

MARINE ALGAE AND SEAGRASSES
FROM THE TOBACCO RANGE FRACTURE ZONE, BELIZE, C.A.

BY

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ABSTRACT

Sixty three species of marine macrophytes (61 algae and 2 vascular plants) were found in the habitats within and surrounding the fractured peat zone of Tobacco Range, a previously unrecognized ecosystem of the Central Province of the Belize Barrier Reef. Of the algae, 35 are Chlorophyta, 22 Rhodophyta, and 4 Phaeophyta; 14 taxa are new records for Belize. All taxa are fully documented, illustrated, and described in detail to provide a utilitarian guide for field identification.

The fracture bottoms contained eight unique species, all of which were psammophytic Chlorophyta, not found on the vertical fracture walls or surrounding seagrass habitat. The fracture walls supported 4 Chlorophyta and 2 Rhodophyta not found in the fracture bottoms or seagrass beds; whereas, the adjacent seagrass beds included 12 Rhodophyta and 3 Chlorophyta not found in the fractured peat habitats. Nine Chlorophyta, two Phaeophyta, and one Rhodophyta were common to all three habitat types. Between-fracture floristic differences were minor and related to the age and size of the fractures. Because of a conspicuous reduction in macrophytic cover and a shift to domination by slower-growing calcareous rhizophytic forms, we hypothesize that the fracturing process is resulting in a considerable loss to total ecosystem primary productivity.

INTRODUCTION

The Belize Barrier Reef complex ranges from 10 to 32 km wide and is about 200 km in length (Rützler and Macintyre, 1982), containing hundreds of mangrove islands, diverse intertidal and subtidal barrier and patch reef zones, two large atolls, and vast lagoonal seagrass beds. However, knowledge concerning the benthic plant communities of these and mainland habitats is at a rudimentary level, especially in light of the developing nature of Belize and its emerging popularity with the diving and scientific communities. Only three algal floristic accounts have been published and include the works of Taylor (1935, documenting 84 marine algae), Tsuda & Dawes (1974, listing 104 marine plants collected at Glovers Reef), and Norris & Bucher (1982, treating 165 taxa of benthic marine algae from the vicinity of Carrie Bow Cay, Southwater Cay, and Twin Cays). Specialized generic treatments have added additional taxa new to Belize; i.e., 7 *Polysiphonia*, Kaprann & Norris (1982); 7 *Udotea*, Littler & Littler (1990); 1 *Anadyomene*, Littler & Littler (1991); 8 *Avrainvillea*, Littler & Littler (1992).

STUDY AREA AND METHODS

The unique ecosystem created by the fractured and subsiding fossil mangrove-peat banks on the northwest margin of Tobacco Range (Fig. 1) provided an interesting contrast in habitat types (fracture bottom, fracture walls, and seagrass beds) and was the impetus for this comparative taxonomic investigation. The physiographic characteristics of the fractured peat zone are described by Littler et al. (1995 this volume). To our knowledge, no other studies of comparable fractured mangrove-peat habitats have been performed.

We collected intensively all major marine algae in the eastern, central, and western fractures (Fig. 1) within the three major habitat types from 16 to 20 February 1993 using SCUBA. All material was returned to the laboratory where it was identified, sorted to species while fresh, numbered, and fixed in 5% buffered Formalin. Specimens were later transferred to 70% alcohol for long-term storage.

All taxa present were described and illustrated in detail and arranged in phylogenetic order for higher taxa following Wynne (1986), with the species appearing alphabetically. New records for Belize are designated with asterisks. All identifications were checked against the original published descriptions. Descriptions are representative of the entire species and are not restricted to those specimens from the fracture zone. Species names are followed by citation of the original publication and the basionym with its reference is then given below, if the species is based on an earlier name. The thallus description appears next and includes the macroscopic characters of the organisms presented in easily understood terminology (i.e., we attempted to eliminate technical jargon). The following anatomical descriptions of the microscopic characters (second paragraph) required us to use some specialized technical terms, but these were kept to a minimum and are defined when first used. Specimens cited are only those collected during this specific study and are deposited in the Algal Collection, United States National Herbarium, Department of Botany, National Museum of Natural History, Smithsonian Institution (US).

CHLOROPHYTA

Siphonocladaceae, Siphonocladales

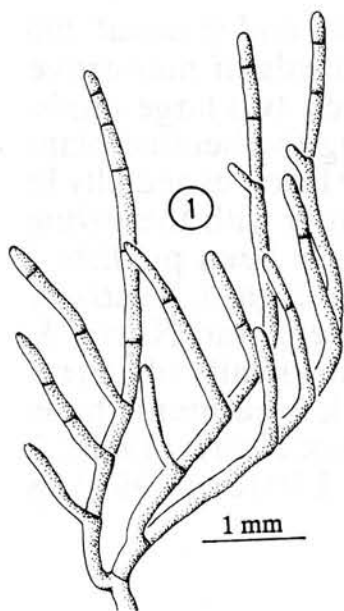
Cladophoropsis membranacea (C. Agardh) Børgesen 1905: 289, figs. 8-13.

Conferva membranacea C. Agardh 1824: 120.

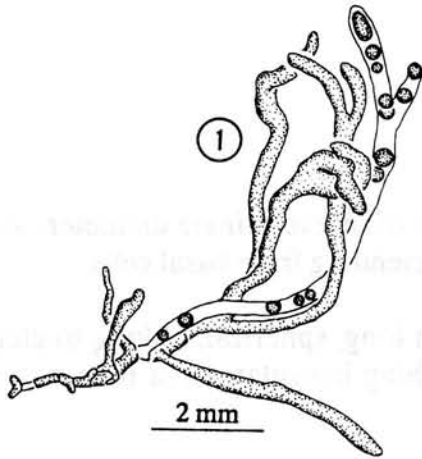
Thallus filamentous forming dense mats or in mixed turfs; mostly 2-5 (up to 10) cm tall; light green, glossy; branching alternate below, unilateral above; attaching filaments horizontally spreading, pale or colorless, entangled, fibrous.

Main filaments 150-280 μm diam.; branchlets 100-150 μm diam., originating from upper end of parent cell; wall formation irregular at long intervals; wall absent from base of branchlet, in open connection to parent cell; attaching filaments often terminating in tenacula-like cells (finger-like pads).

Fracture zone specimen: Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25160 (US).



1. Filaments - showing lack of wall at base of branchlet with open connection to parent cell.



1. Habit of plant - clear filament is reproductive.

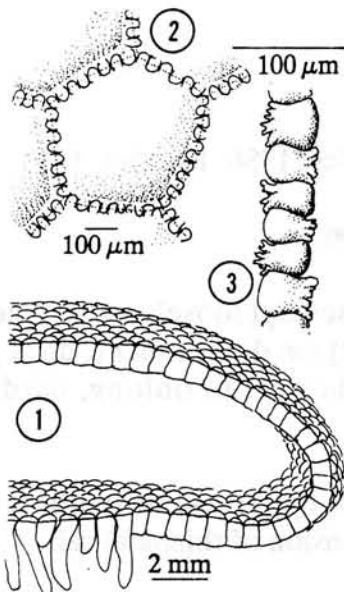
**Siphonocladus rigidus* Howe 1905a: 244, pl. 13, fig. 1; pl. 14, figs. 1-10.

Thallus coarsely filamentous, crisp, rigid, cushion-like; to 5 cm long; pale to translucent green; main axis indistinct; branching unilateral or irregular; branchlets blunt, not tapered, often growing downward; attached by similar filaments.

Main axis 350-1150 μm diam.; branches single series of cells, rarely 2-3 cells wide; branch cells elongate laterally to form branchlets; branchlets 350-900 μm diam., walls conspicuously thick, 15-70 μm ; reproductive structures common, as bright yellow-green spheres formed within filament sheath, spheres slowly released at branch apex.

Fracture zone specimen: Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25171 (US).

Valoniaceae, Siphonocladales



1. Cross section. 2. Surface view - macroscopic cells with connecting tenacular cells. 3. Surface view - tenacular cells.

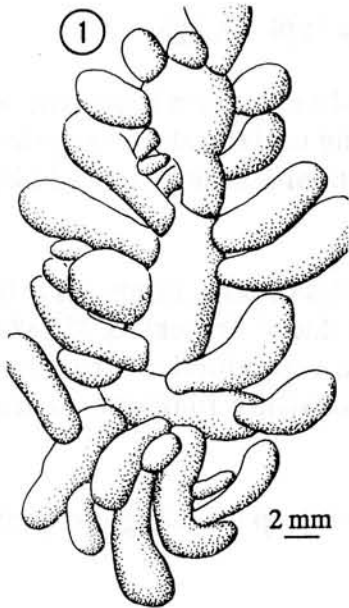
Dictyosphaeria cavernosa (Forsskål) Børgesen 1932: 2, pl. 1, fig. 1.

Ulva cavernosa Forsskål 1775: 187.

Thallus sack-like, hollow, spherical when young, irregularly lobed, ruptured when old; to 12(-30) cm diam.; light green; cells macroscopic, in one layer, honeycomb-like, angular or polygonal in surface view; rhizoids short, branched or unbranched.

Cells 0.1-3.0 mm diam., adhering to one another by minute tenacular cells; tenacular cells form continuous row adjacent to large cells, alternately opposite one another.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25099 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25040 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25136 (US).



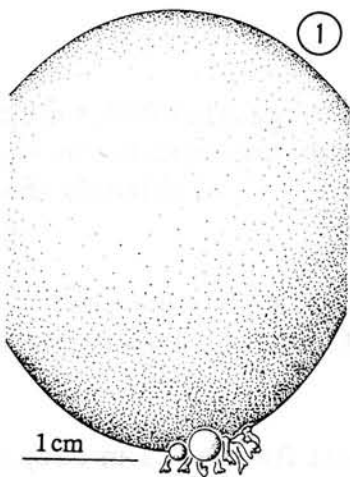
1. Habit of plant.

Valonia macrophysa Kützing 1843: 307.

Thallus of large macroscopic, crowded cells; of indeterminate diameter, to 5 cm thick; shiny, dark olive-green; rhizoids extending from basal cells.

Cells tightly packed, 5-15 mm diam., 1-4 cm long, spherical, oblong to club-shaped; cell wall thin, tough, elastic; branching irregular, from base or any exposed area.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25027* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25138* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25048* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25169*.



1. Habit of plant - base with rhizoidal cells and vegetative propagules.

Ventricaria ventricosa (J. Agardh) Olsen & West 1988: 104, figs. 1-4.

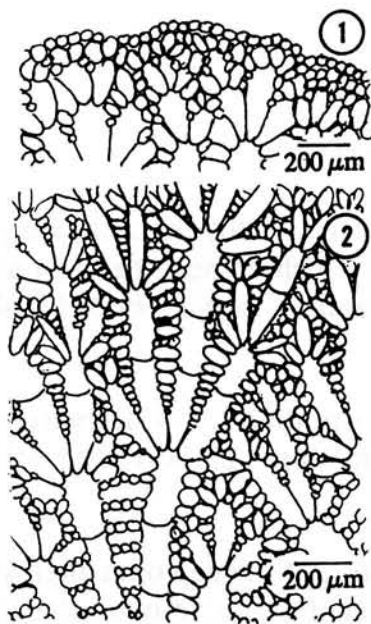
Valonia ventricosa J. Agardh 1887: 96.

Thallus single solitary macroscopic cell or several loosely connected; cells large, unbranched, balloon-like; to 5(-10) cm diam.; shiny, dark green, iridescent, with reflective glare; cells spherical to oblong, hard, firm; rhizoidal cells minute, branched.

Cell wall thin, tough, elastic; reproduction by release of small, juvenile, cytoplasmic spheres from parent cell or expansion of rhizoidal cell.

Fracture zone specimens: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25134* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25164* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25079* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25195* (US).

Anadyomenaceae, Cladophorales

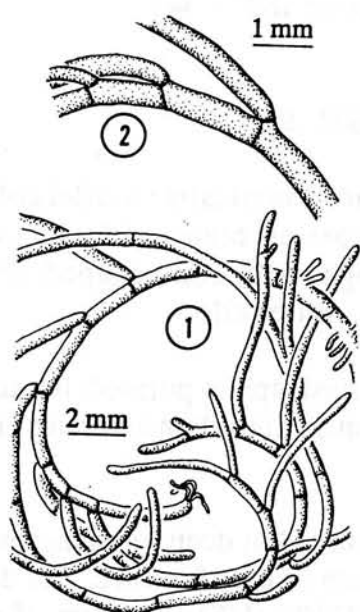
Anadyomene stellata (Wulfen) C. Agardh 1822a: 400.*Ulva stellata* Wulfen in Jacquin 1786: 351.

1. Margin of plant. 2. Cell arrangement - note parallel cells between veins.

Thallus densely packed tufts or erect ruffled clumps; to 10 cm tall; bright yellow-green; blades crisp; veins faintly visible, in fan shaped patterns, margins lobed or undulating; rhizoids loosely entangled.

Veins radiating peripherally from base; branching polychotomous at segment apices; vein cells mid-blade length (0.6-3.0 mm) to width (0.25-0.38 mm) ratio highly variable from 8:1 in young to 2:1 in older blades; cells between veins parallel; margin cells small, oval; rhizoids from basal extensions of corticating siphons, attach directly to substratum or intertwined to form multiple stipes.

Fracture zone specimens: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25153* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25028* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25071* (US), *D&M Littler 25072* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25050* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25166* (US).



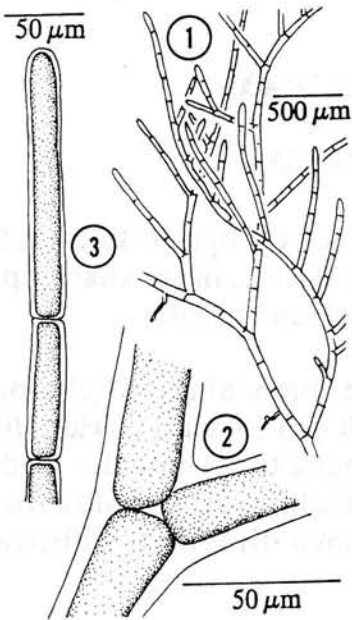
1. Habit of plant. 2. Unilateral branching pattern.

Valoniopsis pachynema (Martens) Børgesen 1934: 10, figs. 1-2.*Bryopsis pachynema* Martens 1866: 24, pl. IV, fig. 2.

Thallus filamentous, coarse, stiff, loose, entangled, forming pad-like cushions; to 8 cm diam., 3 cm thick; glossy green; branching generally unilateral; attached by small sparse rhizoids, older branches often secondarily attached by short lateral branchlets.

Main filaments cylindrical, 0.3-1.0 mm diam., 2-10 or more diameters long; branchlets cylindrical with no or little taper, originating from upper end of parent cell; wall formation of branchlets basal to main filament.

Fracture zone specimens: Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25056* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25163* (US).



1. Habit of plant. 2. Cell arrangement at branch base. 3. Apex of branchlet.

Cladophoraceae, Cladophorales

**Cladophora albida* (Nees) Kützing 1843: 267.

Annulina albida Nees 1820: index [1].

Thallus filamentous, undulating, spongy; to 10(-40) cm tall; pale yellow-green to dark green; branching irregular to dichotomous below, unilateral above, at apex of parent cell; branches gracefully curving or sickle shaped; rhizoids fine, short.

Main filaments cylindrical, to 40(-80) μm diam., 2-7 diameters long; branchlets cylindrical, tapering to 12 μm diam.; cell division primarily intercalary (between cells), not apical.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25070* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25104* (US).

