branching. Scale bar: 100 µm. **F-G**. *Acrothamnion butlerae.* **F**. Habit. Scale bar: 100 µm. **G.** Detail of branching with apical gland cell (arrow). Scale bar: 25 µm


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◂**Fig. 5** **A**-**B** Corallophila atlantica . (**A**) Habit. Scale bar: 250 µm. (**B**) Cortication. Scale bar: 25 µm. **C**-**D**. Perikladosporon percurrens . (**C**) Habit. Scale bar: 100 µm. (**D**) Detail of branching. Scale bar: 25 µm. **E**-**H**. Chondria atropurpurea . (**E**) Habit. Scale bar: 2 cm. (**F**) Branches with branchlets constricted at base (arrow). Scale bar: 1 cm. (**G**) Pointed apex with protruding apical cell. Scale bar: 100 µm. (**H**) Blunt apex. Scale bar: 100 µm

Remarks The alga was present as floating biomass in a *Cladophora*-dominated underwater bloom. Widely distributed in the western Atlantic, it has been reported also in Korean waters (Guiry and Guiry 2024). In Colombia, the species has been registered for the coast of Magdalena Department (Díaz-Pulido and Díaz-Ruíz 2003).

Herposiphonia secunda (C. Agardh) Ambronn* (Fig. 6A-B).

Type Locality Mediterranean Sea.

Specimens Observed PAFM201, Station 1, N 13°23'52.1'', W 81°23'46.9'', 6,3 m depth. 9 September 2019. PAFM105, Station 7, N 13°24'41.6'', W 81°19'20.5'', 14,2 m depth. 11 September 2019. VH062, Station 15, Pinnacles, N 13°23'26.7'', W 81°20'19.6'', 8,5 m depth. 14 September 2019.

Thallus prostrate and erect, dark-red to brown, epiphytic. Prostrate axes 85–105 µm diameter, segments 160–230 µm long, attached to the substrate by rhizoids. Apex of prostrate axis upturned. Erect axes in pairs, 60–80 µm diameter, with one determinate axis (long) followed by an indeterminate axis (short) at successive joints of prostrate axes, with 3–4 segments between sets (Fig. 6A). 8 pericentral cells (Fig. 6B).

Remarks *Herposiphonia* Nägeli is a large genus with 60 species currently accepted, eleven of which are present in the western Atlantic (Wynne 2022). The species are often difficult to identify due to ambiguous characters or morphological plasticity (Albis and Gavio 2011); the branching pattern of the observed specimen may suggest the species *Herposiphonia bipinnata* M. Howe, which is characterized by a d: i branching pattern, followed by several segments with no branching. However, *H. bipinnata* is much more robust (Howe 1920). *Herposiphonia secunda* has been described as having a branching pattern rather polymorphic, with a ddd: i to a d: i pattern followed by 5–6 segments without branches. Our specimen is very slender, with a d: i pattern.

Herposiphonia pecten-veneris (Harvey) Falkenberg* (Fig. 6C-D).

Type Locality Key West, Florida, U.S.A.

Specimens Observed CMD 157, Station 10, N 13°22'09.5'', W 81°24'30.0'', 12,7 m depth. 12 September 2019.

Thallus filamentous, mainly erect, epiphytic, dark red to maroon, 4–5 cm tall. Axes polysiphonous, ecorticated (Fig. 6C). Prostrate axis with recurved tips, attached to the substrate by unicellular rhizoids 150–200 µm diameter. Erect axes are recurved, comb-like, 150–170 µm diameter, with 9 pericentral cells (1,5 – 2 diameter long) (Fig. 6D). Branchlets short, perpendicular to axes, alternately offset in second series 40–70 µm diameter. Trichoblasts abundant, at tips, deciduous, dichotomously branched. Reproductive structures not observed

Remarks The species has been widely reported in the Caribbean Sea, and in Colombia, there are records from the continental coast, in Urabà and Rosario islands (Díaz-Pulido and Díaz-Ruíz 2003).

Melanothamnus sphaerocarpus (Børgesen) Díaz-Tapia and Maggs (Fig. 6E-G).

Type Locality Magens bay, St. Thomas, Virgin Islands.