Caulerpaceae, Bryopsidales

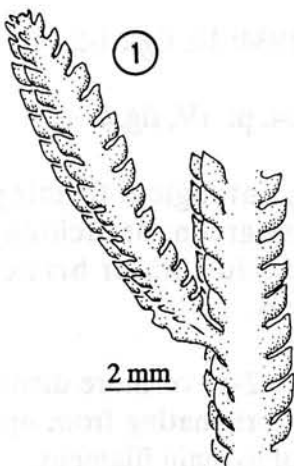
Caulerpa cupressoides (West in Vahl) C. Agardh 1822a: 441.
[var. *cupressoides*]

Fucus cupressoides West in Vahl 1802: 38.

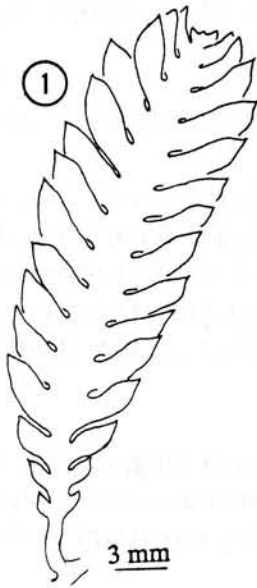
Frond erect, stiff, densely covered with short, vertically parallel columnar branchlets; small bushy forms 2-8 cm tall, sparsely branched forms to 25 cm tall; grass-green; branchlets knobby, tough, stiff, cone shaped; rhizome creeping, stoloniferous; rhizoids numerous, white-yellow.

Branchlets 1 mm diam., 1.5 mm long, upcurved, apices pointed; branch stalk 1.5 mm diam.; rhizome 1.5-2.5 mm diam.; rhizoids numerous, thickly stalked, branching to slender apices.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25063* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25106* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25103* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25184* (US).



1. Branch with pointed, knob-like branchlets.



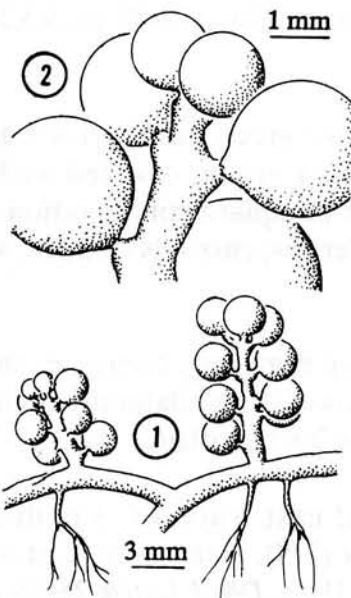
1. Upright with flattened, upturned, pointed branchlets.

Caulerpa mexicana Sonder in Kützing 1849: 496.

Frond erect, resembling flattened feathers; highly variable, dwarf forms to 2 cm tall, 4-10 mm wide in wave-exposed areas, elongated forms 15-25 cm tall, 5-16 mm wide in calm protected habitats; grass-green; unbranched or occasionally branched; branchlets opposite, flattened, upcurved, apices tapering, pointed, base narrows into flat, broad (1-3 mm) midrib; rhizome creeping, stoloniferous; rhizoids delicate, branched.

Branchlets flat, 2(-3) mm wide., 2-10 mm long; stalk 1 mm diam., to 5 mm long; rhizome 0.5-1.25 mm diam.,; rhizoids numerous, slender, finely branched.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25078* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25185* (US).



1. Frond with spherical branchlets. 2. Spherical branchlet - note constriction at junction with stalk.

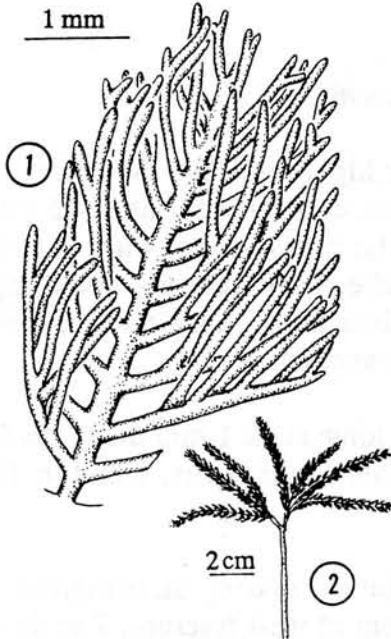
Caulerpa microphysa (Weber-van Bosse) J. Feldmann 1955: 430.

Caulerpa racemosa f. *microphysa* Weber-van Bosse 1898: 361, pl. XXXIII, fig. 5.

Frond bearing clusters of small, spherical to tear shaped branchlets; to 30 mm tall; grass-green; rhizome spreading, creeping, stoloniferous; rhizoids numerous, branched, tapering to slender apices.

Branchlets spherical, to 2.5 mm diam., constricted at base; branchlet stalks to 0.5 mm long, 45°-90° angle from branch; rhizome 1.5 mm diam.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25073* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25110* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25005* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25186* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.93, *D&M Littler 25168* (US).



1. Branch - opposite branchlets with alternate ultimate branchlets. 2. Habit of plant.

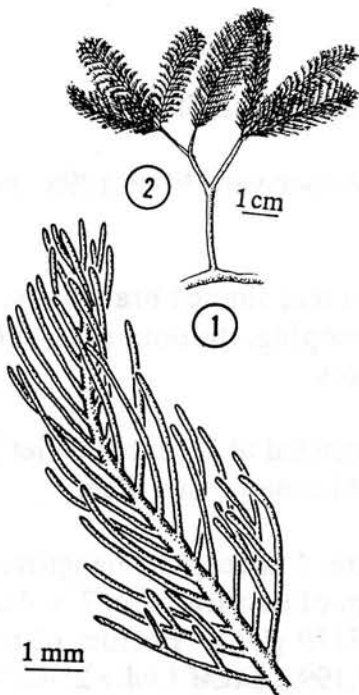
**Caulerpa paspaloides* var. *phleoides* (Bory de Saint-Vincent) J. Agardh 1849: 500.

Chauvinia phleoides Bory de Saint-Vincent 1829: 205, pl. 23.

Fronde erect; to 7 cm tall; stipe naked, green, often branched near midpoint, forked 3-5 times at summit; summit branches 3-6 cm long, dark green, densely covered with fine branchlets set in 3-4 vertical rows, triangular or square configuration when viewed from tip; rhizome creeping, stoloniferous; rhizoids numerous, initially thick, to 1 mm diam., branching to slender apices, white-yellow.

Branchlets cylindrical, 100-120 μm diam., 2-3 mm long, angling 45-55° from axis, stiff, branching opposite, in two ranks; ultimate branchlets alternate angling 45° or less from one another, appearing unilateral at times; stalk 3 mm diam., to 4 cm long; rhizome 4 mm diam.

Fracture zone specimen: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25061 (US).



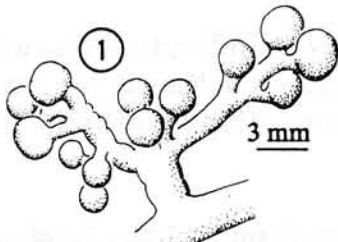
1. Branch - branchlets unbranched except lower 2 sets. 2. Habit of plant.

**Caulerpa paspaloides* var. *wurdemanni* Weber-van Bosse 1898: pl. XXX, fig. 6.

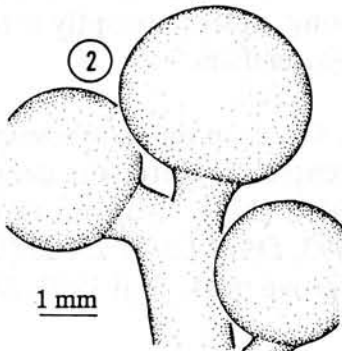
Fronde erect; to 14 cm tall; stipe naked, yellow-green, forked 1-4 times at summit; summit branches 5-10 cm long, dark green, covered with fine branchlets set in 3-4 vertical rows, triangular or square configuration when viewed from tip; rhizome creeping, stoloniferous; rhizoids slender, white-yellow.

Branchlets cylindrical, 160-176 μm diam., 4-6 mm long, opposite, angling 90° from one another, mostly unbranched, lower 2-3 unilaterally branched; stalk 2-3 mm diam., to 6-12 mm long; rhizome 2-4 mm diam.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25084 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25029 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25133 (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25162 (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25108 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25001 (US).



Caulerpa racemosa (Forsskål) J. Agardh 1873: 35.



Fucus racemosa Forsskål 1775: 191.

Fronde erect or creeping, bearing small, spherical, bead-like branchlets; 1-15 cm tall; grass-green; rhizomes creeping, stoloniferous, often branched; rhizoids numerous, branched, tapering.

Branchlets spherical, 4 mm diam., stalked, not constricted at base; branch stalk to 2 mm diam.; rhizome 3 mm diam.; rhizoid stalk to 1.5 mm diam., soon branching to fine filamentous apices.

Fracture zone specimen: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25116 (US).

1. Upright with bulbous branchlets. 2. Spherical branch apex - not constricted at base/stalk junction.



Caulerpa sertularioides (S.G. Gmelin) Howe 1905b: 576.

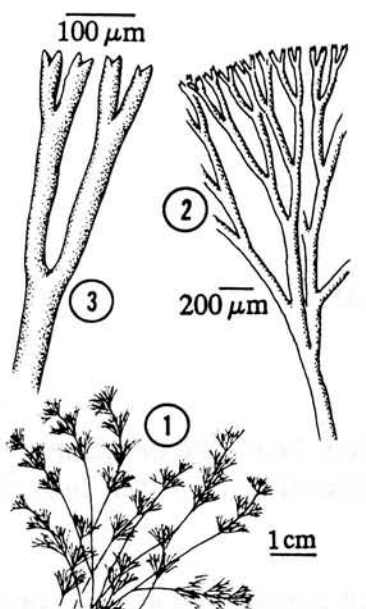
Fucus sertularioides S.G. Gmelin 1768: 151, pl. XV, fig. 4.

Fronde erect, feather-like, occasionally branched; to 20 cm tall, 1-2 cm wide; light green; branchlets opposite, cylindrical, needle shaped, apices bluntly pointed; rhizomes creeping, stoloniferous, extensive; rhizoids branched, filamentous.

Branchlets 180-330 μm diam., 3-11 mm long, upcurved; stalk 1.0-1.5 mm diam.; rhizome 2.5 mm diam., to 2 m long, generally shorter; rhizoid stalk to 2 mm diam., branching to fine tapering apices.

Fracture zone specimens: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25117 (US).

1. Upright - feather-like in appearance. 2. Apex - note cylindrical aspect of branchlets and main rib.



1. Habit of plant. 2. Dichotomous branching of branchlet. 3. Forked branchlet apices.

Caulerpa verticillata J. Agardh 1847: 6.

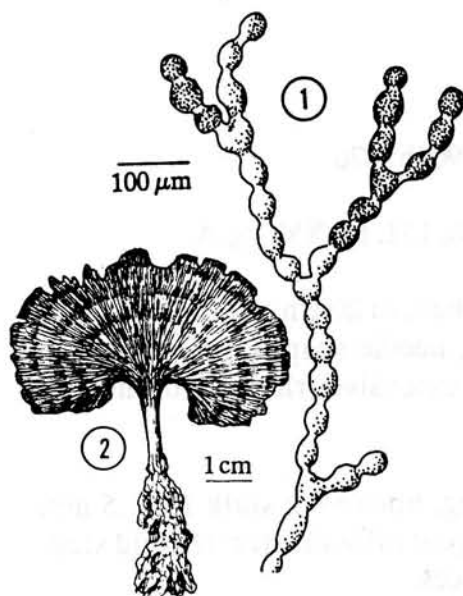
Thallus fine, fibrous, felt-like mats, rarely as individual strands; of indeterminate area, to 7 cm tall; dark green; fronds delicately whorled, 5-8 mm diam.; rhizomes creeping, stoloniferous, slender; rhizoids few, branched.

Branchlets 5-7 times dichotomous, 100-210 μm diam. at base, 30-40 μm at apex, lower segments 10 or more diameters long; apices abruptly forked, pointed; stalk 140-200 μm diam.; rhizome to 560 μm diam.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25064* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25057* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25122* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25017* (US).

Udoteaceae, Bryopsidales

Avrainvillea nigricans f. *parva* D.S. Littler & M.M. Littler 1992: 402, fig. 17.

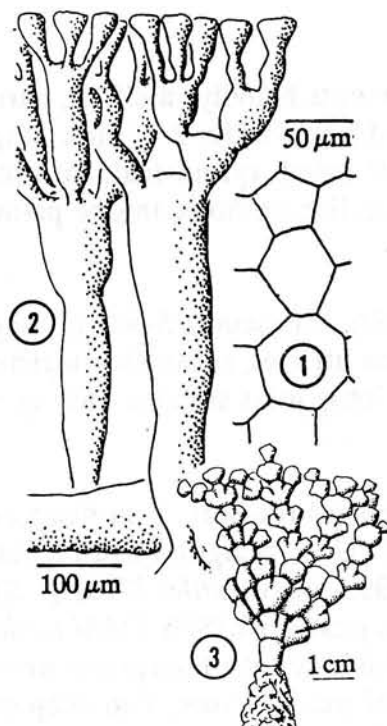


1. Surface siphon of blade. 2. Habit of plant

Thallus solitary, seldom clustered; to 16 cm tall; pale green to brown-green, fringed in black; mature blades kidney shaped to oval, 15 cm long, 23 cm wide, thin (<2 mm), loosely woven; margins smoothly rounded, lacerate, or ragged; blade base flat or lobed; zonation faint; stipe to 1-4(-9) cm long, narrow, cylindrical, seldom branched; rhizoidal mass bulbous.

Blade inner siphons 30-40 μm in diam., moniliform; blade surface siphons 20-30 μm diam., deeply moniliform, forming loose cortex; stipe central siphons 30-60 μm diam., slightly moniliform; stipe surface siphons 10-20 μm diam., deeply moniliform.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25089* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25145* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25075* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25047* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25179* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25193* (US).



1. Surface cells of segment. 2. Cross section - utricles. 3. Habit of plant.

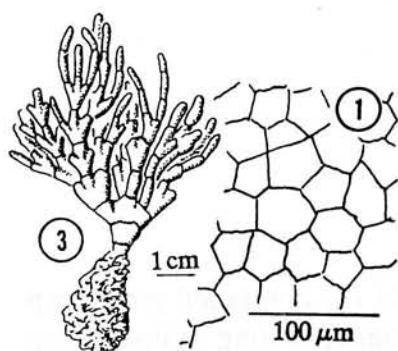
Halimeda incrassata (Ellis) Lamouroux 1812: 186.

Corallina incrassata Ellis 1768: pl. 17, figs. 10-17.

Thallus erect; to 25 cm tall; light to dull green; segments heavily calcified, hard, brittle, disc-like, oval to kidney-shaped, to 14 mm wide, 10 mm long, distinctly ribbed and/or somewhat lobed; basal segments fused; branching somewhat dichotomous, initial branching in one plane; rhizoidal mass bulbous.

Utricles (swollen tips of siphons) in 3-5 layers; surface utricles 34-90(-105) μm diam., 40-125 μm long, 2-4 supported by subsurface utricles; subsurface utricles oval, swollen, 23-90 μm diam., 30-115 μm long; joint siphons uniting as single group; gametangia spherical to oval, bright green, 200-380 μm diam., on dichotomously forked stalk, densely clustered at margins of fertile segments.

Fracture zone specimen: Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25189 (US).



1. Surface cells of segment. 2. Cross section - utricles. 3. Habit of plant.

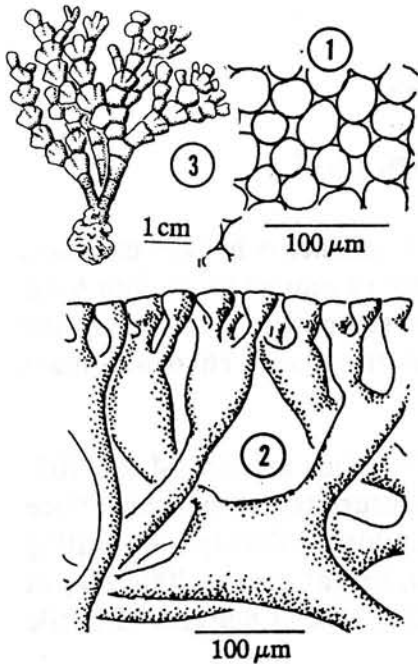
Halimeda monile (Ellis & Solander) Lamouroux 1812: 186.

Corallina monile Ellis & Solander 1786: 110, pl. 20, fig. c.

Thallus erect; to 20 cm tall; dark green; segments calcified, distally cylindrical, elsewhere disc-like or trilobed, 1-5 mm diam., 3-8 mm long; basal segments cylindrical, fused to form stipe; rhizoidal mass bulbous.

Utricles in 3-5 layers; surface utricles 30-60(-80) μm diam., 48-115 μm long, 2-4 supported by subsurface utricles; subsurface utricles 23-90 μm diam., 23-130 μm long; joint siphons uniting in twos, threes, or larger groups.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25098 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25024 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25015 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25188 (US).



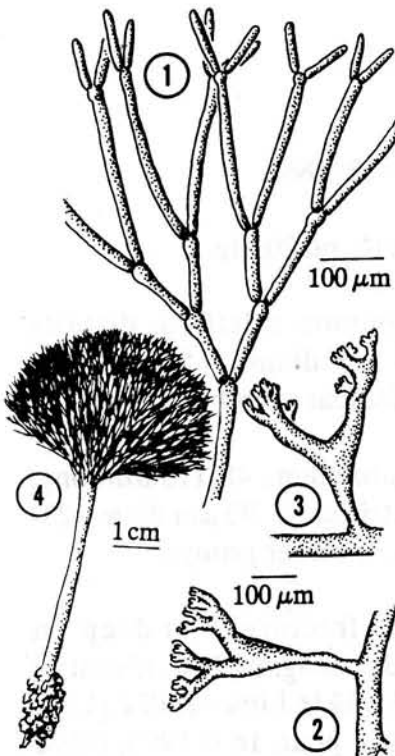
1. Surface cells of segment. 2. Cross section - utricles. 3. Habit of plant

Halimeda simulans Howe 1907: 503, pl. 29.

Thallus erect; to 15 cm tall; light green; segments heavily calcified, hard, disc-like, kidney shaped to oval, trilobed, 4-15 mm wide, 2-11 mm long, distinctly ribbed and/or lobed; basal segment fused, cylindrical, forming short 1-3 segmented stipe; branching somewhat dichotomous, in one plane; rhizoidal mass bulbous.

Utricles in 3-5 layers; surface utricles 25-45(-60) μm diam., 25-90 μm long, rounded triangular, 2-4 supported by subsurface utricles; subsurface utricles variable, swollen, 30-72 μm diam., 30-115 μm long; joint siphons uniting as single group.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25025* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25131* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25112* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25014* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25183* (US).



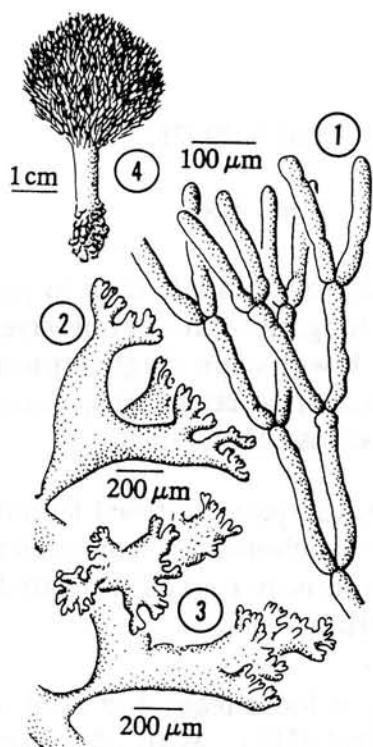
1. Cap siphons. 2 & 3. Lateral appendages of stipe cortex. 4. Habit of plant.

Penicillus capitatus Lamarck 1813: 299.

Thallus bristly, calcified, shaving brush-like; to 18 cm tall; faded green; cap smoothly rounded, spherical to oblong, 2-6 cm diam., as long as broad; cap siphons slender, crowded, dichotomously branched; stipe to 3 mm diam. below, 10 mm diam. above, 14 cm long, seldom branched, surface smoothly corticated; rhizoidal mass bulbous.

Cap siphons 125-300 μm diam., not tapering distally, 2-3 cm long, constricted at all dichotomies, apices slightly swollen; stipe appendages closely set, 4-5 times dichotomous, apices flat, thick.

Fracture zone specimens: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25113* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25007* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25182* (US).



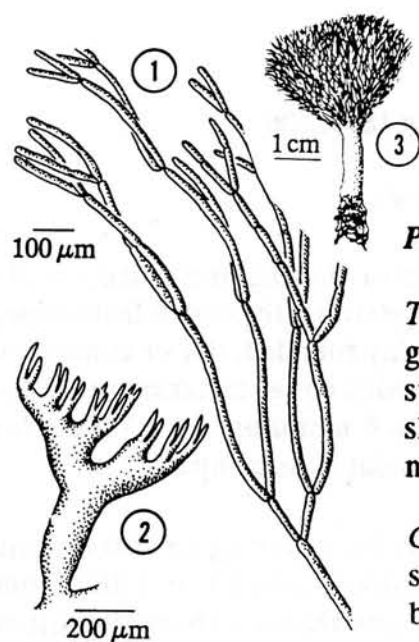
1. Cap siphons. 2 & 3. Lateral appendages of stipe. 4. Habit of plant.

Penicillus lamourouxii Decaisne 1842: 97.

Thallus shaggy, bristly, heavily calcified, shaving brush-like; to 10 cm tall; faded, light green; cap spherical to oval, 2-5 cm diam., as long as broad; cap siphons sparsely scattered, dichotomously branched; stalk unbranched, 5-8 mm diam., 3-4 cm long, often compressed, surface smoothly corticated; rhizoidal mass bulbous.

Cap siphons 300-500 μm diam., stiff, often sporadically moniliform (constrictions at close intervals), constricted above dichotomies; stipe appendages close set, basal branches wide, swollen, dichotomous, apices short, flat.

Fracture zone specimens: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25140* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25077* (US). Wall of central fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25049* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25010* (US).



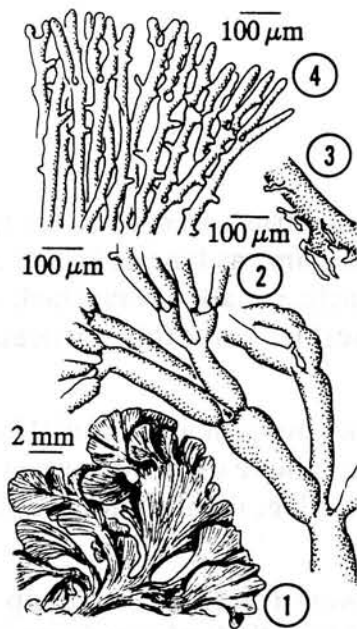
1. Cap siphons. 2. Lateral appendages of stipe cortex. 3. Habit of plant.

Penicillus pyriformis A. Gepp & E.S. Gepp 1905: 1, pl. 468, fig. 1.

Thallus flat topped, heavily calcified, compact, brush-like; to 12 cm tall; gray-green; cap cone shaped, apex flat, sides tapering into stalk; cap siphons stiff, matted or entangled, dichotomously branched; stipe cylindrical or slightly flattened, 5-7 mm diam., 3-10 cm long, rarely branched; rhizoidal mass bulbous.

Cap siphons 150-250 μm diam., 2-3 cm long, constricted above dichotomies; stipe appendages 2-4 times dichotomous, loosely branched, apices tapering, bluntly pointed.

Fracture zone specimen: Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25190* (US).



1. Habit of plant. 2. Basal siphons of blade. 3. Lateral appendages of stipe/rhizome. 4. Blade margin.

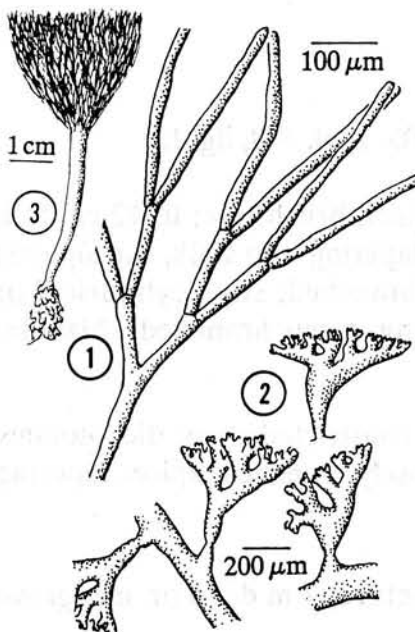
**Rhipiliopsis stri* (Earle & Young) Farghaly & Denizot 1979: 71.

Siphonoclathrus stri Earle & Young 1972: 3, pls. 1-8.

Thallus in ruffled clumps or turf-like, gregarious; to 8 mm tall; dark to pale green; blades fan shaped, flattened, to 5 mm long, net-like, in one layer; upper stipe of several intertwined siphons, lower stipe single siphon, cylindrical, at times rhizome-like, with short contorted lateral projections; contorted projections developing into rhizoids at base of plant.

Blade siphons 40 μm diam. throughout, cylindrical, parallel, fused laterally by short, lateral branchlets, constrictions above dichotomies symmetrical; stipe siphons 40 μm diam.; stipe appendages loosely packed, repeatedly branched; single connecting stipe/rhizome to 70 μm diam.

Fracture zone specimens: Wall of east fracture, as loose mats, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25065* (US). Wall of central fracture, individual or as loose mats, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25054* (US). Wall of west fracture, as loose mats, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25167* (US).



1. Cap siphon. 2. Lateral appendages of stipe cortex. 3. Habit of plant.

**Rhipocephalus oblongus* (Decaisne) Kützing 1849: 506.

Penicillus oblongus Decaisne 1842: 97.

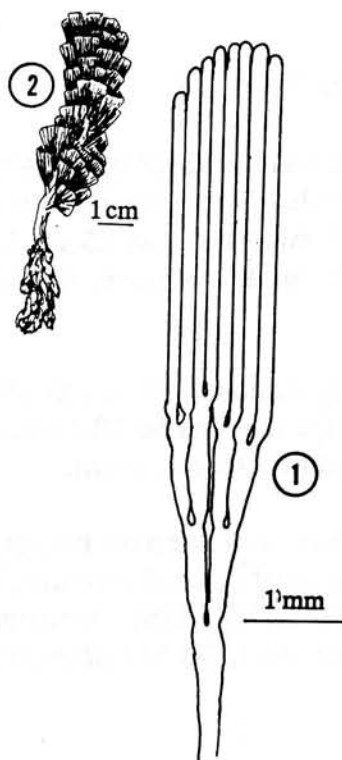
Thallus bristly, lightly calcified, flat-topped or shaving brush-like; to 20 cm tall; dark green; cap cone shaped, lower edge straightly angled from stipe, 1-3 cm diam., to 5.5 cm long; cap apex smoothly rounded, flat or concave; cap siphons slender, free, not fused, dichotomies equal distances from base, symmetrical branching in one plane; stipe 6 mm diam., 4.0-7.5 cm long, penetrating to apex, seldom branched; rhizoidal mass compact.

Cap siphons 200-350 μm diam. proximally, tapering to 160 μm diam. distally, 7-15 mm long; basal segments shorter, lower 1 or 2 dichotomies not constricted; outer segments longer, constrictions above dichotomies symmetrical; stipe appendages 5-7 times divided, apices blunt, finger-like.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25062* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25109* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25002* (US).

Rhipocephalus phoenix (Ellis & Solander) Kützing 1843: 311. [f. *phoenix*]

Corallina phoenix Ellis & Solander 1786: 126, tab. 25, figs. 2, 3.

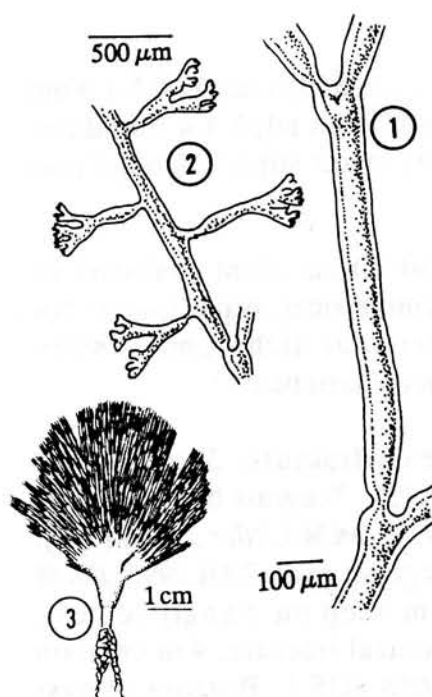


1. Cap siphons. 2. Habit of plant.

Thallus cap cylindrical, lightly calcified; to 10 cm tall; dark green; cap blades concentric, flattened, to 5 cm long, symmetrical, in close proximity to main stalk; blade siphons cylindrical, parallel, fused laterally, dichotomies equal distances from base; stipe cylindrical, corticated, often long; rhizoidal mass compact.

Blade siphons 200-250 μm diam. proximally, 50-100 μm diam. distally, constrictions above dichotomies symmetrical; stipe appendages tightly packed, repeatedly branched, apices blunt, finger-like.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25096 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25037 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25139 (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25074 (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25046 (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25177 (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25121 (US). Bottom of central fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25003 (US).



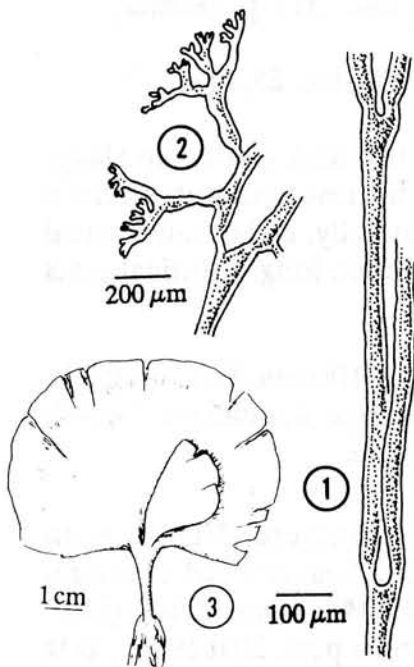
1. Blade siphon. 2. Stipe siphon with lateral appendages. 3. Habit of plant.

Udotea abbottiorum D.S. Littler & M.M. Littler 1990: 210, fig. 1.

Thallus narrowly fan shaped, calcified; to 15 cm tall; yellow-green, growing margin often darker green; blade to 5 cm wide, 8 cm long, 1-3 mm thick; cortex absent; zonation obscure with age; stipe cylindrical, flattened above, gradually widening into blade; rhizoidal mass bulbous, entangled.