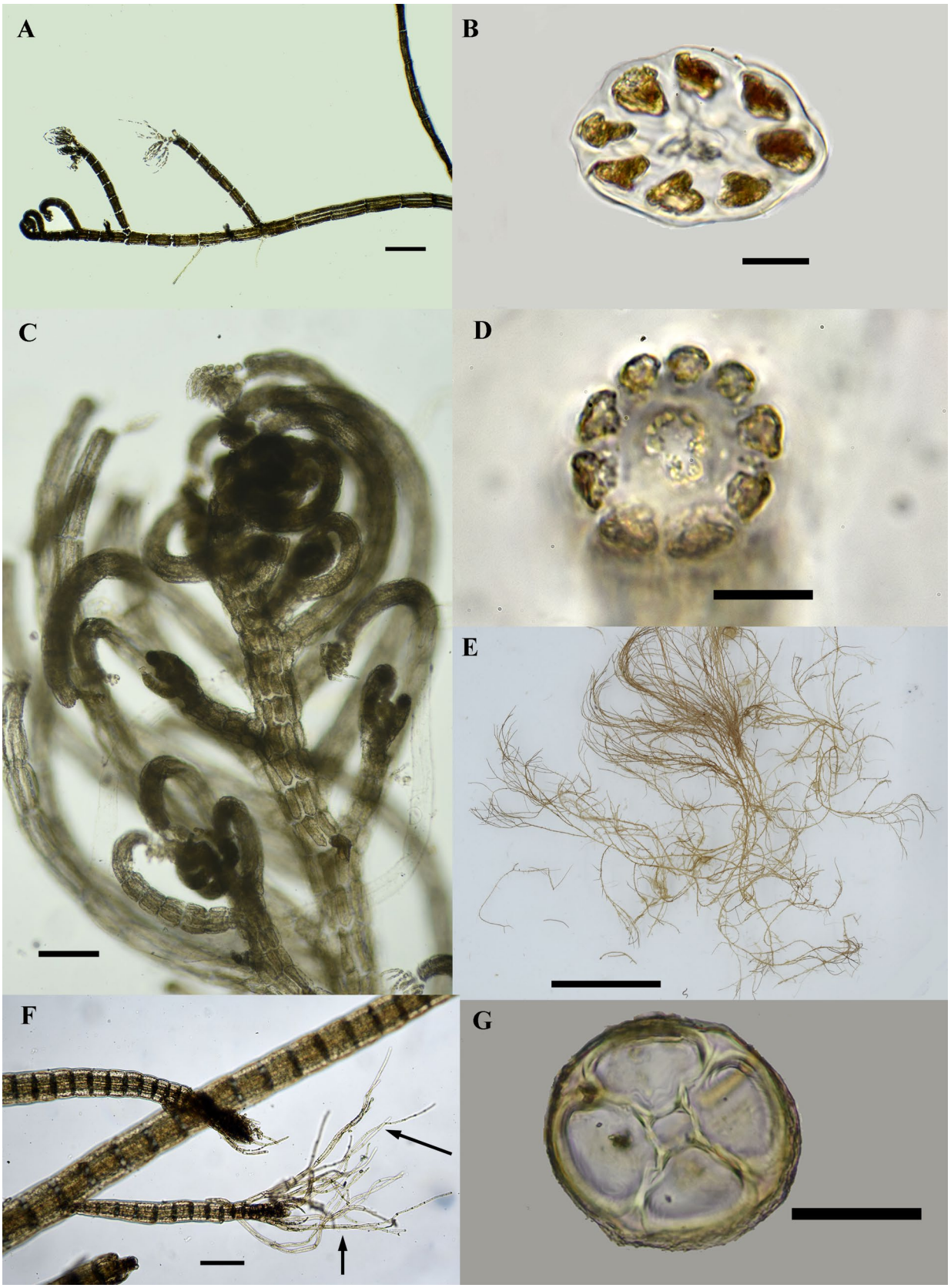
Specimens Observed CMD 269, Station 3, N 13°30'43.0'', W 81°19'47.8'', Old Providence, 10 September 2019, depth 10.3 m. Mixed in an underwater bloom dominated by *Cladophora* spp. (JIW0004780)

Thallus filamentous, bushy, dark-red to brown, to 7 cm tall (Fig. 6E). Axes ecorticated, with branchlets constricted at base (Fig. 6F), replacing trichoblasts. Axes formed by four pericentral cells (60–70 × 90–100 µm in cross section) surrounding a smaller axial cell, 30 µm diameter (Fig. 6G). Prostrate axes attached by rhizoids in closed connection to parent cell. Prostrate axes 150–180 µm diameter. Erect axes 100–130 µm diameter, segments 0,8 – 1,8 diameter long, scar cells common. Reproductive structures not observed.

Remarks As for *Chondria atropurpurea*, this species was observed in an underwater bloom dominated by *Cladophora* sp. Our specimens are larger than previously reported, but otherwise fit the description by Kapraun and Norris (1982) of the taxon. A pantropical species, it has been reported for Darien (Díaz-Pulido and Díaz-Ruíz 2003) on the continental coast of Colombia, and as a component of drift algae in San Andres Island (Ortíz and Gavio 2012, as *Neosiphonia sphaerocarpa*).

Discussion

Most of the specimens reported here are small-sized algae, epiphytic of more conspicuous taxa. Since 2011 (Albis and Gavio 2011) a large number of epiphytic species have reported for the International Biosphere Reserve *Seaflower* (p.e. Gavio et al. 2013; Rincón-Díaz et al. 2014, 2016; Reyes-Gómez et al.