Blade siphons lacking lateral appendages, 90-110 μm diam., constrictions above dichotomies symmetrical; stipe siphons 70-100 μm diam.; stipe appendages repeatedly dichotomous, apices flattened in lower stipe, swollen in upper stipe.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25091 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25142 (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25068 (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25178 (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25115 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25198 (US).



1. Blade siphon. 2. Stipe siphon with lateral appendages. 3. Habit of plant.

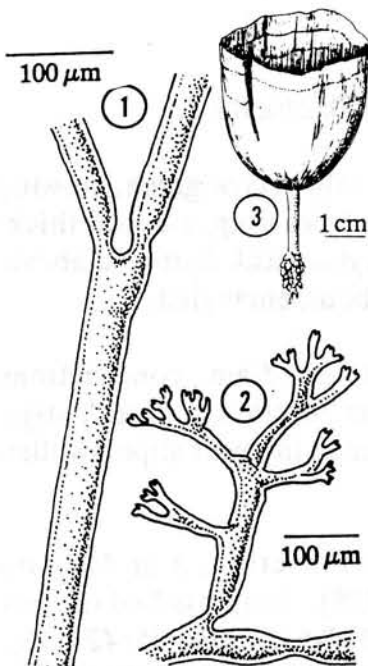
Udotea caribaea D.S. Littler & M.M. Littler 1990: 211, fig. 2.

Thallus widely fan shaped, heavily calcified; to 9 cm tall; yellow or white-green, ash-white when dried; blade to 10 cm wide, 7 cm long, 0.5-1.0 mm thick; cortex absent; zonation obscure; stipe 2-5 mm diam., to 2.5 cm long, no clear demarcation between stipe and blade surface texture; rhizoidal mass bulbous, entangled.

Blade siphons lacking lateral appendages, tightly compact, 30-50 μm diam., constrictions above dichotomies symmetrical; stipe siphons 60-80 μm diam.; stipe appendages repeatedly branched, apices stubby, digitate, blunt.

Fracture zone specimens: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25107 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25102 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25195 (US).

Udotea cyathiformis Decaisne 1842: 106.

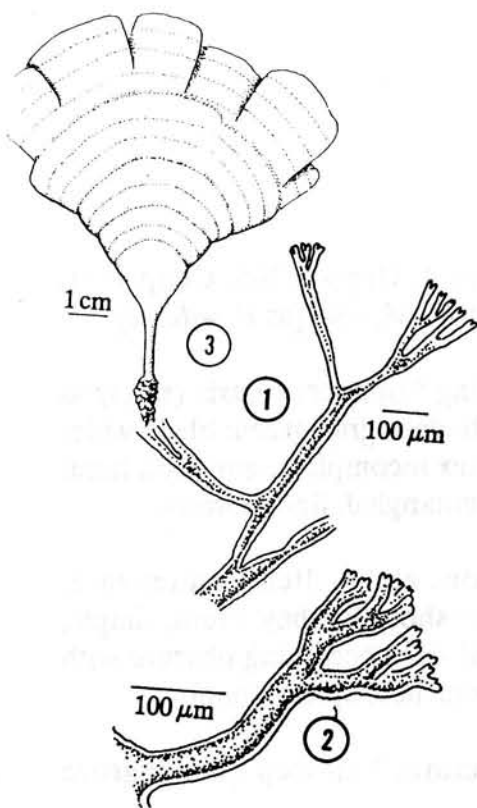


1. Blade siphon. 2. Stipe siphon with lateral appendages. 3. Habit of plant.

Thallus cup-shaped, calcified; to 8 cm tall; green; blade delicate, 0.5-1.0 mm thick, fibrous to papery; cortex absent; zonation faint; stipe 1-4 mm diam., 0.3-2.0 cm long, sharp demarcation where blade meets stipe; rhizoidal mass fibrous.

Blade siphons lacking lateral appendages, 30-70 μm diam., parallel to interwoven, constrictions above dichotomies symmetrical; stipe siphons 50-120 μm diam., generally unequally constricted at dichotomies; stipe appendages repeatedly branched, apices swollen or flattened.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25092 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25036 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25141 (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25067 (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25058 (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25120 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25011 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25196 (US).



1. Blade siphon with lateral appendages. 2. Blade lateral appendage. 3. Habit of plant.

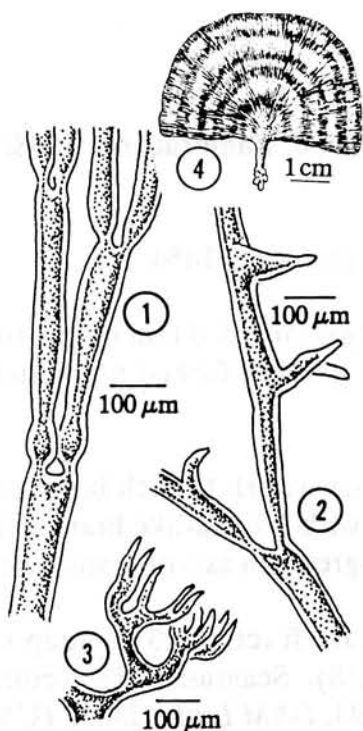
Udotea flabellum (Ellis & Solander) Howe 1904: 94.

Corallina flabellum Ellis & Solander 1786: 124, pl. 24.

Thallus fan shaped, moderately calcified, solitary; to 30 cm tall; dark green to pale green; blade variable, undivided to highly divided, size variable, 0.8-1.5 mm thick, leathery, corticated; zonation distinct; no variations between stipe and blade surface; stipe unbranched, 5-7 mm diam., 2 cm long, cylindrical below, flattened above; rhizoidal mass bulbous to elongated.

Blade siphons 30-50 μm diam., constrictions above infrequent dichotomies absent or slightly asymmetrical; lateral appendages irregularly spaced, long stemmed, dichotomously branched, apices crowded, short, rounded, when dried shrunken or flat; stipe siphons 20-80 μm diam.; stipe appendages similar to blade.

Fracture zone specimens: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25114 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25008 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25197 (US).



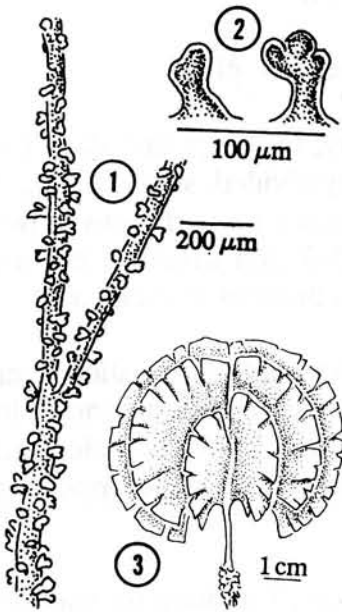
1. Blade siphon. 2. Siphon near base of blade. 3. Stipe lateral appendage. 4. Habit of plant.

Udotea luna D.S. Littler & M.M. Littler 1990: 232, fig. 16.

Thallus fan-shaped to half-moon-shaped, lightly calcified; to 7 cm tall; dark green when young, light green when old; blade broader (6 cm) than long (4 cm), to 1 mm thick; cortex absent; zonation faint; texture velvety when young; margins ragged, often torn or fluted (overlapping one another); base flat to lobed; stipe 1-2 mm diam., 5 mm tall, gradual transition of surface texture from smooth stipe to fibrous blade; rhizoidal mass small, entangled.

Blade siphons lacking lateral appendages, 50-80 μm diam., deep symmetrical constrictions above dichotomies; basal blade siphons possess abbreviated lateral appendages; appendages increasing in density toward stipe; stipe siphons 60-90 μm diam., constrictions at dichotomies slightly uneven; stipe appendages repeatedly branched, apices pointed.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25090 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25143 (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25069 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25009 (US).



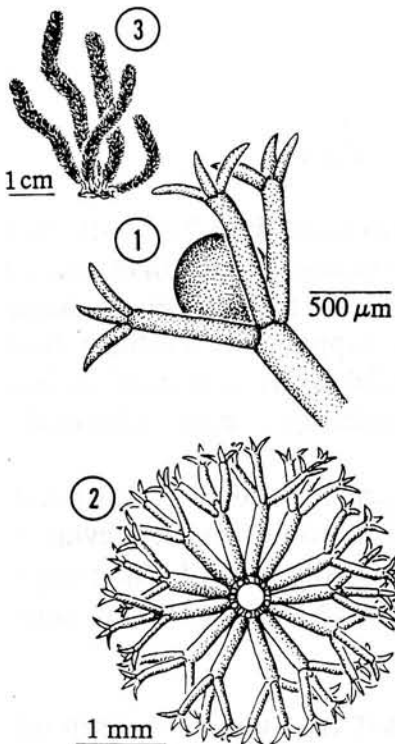
1. Blade siphons. 2. Lateral appendages of blade. 3. Habit of plant.

Udotea wilsonii A. Gepp, E.S. Gepp & Howe in A. Gepp & E.S. Gepp 1911: 130-131, 144, pl. VII, fig. 66; pl. VIII, figs. 67, 67a, 68, 68a. [as *U. wilsoni*]

Thallus of multiple fan shaped blades radiating from central axis (rarely as single flat blade), lightly calcified; to 13 cm tall; dark gray-green; blade wider (10 cm) than long (8 cm), thin (1-2 mm); cortex incomplete; zonation faint; stipe 1-2 mm diam., 1-2(-4) cm long; rhizoids entangled, fine, fibrous.

Blade siphons 40-80 μm diam., constrictions above dichotomies rare, asymmetrical when present; lateral appendages short, knobby, blunt, simple, or forked, 25-90(-120) μm long, in 2-4 vertical rows becoming obscure with age; stipe appendages short, dichotomously branched, apices knobby.

Fracture zone specimen: Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25118* (US).



1. Cross section at whorl of branchlets. 2. Fertile branchlet with solitary, spherical sporangia. 3. Habit of plant.

Dasycladaceae, Dasycladales

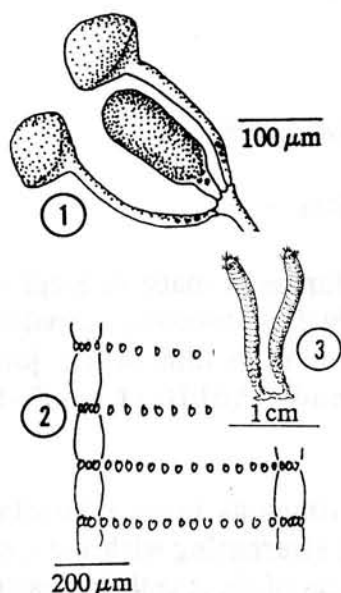
**Dasycladus vermicularis* (Scopoli) Krasser in Beck & Zahlbruckner 1898: 5, fig. 8.

Spongia vermicularis Scopoli 1772: 412, pl. 64, fig. 1454.

Thallus fuzzy, soft, individuals cylindrical, gregarious; 5-8 mm diam., to 6 cm tall; green; main axis whorled with tightly packed, forked branchlets; stipe short, naked; holdfast of short lobes.

Branches in whorls from central axis, 10-15 per whorl; branch basal cell large, capped with 3-4 branchlets, these capped with 3 spine-like branchlets; sporangia 1 per branch, spherical, bright yellow-green, in axis of branchlets.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25100* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25032* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25137* (US).



Neomeris annulata Dickie 1874: 198.

Thallus solitary or in dense clusters, cylindrical, erect, or arched downward; 1-3 mm diam., 1-2(-3) cm tall; base white, heavily calcified; apex fuzzy green, tufted with apical filaments; surface of polyhedral cells in annular rows; holdfast small, pad-like.

Central axis to 640 μm diam.; apical filaments unbranched, deciduous, fine; branchlets in whorls from central axis, terminating in 2 surface cells flanking sporangia; surface cells with bulbous apex, 80-135 μm diam.; sporangia elongated oval, stalked; spores oval, 46-80 μm diam., 115-175 μm long, at maturity fusing in heavily calcified sets of 5-8(-12); holdfast short, contorted siphons.

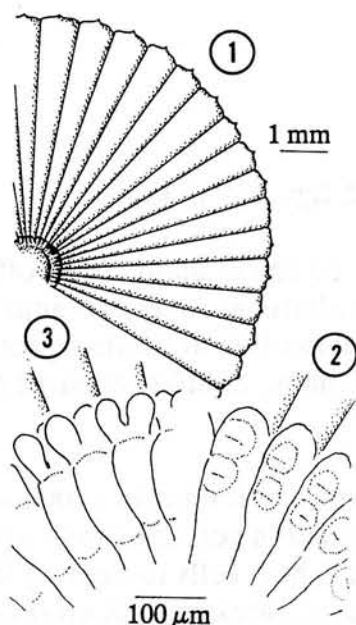
1. Sporangia flanked by surface cells. 2. Longitudinal section of central axis showing small scars where whorled branchlets were attached. 3. Habit of plant.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, specimen lost after identification.

Polyphysaceae, Dasycladales

Acetabularia crenulata Lamouroux 1816: 249, tab. viii, fig. 1.

Thallus solitary or in clusters, parasol shaped, moderately calcified; 2-8 cm tall; white-green; discs one or more, flat or cup shaped, 12-20 mm diam.; stalk slender; holdfast small, pad-like.



Disc of 30-80 rays, evenly tapered, oval in cross section; outer margin of ray with centered tooth or spine; corona superior (at base of rays) of short inconspicuous projections, apices rounded or slightly lobed, with 2 exceedingly faint hair scars; corona inferior (under side, base of ray) of short inconspicuous projections, apices forked; mature rays forming sporangia; aplanospores 65-80 μm diam., to 500 per ray.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25093 (US)*, *D&M Littler 25094 (US)*. Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25021 (US)*, *D&M Littler 25022 (US)*. Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25129 (US)*. Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25053 (US)*. Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25173 (US)*. Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25124 (US)*. Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25012 (US)*. Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25191 (US)*.

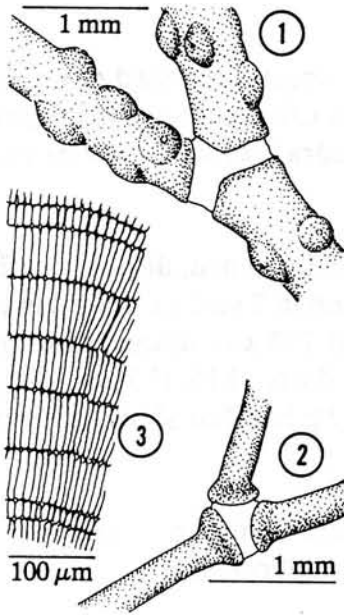
1. Disk of rays. 2. Corona superior with 2 hair scars. 3. Corona inferior with lobed apices.

RHODOPHYTA

Corallinaceae, Corallinales

Amphiroa fragilissima (Linnaeus) Lamouroux 1816: 298.

Corallina fragilissima Linnaeus 1758: 806.

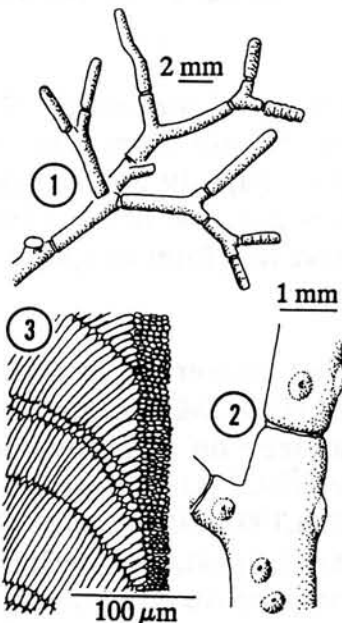


1. Mature branch with hemispherical conceptacles.
2. Immature branch - note swollen segment ends.
3. Longitudinal section showing one alternating short to five long cells.

Thallus entangled, fragile, calcareous, dense clumps or mats; to 8 cm thick; yellow-green to white-pink; branching widely dichotomous, occasionally trichotomous, primarily at uncalcified joints; branches thin, brittle, jointed, cylindrical, often swollen at segment ends; holdfast crust-like, inconspicuous.

Lower segments 150-600 μm diam., 8-20 times as long; medulla 4-8 transverse rows of long cells (55-90 μm long) alternating with 1-2 rows of short cells (15-35 μm long); surface several layers of short cells increasing in thickness with age; joint structure similar; conceptacles lateral on calcified segments, hemispherical, 300-340 μm diam. with terminal pore; tetrasporangia 25 μm diam., 50 μm long.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 250095* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25020* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25130* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25076* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25052* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25165* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25123* (US).



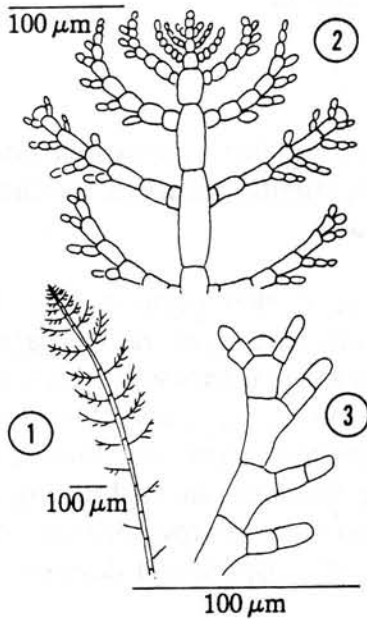
1. Branch showing joints generally not at forks.
2. Mature branch with raised conceptacles.
3. Longitudinal section showing one alternating short to two long cells and smaller surface cells.

Amphiroa rigida var. *antillana* Børgesen 1917: 182, figs. 171-173.

Thallus open, brittle, heavily calcified clumps; 10-15 cm diam.; light off-white; branching widely dichotomous, joints seldom at forks; branches unequal in length, cylindrical, 1-2 mm diam., not swollen at joints; apices tapered slightly or bluntly rounded, 0.5-1.5 mm diam.; holdfast crust-like, inconspicuous.

Medulla cells alternating between 2 transverse rows of long cells (100 μm long) with 1 row of short cells (20 μm long), aligned in vertical rows - not offset, with blunt apices; surface several layers of short cells increasing in thickness with age; joint cells in 2 transverse sets, thick walled, aligned obliquely - offset, with joining apices pointed; conceptacles lateral, convex, to 250 μm diam. with terminal pore.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25151* (US).



1. Habit of plant. 2. Apex showing ultimate branchlets unilateral on lower side of branch, eventually becoming opposite. 3. Terminal gland cell on lateral branch.

Ceramiaceae, Ceramiales

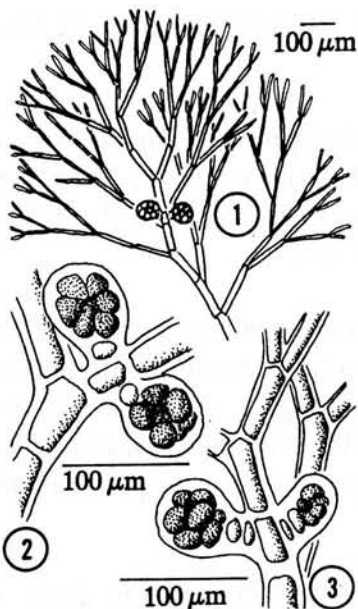
**Acrothamnion butleriae* (Collins) Kylin 1956: 375.

Antithamnion butleriae Collins 1901: 258.

Thallus fine, delicate, filamentous; to 1 cm tall; translucent, pale red; main branching sparse, irregular; lateral branchlets at first regularly alternate, becoming symmetrically opposite; rhizoids fine, inconspicuous.

Prostrate filaments to 30 μm diam., 100-150 mm long; erect filaments to 30 μm diam., 120 μm long; branchlets proximally forming at point one third along axial cell, distally forming above upper two thirds or higher on axial cell; ultimate branchlets initially unilateral on lower side of branch, soon becoming opposite; gland cells, when present, terminal on lateral branches.

Fracture zone specimens: Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25059* (US). Bottom of east fracture, 7 m deep, epiphytic on larger algae or *Thalassia testudinum*, 16.ii.1993, *D&M Littler 25125* (US).



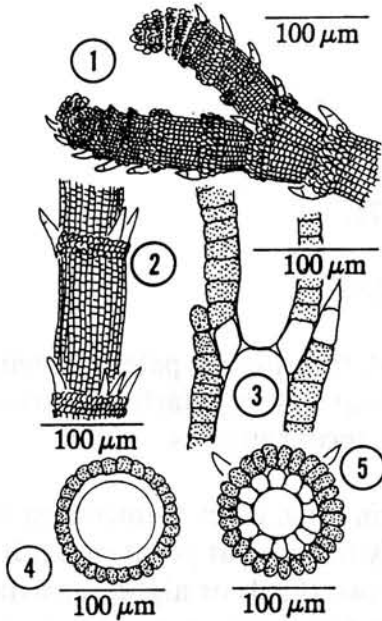
1. Habit of plant. 2 & 3. Paired, opposite gonimoblast masses with dark carpospores.

Callithamnion halliae Collins in Collins, Holden, & Setchell 1900: 698.

Thallus filamentous, small, bushy; to 2(-5) cm tall; pale pink; branching alternately spiral proximally, dichotomous distally; rhizoids branched, fine.

Main axis cells to 100(-200) μm diam., 250-600 μm long, tapering distally; apical cells slender, to 6 μm diam., 50 μm long, tips rounded, uncorticated throughout; tetrasporangia pear-shaped, sessile; spermatangial clusters tufted, colorless, on upper side near base of branchlet; gonimoblast masses opposite, at base of branch, to 75 μm diam., dividing into 6-10 darkly pigmented carpospores; gonimoblast stalk short, inconspicuous, of 1-2 cells.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep, epiphytic on larger algae or *Thalassia testudinum*, 20.ii.1993, *D&M Littler 25154* (US).



1. Branch apex - note incurved apices.
2. Branch with heavily corticated, spined joints.
3. Longitudinal section of joint.
4. Cross section of segment.
5. Cross section of joint.

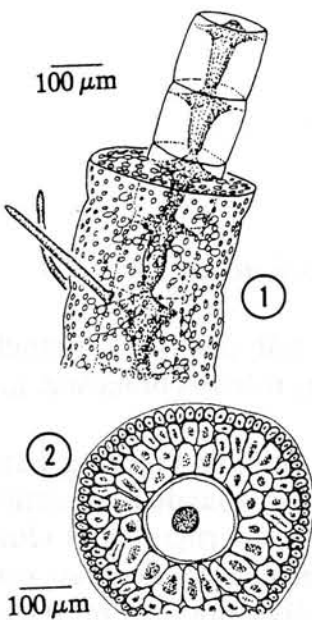
Centroceras clavulatum (C. Agardh) Montagne 1846: 140.

Ceramium clavulatum C. Agardh 1822b: 2.

Thallus filamentous, stiff, entangled; to 20 cm long; dark brown-maroon; branching narrowly dichotomous; apices forked, slightly incurved, pincher-like; rhizoids filamentous, terminating in lobed disc.

Branches 50-200 μm diam., heavily pigmented, darker pigmentation at joints; central filament corticated; surface cells in 1 layer, rectangular, longitudinally aligned; segments 300-500 μm long; joints whorled with spines, 2 layers of corticating cells; spines deciduous or worn away with age; sporangia oval to spherical, tetrahedral, occasionally cruciate, 45-50 μm diam., 50-63 μm long, thick walled, enveloping filaments short, forming at joints; spermatangia in terminal clusters; procarps (cargogonium and auxiliary cell system) formed laterally at joints; carposporangia developing from gonimoblast cells.

Fracture zone specimens: Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25175 (US).



1. Strand structure - inner core filament surrounded by smaller cells.
2. Cross section.

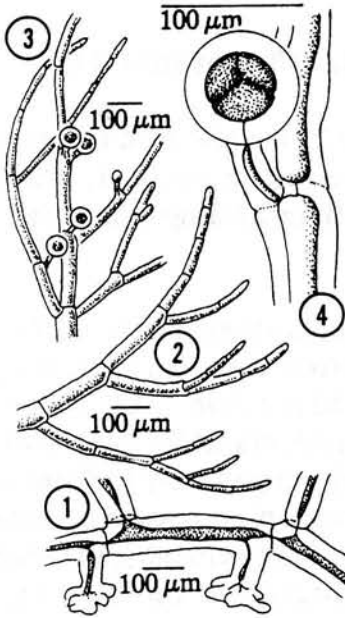
Ceramium nitens (C. Agardh) J. Agardh 1851 [1851-1863]: 130.

Ceramium rubrum (Hudson) C. Agardh var. *nitens* C. Agardh 1824: 136.

Thallus stiff firm strands (occasionally soft and slippery) forming tufts or small entangled clumps; to 10 cm tall; bright rust or rose; branching dichotomous to alternate, widely spreading; apices often secund (branching on outer side only), incurved; rhizoidal mats turf-like.

Strands 130-430 μm diam., central filament cells 2-3 times as long as broad; corticating cells darkly pigmented, obscuring banding characteristic in most *Ceramium*; hairs short (to 1 mm long), straight, often at joints; tetrasporangia random, embedded in surface cells, cruciate (divided in two planes at right angles to one another); cystocarps lateral on upper branches with 3 enveloping filaments.

Fracture zone specimen: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25082 (US).



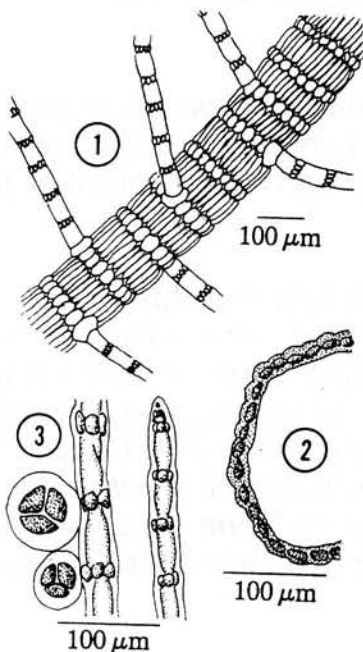
1. Rhizome with unbranched rhizoids. 2. Branch apices with unilateral branchlets. 3. Branch with tetraspores. 4. Tetraspore on unicellular stalk.

**Spermothamnion gymnocarpum* Howe 1920: 579.

Thallus tufted, small, bushy, filamentous; to 3 cm tall; purple-pink; branching dichotomous below, soon becoming opposite, distally unilateral; rhizome conspicuous, filamentous; rhizoids unbranched, terminating in attachment pad.

Main axis erect, filament cells 50-115 μm diam., 300-375 μm long, walls 5-40 μm thick, distally tapering to 12-20 μm diam.; rhizome cells 50-130 μm diam., 130-400 μm long, walls 13-50 μm thick, uncorticated throughout; tetrasporangia solitary or in groups of 2-5 near joint, 60-80 μm diam., on unicellular stalk; spermatangial clusters oval to spherical, 26-40 μm diam., 40-80 μm long; cystocarp solitary or in small groups, hemispherical, 80-150 μm diam.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep, epiphytic on larger algae or *Thalassia testudinum*, 16.ii.1993, D&M Littler 25041 (US). Seagrass bed of west fracture, 3 m deep, epiphytic on larger algae or *Thalassia testudinum*, 20.ii.1993, D&M Littler 25149 (US). Bottom of east fracture, 7 m deep, epiphytic on larger algae or *Thalassia testudinum*, 16.ii.1993, D&M Littler 25126 (US).



1. Main axis with branchlets somewhat radially arranged. 2. Cross section of main branch. 3. Branchlet with tetraspores forming at joints and branchlet apex.

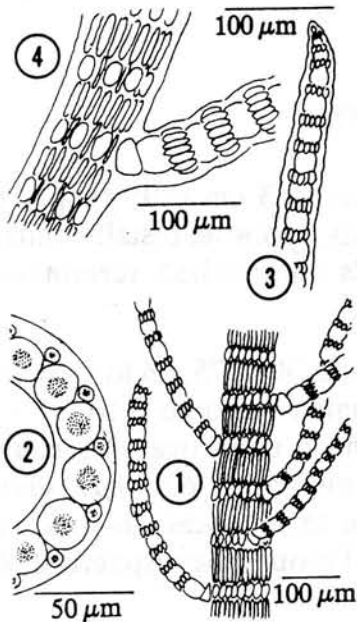
Spyridia filamentosa (Wulfen) Harvey 1833: 337.

Fucus filamentosus Wulfen 1803: 64.

Thallus filamentous, fuzzy, bush-like; to 20 cm tall; dull, pale pink; branching alternate; branchlets numerous, delicate, deciduous, unbranched, banded; holdfast small, disc-like.

Main axis 1-2 mm diam., central cell large, in single chain; surface cells in 1 layer, alternating zones of long narrow cells (6-10 μm diam., 50-70 μm long) and short wide cells (15-20 μm diam., 30-40 μm long; half as long, twice as wide); zones becoming obscure with age; branchlets radial, highly variable, 20-45 μm diam., 0.5-1.5 mm long; branchlet segments 40-100 μm long, uncorticated, apex pointed, spine-like; branchlet joints corticated; tetrasporangia spherical, sessile, 40-70 μm diam. at branchlet joint; spermatangia to 5 μm diam., blanketing lower third of branchlet; cystocarps terminal on short branches.

Fracture zone specimens: Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25045 (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, D&M Littler 25006 (US).



1. Main axis with radial branchlets. 2. Cross section. 3. Branchlet apex. 4. Axis with branch showing corticating cell arrangement.

Spyridia hypnoides (Bory) Papenfuss 1968: 281.

Thamnophora hypnoides Bory de Saint-Vincent 1834: 175.

Thallus fuzzy, filamentous, densely bushy; to 25 cm tall; rose-red; branching alternate in all directions; branch apices often hooked; branchlets numerous, delicate, deciduous, banded, radially arranged; holdfast small, inconspicuous.

Main axis 1-2 mm diam., central cells large, in single chain; surface cells small, initially alternating between long narrow cells and short wide cells, eventually in several layers; branchlets 30-50 μm diam., 0.3-2.0 mm long; branchlet segment 40-100 μm long, uncorticated; branchlet joints corticated, cells initially elongated, eventually splitting transversely to form smaller cells; apex pointed, occasionally with recurved spine; sporangia spherical, sessile, 50-85 μm diam., at joints, solitary or 2-5 in clusters; spermatangia expanding from joints; carposporophytes terminal on short branches surrounded by incurved filaments.

Fracture zone specimen: Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, D&M Littler 25174 (US).

Dasyaceae, Ceramiales

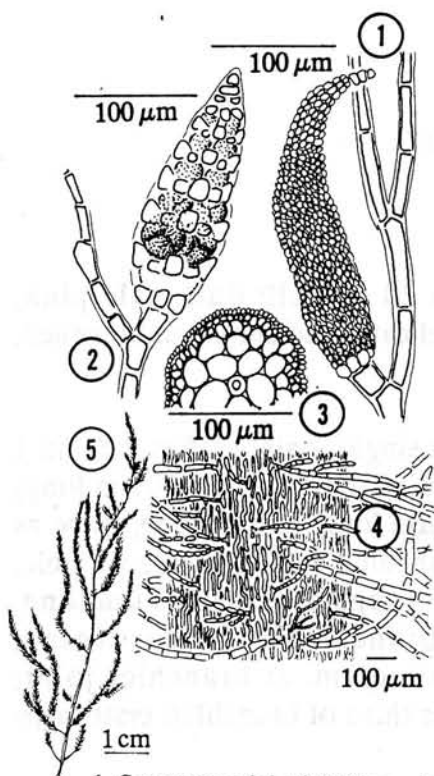
**Dasya baillouviana* (Gmelin) Montagne 1841 [1839-1842]: 165.