A
B
C
D
E
F
G

◂**Fig. 6** **A**-**B**. Herposiphonia secunda. **A**. Habit. Scale bar: 250 µm. **B**. Cross section with 8 pericentral cells Scale bar: 25 µm. **C**-**D**. Herposiphonia pecten-veneris. **C**. Habit. Scale bar: 100 µm. (**D**) Cross section with 9 pericentral cells. Scale bar: 25 µm. **E**-**G**. Melanothamnus sphaerocarpus . (**E**) Habit. Scale bar: 2 cm. (**F**) Branches constricted at base with apical trichoblasts (arrow). Scale bar: 100 µm. (**G**) Cross section of branches with four pericentral cells. Scale bar: 100 µm

2013, 2021), increasing greatly the diversity of its marine flora. Most of the species reported here are probably rather common but are overlooked due to their inconspicuous habit or to the difficulty to identify them correctly, as for the family Liagoraceae. Additionally, their biomass is usually very modest, and normally there is not enough material to pursue molecular and morphological analyses in light of the current trends, to have a better understanding of the cryptic diversity of some taxa or genera.

Recently, Suarez and Martínez-Daranas (2020) analyzed the marine algal flora in the western Atlantic to determine its biogeographic patterns. In light of their analyses, Colombia shares greater affinities to the marine flora of Central America than to the Southern Caribbean (Venezuela). Their results might be skewed due to the fact that in the past decade the phycological work in the country has been concentrated on the Archipelago, which lies in front of the coast of central America. Almost no recent studies have been published on the seaweed composition of the continental coast of Colombia, and large areas are poorly known. For the Archipelago, despite extensive work in the past decade, new findings continue to appear, highlighting the need of further research.

Some of the larger specimens, such as *Chondria atropurpurea* and *Melanothamnus sphaerocarpus* were observed and collected amid an underwater (10 m depth) bloom of mixed species, where *Ceramium nitens* and *Cladophora* spp. dominated. The sample site was originally a sand plain, but at the moment of collecting it was almost completely covered by the bloom, with several dead crabs and fireworms eating their corpses, and the presence of abundant ctenophores. The bloom was drifting but never reached the beach, so it went unnoticed by authorities. The causes and duration of the bloom are unknown. All the other species reported in the present work were attached to the substrate, which in Old Providence is mainly calcareous rock, rubbles, or, when epiphytic, larger algae. In the Caribbean Sea, a large number of macroalgal taxa has epiphytic habit. In Mexico, for example, Quiróz-González et al. (2023) reported 618 species of epiphytic algae, which correspond to the 37% of the total diversity of algae reported for the country. Along the Caribbean coast of Mexico, the authors reported the highest diversity of epiphytes, with at least 286 taxa. The epiphytic flora is normally neglected (Montañes et al. 2003; Jover et al. 2020; Quiróz-González et al. 2023), but is of ecological importance: these species have normally a high growth rate, contributing to primary productivity, and are an important food source for micro and mesograzers (Quiróz-González et al. 2023). Furthermore, epiphytes may act as bioindicators for monitoring programs of coastal water quality (Michael et al. 2008).

The taxa observed here are mostly filamentous, and normally grow as turf, intermixed with a great diversity of species. In the Caribbean Sea, this is the dominant algal growth form in shallow coral reefs (Fricke et al. 2011), but turf assemblages are rarely characterized to the species constituting them. Along the coastline of Old Providence, coral cover has suffered a constant decline in line with most of the Caribbean basin (Acosta et al. 2016). Turf assemblages are widespread, but no monitoring program includes identification to species level of this algal mix. Interestingly, Fricke et al. (2011) observed that despite the great changes coral ecosystems have suffered in the past thirty years, little difference was found in turf succession patterns at Curaçao, offshore the coast of Venezuela. In Australia, algal colonization of available substrate after a massive coral bleaching event evidenced that algae may increase the stress corals suffer for the bleaching, as well as the colonies' ability to recover (Díaz-Pulido and McCook 2002). The present results show that epiphytic small algae are very diverse, but still poorly known, in the International Biosphere Reserve *Seaflower*, as in other areas of the Caribbean Sea. Additional efforts should be directed to elucidate successional and competition dynamics among benthic communities, including turf algae.

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Author Contributions YCMD (https://orcid.org/0000-0002-2379-5382) identified specimens, edited photo, wrote part of the ms; VD (https://orcid.org/0009-0009-7541-966X) identified specimens, edited photo, wrote part of the ms; PAF (https://orcid.org/0009-0007-3136-3305) identified specimens, edited photo, wrote part of the ms; BG (https://orcid.org/0000-0001-5364-3374) got the funding, collected the specimens, confirmed identification, wrote and edited the manuscript.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Ethical Approval Specimens were collected with collecting permit issued to the Universidad Nacional de Colombia through Resolución 0255, March 12th 2014, by ANLA.

Competing Interests The authors declare no competing interests.

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