Fucus baillouviana Gmelin 1768: 165.

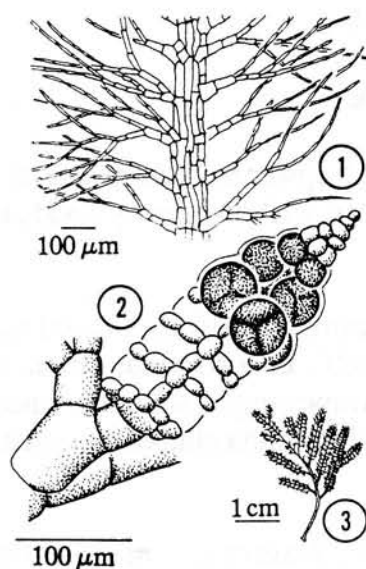
Thallus erect or undulating, delicate, fluffy, soft; to 90 cm tall; bright-red to rose; branching alternate, generally sparse; branches slippery, slimy, long, graceful, densely covered by fine branchlets, base often denuded; holdfast small, inconspicuous, disc-like.

Main branches 2-3(-6) mm diam., corticated; branchlets filamentous, 2-7(-14) mm long, 3 times dichotomous, basal cells 10-40 μm diam., 20-50 μm long, tapering distally, apical cells 5-12 μm diam., to 200 μm long; tetrasporic plants sparser, paler; tetrasporangial stichidia (specialized reproductive branch) lance shaped, 80-160 μm diam., 0.60-1.25 mm long; tetrasporangia spherical, 40-80 μm diam.; spermatangial plants dense, deep red; spermatangial stichidia also lance shaped, 60-75 μm diam., 200-600 μm long; cystocarps single, occasionally 2-3, near tip of branchlets, urn shaped, 1.1 mm diam., neck 100-200 μm diam.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25083 (US), D&M Littler 25085 (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25019 (US), D&M Littler 29031 (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, D&M Littler 25127 (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, D&M Littler 25192 (US).



1. Spermatangial stichidium. 2. Tetrasporangial stichidium. 3. Cross section of branch. 4. Main axis with lateral branchlets. 5. Habit of plant.



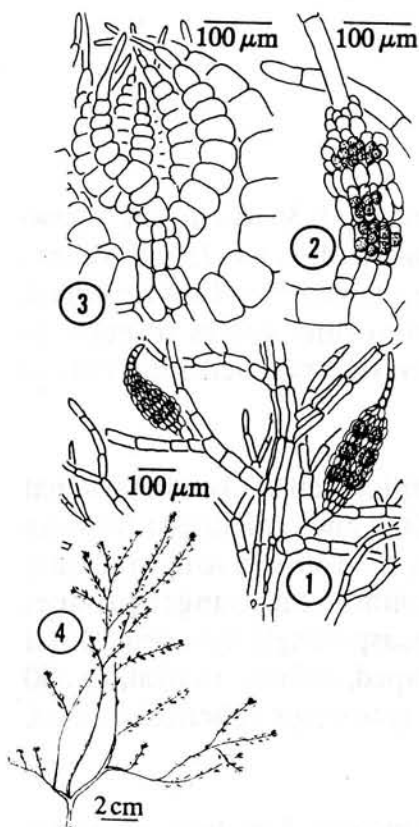
1. Axis with spirally arranged branchlets. 2. Tetrasporangial stichidium. 3. Habit of plant.

**Dasya mollis* Harvey 1853: 62.

Thallus delicate, fine, bush-like; to 4(-15) cm tall; pale rose; branching irregular, no main axis apparent; branchlets filamentous, covering all branches; holdfast inconspicuous, disc-like.

Branches 1 mm diam., tapering distally, corticated; branchlets slender, limp, to 1 mm long, dichotomously dividing, whorled at close intervals, whorls obscured with age; branchlet cells 50 μm diam., 60 μm long at base, tapering to 6 μm diam., 90 μm long; tetrasporangial stichidia 135 μm diam., to 300 μm long, near base of branchlet; tetraspores spherical, to 50 μm diam.

Fracture zone specimen: Seagrass bed of central fracture, 3 m deep on shell fragment, 16.ii.1993, *D&M Littler 25034* (US).



1. Axis with tetrasporangial stichidium. 2. Spermatangial stichidium. 3. Apex with short swollen cells. 4. Habit of plant.

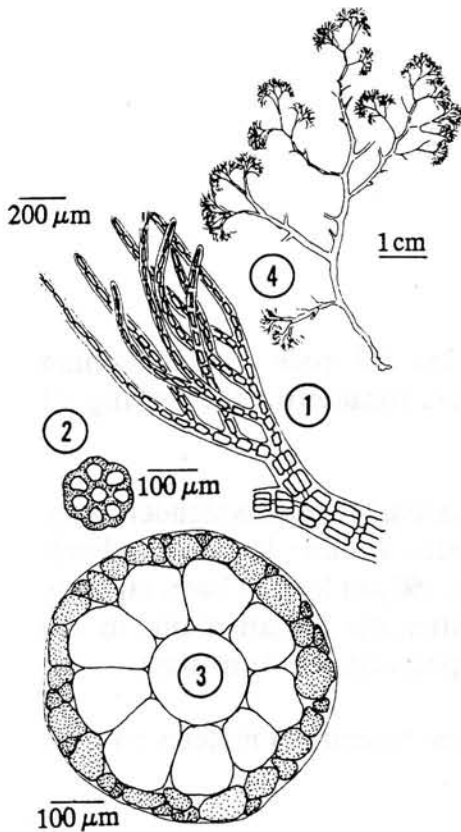
Dasya rigidula (Kützing) Ardissonne 1878: 140.

Eupogonium rigidulum Kützing 1843: 415.

Thallus delicate, fluffy, soft; 1-2(-8) cm tall; rose to purple-red; branching irregular, generally sparse; branchlets spirally arranged, to 5 mm long, branching dichotomous, distally incurved, densely tufted at branch apex; holdfast small, inconspicuous, fibrous, secondarily attached by adventitious rhizoids.

Main axis 300-500 μm diam., uncorticated, occasionally corticated proximally or as small strands at branch base; branchlets uncorticated, basal cells to 140 μm diam., 1 diameter long, tapering distally, apical cells 10 μm diam., 10 diameters long, apices sharply pointed; tetrasporangial stichidia forming at lower branchlets, 120-170 μm diam., to 400 μm long, often with long terminal point, sessile or on 1-3 celled stalk; tetrasporangia spherical, 20-50 μm diam.; spermatangial stichidia similar in shape and position, to 100 μm diam., 300 μm long.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25148* (US).



1. Branchlet with ultimate filamentous apices. 2. Cross section of branchlet. 3. Cross section of main axis. 4. Habit of plant.

**Heterosiphonia gibbesii* (Harvey) Falkenberg 1901: 653.

Dasya gibbesii Harvey 1853: 59, pl. XV, A.

Thallus soft, fluffy; to 20 cm tall; bright pink-red; lower branching sparse, alternate; branchlets absent near base, dense above, dichotomously divided, apices delicate, minute; holdfast small, disc-like.

Main axis to 1.5 mm diam., of 6-9 or more pericentral cells; corticated on older axes; branchlets tapering, of 6 pericentral cells, uncorticated; ultimate branchlets single filaments, to 30 μm diam.; tetrasporangial stichidia lance shaped, replacing lower branchlets; spermatangial stichidia similar, pointed; cystogonium near base of branchlets.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25101* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25023* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25144* (US).

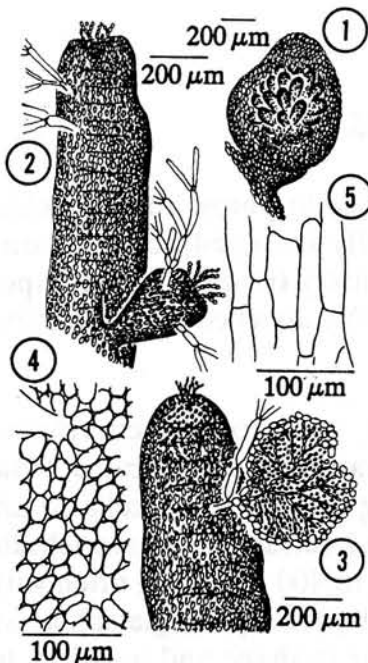
Rhodomelaceae, Ceramiales

**Chondria collinsiana* Howe 1920: 568.

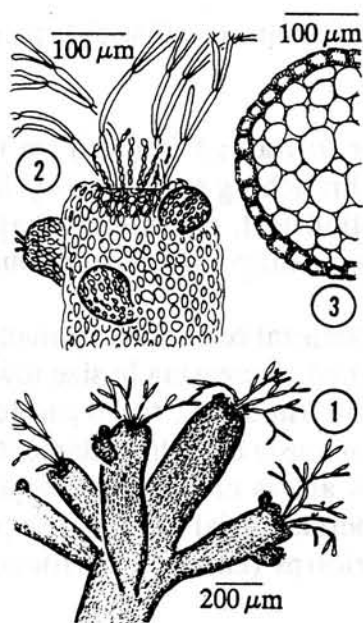
Thallus soft, sparse, erect, solitary or gregarious; 1-3(-8) cm tall; straw-yellow to pink; main axis well-defined, cylindrical, 0.4-0.75 mm diam.; branching sparse, irregular; branchlets sparse, short, irregularly arranged, pinched at base, cone-shaped, unbranched; branchlet apices truncate to slightly rounded, tufted with fine, dichotomously branched filaments in terminal depression; holdfast small, disc-like.

Branchlets 250-450 μm diam., to 4.5 mm long; apical cell sunken in terminal depression; pericentral cells 5-6, large, rounded, ends thickened forming faint banding; surface cells 26-40 μm wide, 65-160 μm long, roundly rectangular, elongating with age, scar cells common on younger surfaces (resulting from deciduous apical filaments); tetrasporangia spherical, distal on outer branchlets; spermatangial sori disc shaped, circular to oval, to 500 μm diam., forming at base of apical filaments; cystocarps spherical to oval, to 700 μm diam., 800 μm long, on short stalk.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep, epiphytic on *Thalassia testudinum*, 20.ii.1993, *D&M Littler 25156* (US).



1. Cystocarp. 2. Branch apex. 3. Branch apex with spermatangial sori. 4. Immature surface cells with surface scars. 5. Elongated mature surface cells.



1. Branch apex. 2. Branchlet apex with tufted filaments arising from terminal depression. 3. Cross section of axis.

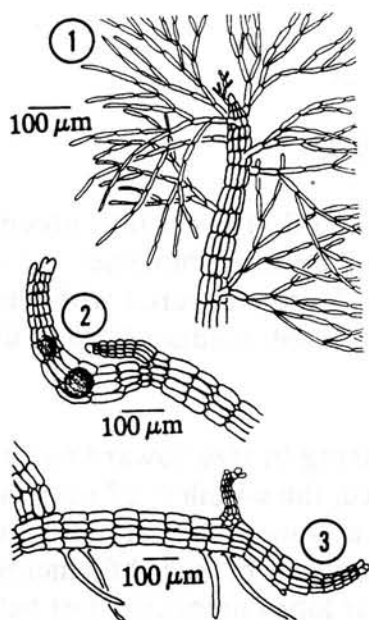
**Chondria dasyphylla* (Woodward) C. Agardh 1817: xviii.

Fucus dasyphyllus Woodward 1794: 239: pl. 23, figs. 1-3.

Thallus soft, sparsely bushy; 5-10(-30) cm tall; light yellow-brown to dark rose-red; main branching irregular; branches cylindrical, 1.0-1.5 mm diam. proximally, thinner distally; branchlets numerous, short, alternate, opposite or spirally arranged, constricted at base, cone shaped, unbranched; apices tufted with fine dichotomously branched filaments in terminal depression; holdfast small, disc-like.

Branchlets cylindrical, 200-600 μm diam, to 2-3(-10) mm long; apical cell sunken in terminal depression; pericentral cells 4-6, large, rounded; surface cells small, rounded; tetrasporangia spherical, 40-170 μm diam., near branchlet apices; spermatangial sori oval, 400-600 μm diam., developed on basal cell of apical filaments; cystocarps spherical to oval, to 1 mm diam., 700 μm long, near branchlet apices.

Fracture zone specimen: Seagrass bed of west fracture, 3 m deep, epiphytic on *Thalassia testudinum*, 20.ii.1993, D&M Littler 25157 (US).



1. Branch apex with dichotomously branched filaments. 2. Tetrasporic branch. 3. Prostrate filament.

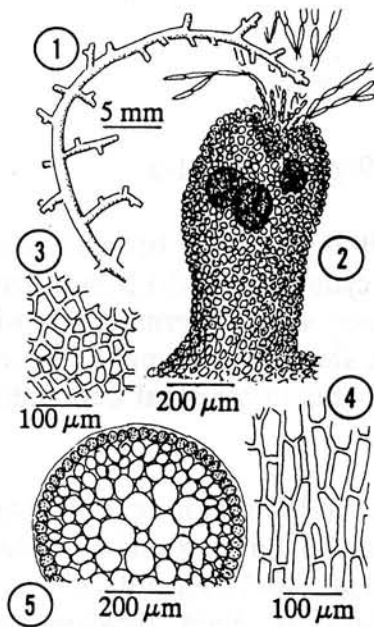
Herposiphonia secunda (C. Agardh) Ambronn 1880: 197.

Hutchinsia secunda C. Agardh 1824: 149.

Thallus prostrate, entangled, finely fibrous mats tightly adhering to substratum; of indeterminate size; red-brown when subtidal, yellow-brown when intertidal; prostrate branching irregularly alternate, apices upcurved; branchlets short, inconspicuous, unbranched; apex tufted; rhizoids single (seldom 2-3) celled, occasionally with finger-like, branched apices.

Prostrate axes 75-150 μm diam., of 7-9 pericentral cells, bearing single upright every 5-6 joints; erect branchlets 60-125 μm diam., 1-2 mm tall, segments as long, 4-9 pericentral cells, unbranched; apical filaments deciduous, dichotomously branched; tetraspores uniseriate (straight series) near branch apex, to 75 μm diam.; pericarps near branchlet apex, solitary.

Fracture zone specimen: Seagrass bed of central fracture, 3 m deep, epiphytic on larger algae or seagrass, 16.ii.1993, D&M Littler 25038 (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, D&M Littler 25081 (US).



1. Habit of plant. 2. Branchlet apex with tufted filaments arising from terminal depression. 3. Immature surface cells. 4. Elongated mature surface cells. 5. Cross section of main axis.

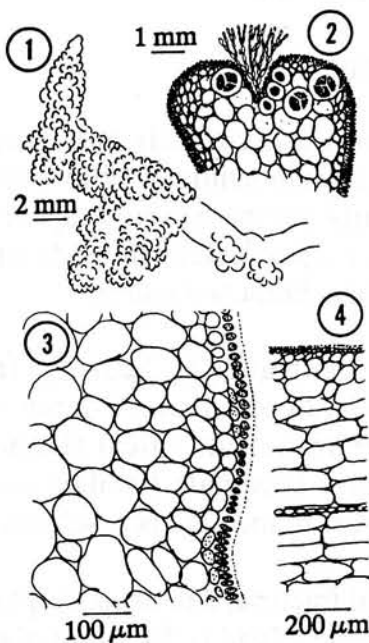
Laurencia implicata J. Agardh 1852 [1852-1863]: 745.

Conspecific with *Laurencia intricata* Lamouroux 1813: 131, plate 9 (figures 8 and 9) - see Silva et al. 1987: 66.

Thallus fleshy, gregarious, in loose mats or solitary; 5-10(-25) cm tall; yellow-green, stubby branchlets often rose; branching sparse, irregularly alternate; branchlets 0.5-0.75 mm diam., cylindrical, rarely club shaped, irregularly alternate, occasionally opposite; apices tufted; holdfast fibrous.

Apical cell sunken in terminal depression; pericentral cells 4, occasionally 6; branch central cells large, colorless, thin walled, decreasing in size toward surface; surface cells deeply pigmented, 40-50 µm diam., to 70 µm long; apices tufted with inconspicuous, fine, dichotomously branched filaments in terminal depression; tetrasporangia just below apices of branchlet, beneath surface cells, forming minute raised areas; spermatangial clusters in apical depression, small, oval, or barrel shaped; pericarps (envelope surrounding cystocarp) partly embedded.

Fracture zone specimen: Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25033* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25150* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25172* (US).



1. Habit of plant. 2. Branchlet apex with tuft of dichotomously divided filaments in apical depression. 3. Cross section - main axis. 4. Longitudinal section - main axis.

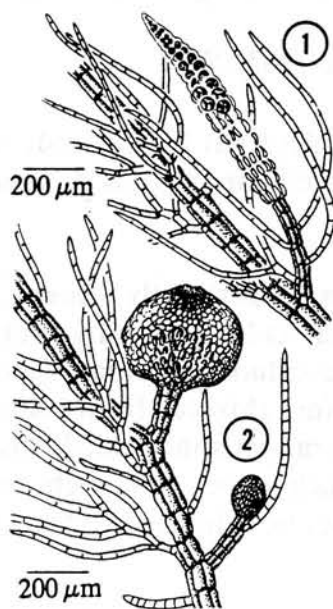
Laurencia papillosa (C. Agardh) Greville 1830: lii.

Chondria papillosa C. Agardh 1822a: 344.

Thallus gregarious or solitary, cartilaginous; 5-8(-16) cm tall; green or purple-green; branching alternate or irregular; proximal branches 1-2 mm diam., devoid of branchlets; distal branches densely covered with short, tough, knobby, club-shaped branchlets; apices tufted; holdfast fibrous, disc-like.

Branch central cells large, colorless, decreasing in size toward surface; surface cells one layer, small, deeply pigmented, thick-walled, 27 µm diam., 30 µm long in main axis, 8-15 µm wide, 30 µm long in lateral branchlets; apices tufted with inconspicuous, fine, dichotomously branched filaments in terminal depression; tetrasporangia in irregular lobed branchlets just below apices, beneath surface cells; spermatangial clusters in apical depression, small, oval, or barrel shaped; cystocarps partly immersed.

Fracture zone specimen: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25088* (US).



1. Axial branch with tetrasporangial stichidium. 2. Axial branch with cystocarp.

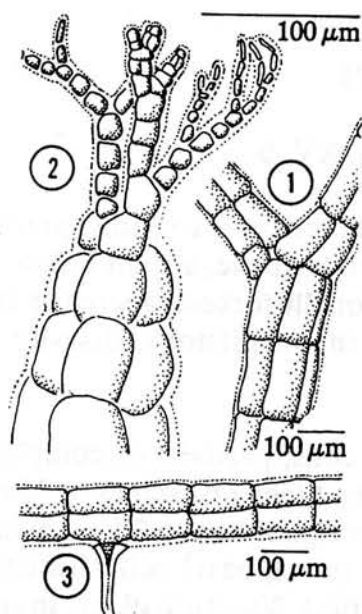
Murrayella pericladus (C. Agardh) Schmitz 1893: 227.

Hutchinsia pericladus C. Agardh 1828: 101.

Thallus dense, erect, turf-like; to 5 cm tall; dull, dark red-brown; branching dichotomous below, alternate above; branchlets deciduous, fine, slightly upcurved, unbranched or branched oppositely alternate; rhizome slender, creeping; rhizoids fine, filamentous.

Branches of 4 pericentral cells, uncorticated; branchlets initially at each joint, monosiphonous; branchlet cells $28\ \mu\text{m}$ diam, $60\ \mu\text{m}$ long; tetrasporangial stichidia to $105\ \mu\text{m}$ diam., $900\ \mu\text{m}$ long, terminal on short polysiphonous branch, unbranched or possessing monosiphonous branchlets; tetrasporangia 4 per whorl, to $55\ \mu\text{m}$ diam.; cystocarps spherical to oval, to $400\ \mu\text{m}$ diam., terminal on short polysiphonous branch.

Fracture zone specimen: Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, D&M Littler 25035 (US).



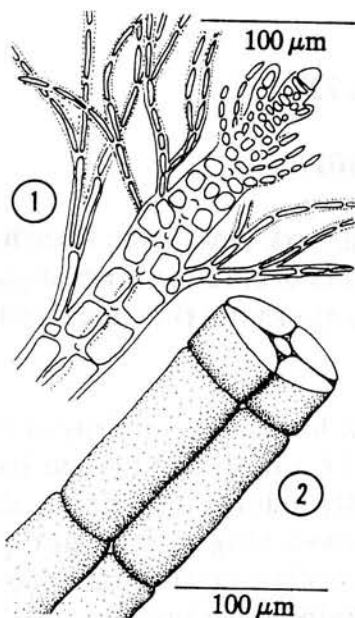
1. Filament branch. 2. Filament apex. 3. Prostrate filament - note rhizoid separated by cell wall.

Polysiphonia ferulacea Suhr in J. Agardh 1863 [1851-1863]: 980.

Thallus filamentous, fine, tufted, bushy; to 6(-15) cm tall; light brown to purple-red; main branching alternate; initially attached by small disc, later by numerous unicellular rhizoids.

Main branches 80-100(-300) μm diam.; secondary branches slightly thinner, often basally constricted, of 4 pericentral cells, uncorticated, filament scar cells common; segments one diameter long or less; apical filaments highly branched, eventually deciduous, abundant, on every 4th-6th segment, immature often sickle-shaped; rhizoids separated by cell wall, distal on pericentral cells; tetrasporangia spherical, 50-60 μm diam., in swollen spiral series on outer branchlets; spermatangial branchlets lateral on lower segment of apical filaments, cylindrical, 60 μm diam., 150-500 μm long, characteristically with 1-2 sterile, conspicuous, thick-walled cells at apex; cystocarps spherical to oval, 200 μm diam.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep, epiphytic on larger algae or seagrass, 16.ii.1993, D&M Littler 25026 (US), D&M Littler 25042 (US).



1. Filament apex. 2. Cross section of filament showing 4 pericentral cells surrounding central filament.

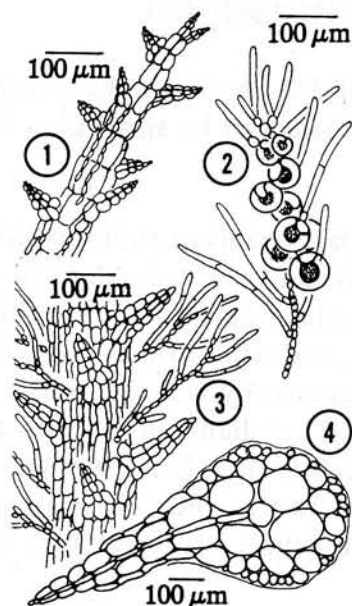
Polysiphonia scopulorum var. *villum* (J. Agardh) Hollenberg 1968: 81, fig. 7a.

Polysiphonia villum J. Agardh 1863 [1851-1863]: 941.

Thallus filamentous, fine, tufted; to 3 cm tall; light brown-red; main branching alternate; attached by numerous unicellular rhizoids descending from prostrate branches.

Main branches 40-80 μm diam.; secondary branches slightly thinner, of 4 pericentral cells, uncorticated; filament scar cells generally lacking; segments to 2 diameters long; apical filaments deciduous, alternate on every 2-6 segments; prostrate runner 60-100 μm diam.; rhizoids from center of pericentral cell, in open connection; tetrasporangia spherical, 50-60 μm diam., in swollen straight series just below branch apices, in straight series; spermatangial branchlets forming from filaments, cylindrical; cystocarps oval, 150-190 μm diam.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep, epiphytic on seagrass, 16.ii.1993, *D&M Littler 25044* (US). Seagrass bed of west fracture, 3 m deep, epiphytic on seagrass, 20.ii.1993, *D&M Littler 25155* (US).



1. Apex. 2. Tetrasporangia spirally arranged on surface filament. 3. Main axis with numerous spines, lateral, alternately branched, surface filaments. 4. Cross section - main axis.

Wrightiella blodgettii (Harvey) Schmitz 1893: 221.

Alsidium blodgettii Harvey 1853: 16, pl. XV, B.

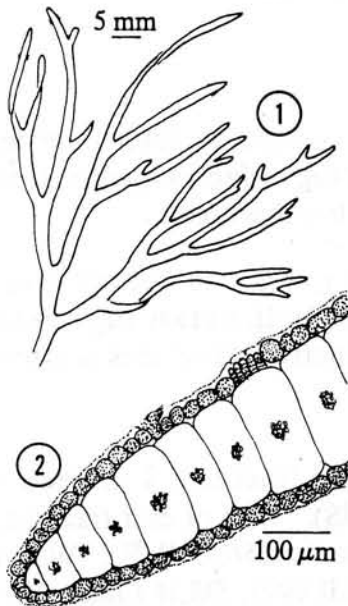
Thallus erect, stiff, spiny; to 20 cm tall; bright red to pink; primary branching proximal, irregular; spines numerous above, absent below, 1-5 mm long, spur-like, solitary or in pairs, occasionally forked, tapered at apex; surface filaments sparse; holdfast small, inconspicuous, disc-like or tap-root-like in soft sediment.

Branches 0.5-1.3 mm diam., 4-5 pericentral cells, partially or completely corticated, with numerous short spines and fine filaments; spines to 350 μm diam., spiral, in 4 vertical rows; filaments monosiphonous, to 30 μm diam., 1 mm long, deciduous, branching irregularly spiral, basal cell of ultimate branchlet uniquely small; tetrasporangia spherical, 30-60 μm diam., in spiral series on main branch of filaments; cystocarps oval or urn shaped, on short stalks.

Fracture zone specimens: Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25132* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25016* (US).

PHAEOPHYTA

Dictyotaceae, Dictyotales



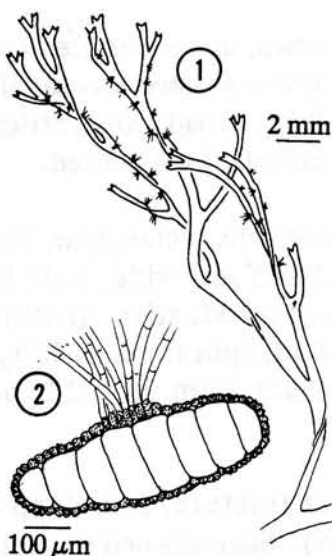
1. Habit of blades showing cervicorn branching pattern. 2. Cross section.

Dictyota cervicornis Kützinger 1859: 11, pl. 24, fig. 2.

Thallus bushy; to 20 cm tall; olive-brown; branching dichotomously asymmetrical (cervicorn - one branch terminating development); branches 1-2.5 mm wide, often twisted or spiral, apices pointed; holdfast small, fibrous, mat-like.

Blades 180-360 μm thick, 10-25 medulla cells wide; medulla cells in 1 layer, rectangular, arranged in rows; surface cells in 1 layer, 30-40 μm diam., 3-5 transverse each medulla cell; surface filaments in tufts, more numerous at margins than central axis, soon deciduous.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25097* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25146* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25055* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25119* (US).



1. Habit of blades. 2. Cross section with large medullary cells, small surface cells and centered filament cluster.

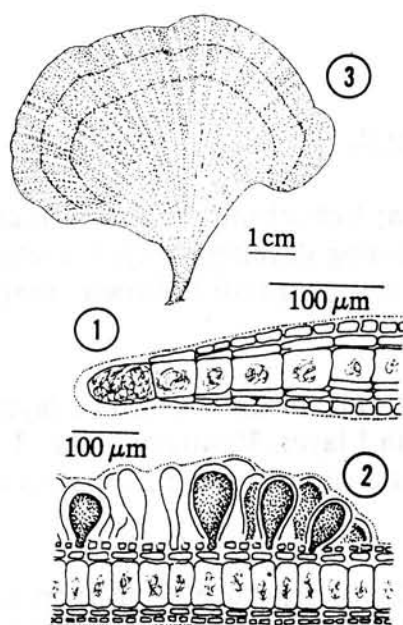
Dictyota linearis (C. Agardh) Greville 1830: xliii.

Zonaria linearis C. Agardh 1820: 134.

Thallus bushy, in entangled clumps; to 12 cm tall; brown; branching dichotomous, occasionally irregular; branches of uniform width, 0.5-1.5 mm throughout, often twisted, apices pointed; holdfast small, fibrous, mat-like.

Blades 200-360 μm thick, 6-20 medulla cells wide; medulla cells in 1 layer, rectangular, arranged in rows; surface cells in 1 layer, 30-40 μm diam., in regular rows, 3-5 transverse each medulla cell; surface filaments tufted, aligned down central axis, often persistent; sporangia solitary, scattered, generally near blade margins.

Fracture zone specimens: Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25030* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25147* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25013* (US).



1. Cross section - blade growing margin. 2. Cross section - reproductive structures on blade surface. 3. Habit of plant.

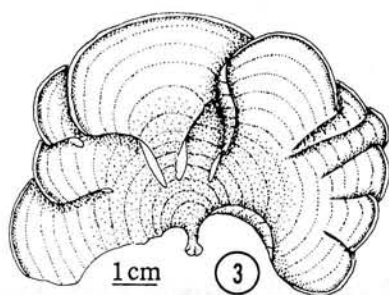
Lobophora variegata (Lamouroux) Womersley 1967: 221.

Dictyota variegata Lamouroux 1809: 331.

Thallus prostrate as crusts, in shelf-like layers, or erect in ruffled clusters; 15 cm diam.; light brown; blades thin, overlapping or fan shaped; rhizoids basal or on lower surface in prostrate forms, tan to olive brown.

Blades 100-300 μm thick; medulla cells in 1 layer, large; subsurface cells in 1-2 layers, mid-sized; surface cells in 1 layer, small, darkly pigmented; growth originates from marginal cells; reproductive structures scattered over upper and lower surfaces.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25086* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25060* (US). Wall of central fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25051* (US). Wall of west fracture, 4 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25170* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25187* (US).



1. Cross section - incurved growing margin. 2. Cross section - 2 layered thallus with sporangia. 3. Habit of plant.

Padina sanctae-crucis Børgesen 1914: 201, fig. 153, 154.

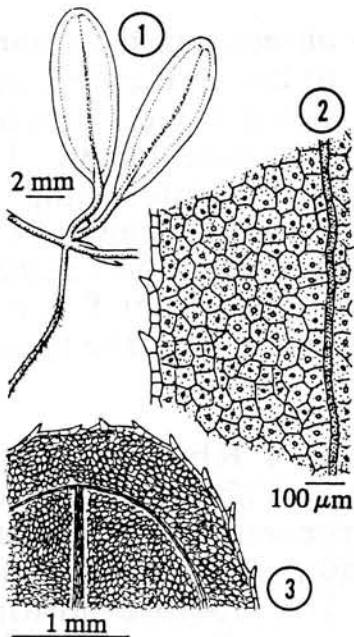
Thallus leaf-like clusters, ruffled; to 15 cm tall; brown, upper surface chalky white alternating with light yellow-brown bands, lower surface less calcified with darker brown bands; blades fan shaped, to 9 cm broad, concentrically zoned, substantially calcified, margins in-rolled; rhizoidal base matted.

Blades to 90(-150) μm thick, of 2 cell layers; dorsal cells rectangular, 30-60 μm wide; ventral cells smaller, rectangular, 24-35 μm wide; hair-like filaments 15-25 μm diam., in concentric zones; reproductive structures above every second filament band on both surfaces; sporangia to 120 μm diam., forming irregular bands; oögonia 30-50 μm diam. in 1-2 bands; antheridia in broken bands.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25087* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25043* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25135* (US). Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25066* (US).

MAGNOLIOPHYTA

Hydrocharitaceae, Butomales



1. Habit of plant. 2. Marginal teeth. 3. Leaf apex with marginal veins meeting center vein.

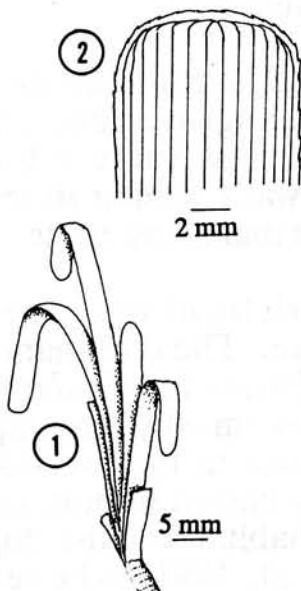
Halophila decipiens Ostenfeld 1902: 260, with fig.

Plants delicate, small, in leafy patches; to 1 m in diam.; bright green; stem slender, 3-15 mm long; leaves to 3 mm wide, 3-6 mm long, oval, one pair per node; leaf margin with extremely fine teeth; rhizome extensive; major root descending below each pair of leaves, soon covered by fine rootlets.

Leaves with central vein of rectangular cells; margin veins splitting from central vein at leaf base, paralleling margin, meeting central vein again just below leaf apex; rhizome 0.5-1.0 mm diam.; roots 0.2-0.5 mm diam.; rootlets colorless, 10-20 μ m diam.

Fracture zone specimens: Wall of east fracture, 4 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25080* (US). Bottom of east fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25111* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25004* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25180* (US).

Hydrocharitaceae, Butomales



1. Habit of plant. 2. Blade apex with parallel veins.

Thalassia testudinum Banks in König 1805: 96.

Plants erect, coarse, grass-like; grass-green; leaves strap shaped, 4-12 mm wide, 10-60 cm tall; rhizomes extensive, creeping, stoloniferous, 3-6 mm diam.; roots fine, fibrous, abundant.

Leaves having 9-15 parallel veins, connected by perpendicular cross veins at approximately 1 mm intervals; margins smooth, distally with minute spines.

Fracture zone specimens: Seagrass bed of east fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25105* (US). Seagrass bed of central fracture, 3 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25018* (US). Seagrass bed of west fracture, 3 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25128* (US). Bottom of central fracture, 7 m deep on mangrove peat, 16.ii.1993, *D&M Littler 25000* (US). Bottom of west fracture, 7 m deep on mangrove peat, 20.ii.1993, *D&M Littler 25181* (US).

DISCUSSION

This study documents the predominant flora of a previously unrecognized fractured mangrove-peat ecosystem. There is little variation from fracture to fracture except as a function of the age (size) of a given fracture. As fractures develop, they become larger and more exposed to light penetration allowing a sparse flora to become established. The unique habitats of the fractured peat zone of Tobacco Range support an interesting but reduced flora of 61 macroalgae and 2 vascular plants (Table 1). The algae consist of 35 Chlorophyta, 22 Rhodophyta, and 4 Phaeophyta. Fourteen of these represent new records for Belize and, in conjunction with the 16 Chlorophyta recently added by Littler & Littler (1990, 1991, 1992), and 7 Rhodophyta added by Kapraun & Norris (1982) bring the marine plant total to 284 taxa.

The peat fractures contain 23 taxa (18 Chlorophyta, 4 Rhodophyta, 1 Magnoliophyta) that were not present in the adjacent seagrass beds (Table 1); the latter contain 15 taxa (12 Rhodophyta, 3 Chlorophyta) that were not present in the fracture habitats. Of the 12 species common to both the fracture habitats and the adjacent seagrass beds, 9 were Chlorophyta, 2 Phaeophyta, and 1 Rhodophyta. The fracture bottoms contained 8 species not found on the vertical walls (*Caulerpa racemosa*, *C. sertularioides*, *Halimeda incrassata*, *Penicillus capitatus*, *P. pyriformis*, *Udotea caribaea*, *U. flabellum*, *U. wilsonii*), whereas the latter supported 6 species (*Caulerpa paspaloides* var. *phleoides*, *Cladophoropsis membranacea*, *Rhipiliopsis stri*, *Siphonocladus rigidus*, *Valoniopsis pachynema*, *Centroceras clavulatum*) not found elsewhere in the fracture zone.

The eight Chlorophyta unique to the fracture bottoms are relatively slow-growing psammophytic rhizophytes (sensu Raven 1981) with rhizoidal systems anchoring them to the silty decomposed peat substratum. Only certain rhizophytes appear capable of attaching to this extremely soft sedimentary medium which consists mainly of the fractured peat blocks that have collapsed and aerobically decomposed. Dominants on the bottoms include *Halimeda simulans*, *H. incrassata*, *Penicillus capitatus*, *Udotea cyathiformis*, *U. flabellum*, *U. caribaea*, *U. wilsonii*, *Caulerpa paspaloides*, *C. sertularioides*, *C. mexicana*, and the seagrass, *Halophila decipiens*. We have not found *U. caribaea* elsewhere in Belize.

The most interesting dominant of the fracture wall habitat is *Rhipiliopsis stri*, an otherwise rare alga. *Caulerpa verticillata*, a common alga on mangrove roots, is quite abundant on fracture walls, but also spreads laterally over the silty fracture bottoms. *Lobophora variegata* forms unusually large shelf-like thalli on the walls, similar to those we have observed on vertical, calcareous, wall-like reef habitats and on mangrove roots.

The adjacent *Thalassia testudinum* beds are characteristic of other seagrass communities, even though the substratum is fossil peat in this case. The dominant plants are *T. testudinum*, *Lobophora variegata*, and various species of *Halimeda* and *Caulerpa*. The *Thalassia* blades provide attachment sites for numerous epiphytes (mostly Rhodophyta), thereby greatly increasing the biodiversity of this algal group relative to the two disturbed fracture habitats. Because overall macroalgal cover on the mostly barren bottom and wall habitats is conspicuously lower than on the surrounding seagrass habitat and the dominant plants within fractures are calcareous forms documented (Littler et al., 1983) to be relatively slow growing, this lower community biodiversity and productivity is posited as a result of the fracturing process.

ACKNOWLEDGEMENTS

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Table 1. Macrophytes occurring in eastern (E), central (C), and western (W) fractures within the three major habitat types of the Tobacco Range Fracture Zone. Species indicated by asterisks indicate records new to Belize.

Phyla and Species	Habitat Types		
	Seagrass Beds	Vertical Walls	Fracture Bottoms
Chlorophyta			
<i>Acetabularia crenulata</i>	ECW	CW	ECW
<i>Anadyomene stellata</i>	CW	ECW	
<i>Avrainvillea nigricans</i>	E W	ECW	W
<i>Caulerpa cupressoides</i>		E	ECW
<i>Caulerpa mexicana</i>		E W	W
<i>Caulerpa microphysa</i>		E W	ECW
* <i>Caulerpa paspaloides</i> var. <i>phleoides</i>		E	
* <i>Caulerpa paspaloides</i> var. <i>wurdemanni</i>	ECW	W	EC
<i>Caulerpa racemosa</i>			E
<i>Caulerpa sertularioides</i>			E
<i>Caulerpa verticillata</i>		EC	EC
* <i>Cladophora albida</i>		E	C
<i>Cladophoropsis membranacea</i>		W	
* <i>Dasycladus vermicularis</i>	ECW		
<i>Dictyosphaeria cavernosa</i>	ECW		
<i>Halimeda incrassata</i>			W
<i>Halimeda monile</i>	EC		CW
<i>Halimeda simulans</i>	CW		ECW
<i>Neomeris annulata</i>	W		
<i>Penicillus capitatus</i>			ECW
<i>Penicillus lamourouxii</i>	W	EC	C
<i>Penicillus pyriformis</i>			W
* <i>Rhipiliopsis stri</i>		ECW	
* <i>Rhipocephalus oblongus</i>		E	EC
<i>Rhipocephalus phoenix</i>	ECW	ECW	EC
* <i>Siphonocladus rigida</i>		W	
<i>Udotea abbottiorum</i>	E W	E W	E W
<i>Udotea caribaea</i>			ECW
<i>Udotea cyathiformis</i>	ECW	EC	ECW
<i>Udotea flabellum</i>			ECW
<i>Udotea luna</i>	E W	E	C
<i>Udotea wilsonii</i>			E
<i>Valonia macrophysa</i>	CW	CW	
<i>Valoniopsis pachynema</i>		CW	
<i>Ventricaria ventricosa</i>	W	E W	W

Table 1. Continued.

Phyla and Species	Habitat Types		
	Seagrass Beds	Vertical Walls	Fracture Bottoms
Rhodophyta			
<i>*Acrothamnion butleriae</i>		C	E
<i>Amphiroa fragilissima</i>	ECW	ECW	E
<i>Amphiroa rigida</i> var. <i>antillana</i>	W		
<i>Centroceras clavulatum</i>		W	
<i>Ceramium nitens</i>	E		
<i>*Chondria collinsiana</i>	W		
<i>*Chondria dasyphylla</i>	W		
<i>*Dasya baillouviana</i>	ECW		W
<i>*Dasya mollis</i>	C		
<i>Dasya rigidula</i>	W		
<i>Herposiphonia secunda</i>	C	E	
<i>*Heterosiphonia gibbesii</i>	ECW		
<i>Laurencia intricata</i>	CW	W	
<i>Laurencia papillosa</i>	E		
<i>Murrayella pericladus</i>	C		
<i>Callithamnion halliae</i>	W		
<i>Polysiphonia ferulacea</i>	C		
<i>Polysiphonia scopulorum</i> var. <i>villum</i>	CW		
<i>*Spermothamnion gymnocarpum</i>	CW		E
<i>Spyridia filamentosa</i>		C	C
<i>Spyridia hypnoides</i>		W	
<i>Wrightiella blodgettii</i>	W		C
Phaeophyta			
<i>Dictyota linearis</i>	CW		
<i>Dictyota cervicornis</i>	E W	C	EC
<i>Lobophora variegata</i>	E	ECW	W
<i>Padina sanctae-crucis</i>	ECW	E	
Magnoliophytae			
<i>Halophila decipiens</i>		E	ECW
<i>Thalassia testudinum</i>	ECW		CW

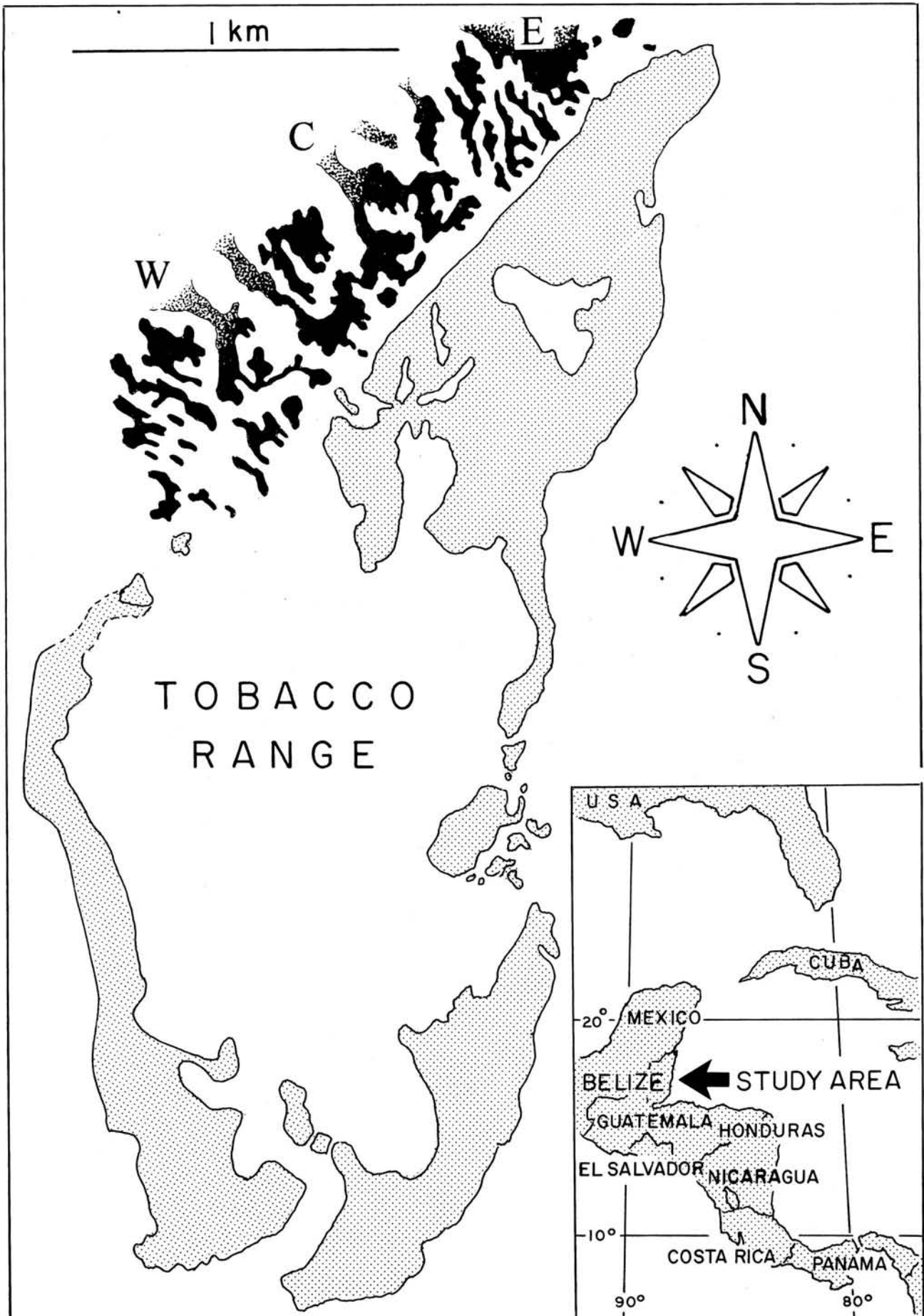


Figure 1. Map of Tobacco Range mangrove islands showing fractured peat area in black along the northwest shoreline of the north island. Fractures studied are labelled W = west, C = central, and E = east.

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**MARINE ALGAE AND SEAGRASSES FROM THE TOBACCO RANGE
FRACTURE ZONE, BELIZE, C.A.**

BY

D.S. LITTLER, M.M. LITTLER, AND B.L. BROOKS

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