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NOAA Technical Memorandum
NOS MEMD 22



**GRAY'S REEF
NATIONAL MARINE SANCTUARY**

**AN ILLUSTRATED FIELD AND LABORATORY
GUIDE TO THE SEAWEEDS OF GRAY'S REEF
NATIONAL MARINE SANCTUARY**

**Washington, D.C.
September 1988**

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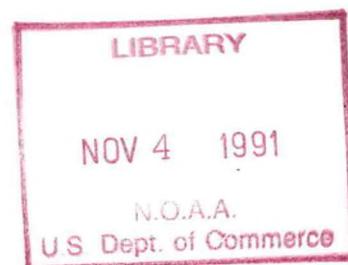
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Richard B. Searles*

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Durham, North Carolina 27706

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National Ocean Service Series

Marine and Estuarine Management Division

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**National Marine Sanctuary Program
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REPORT TO
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NOAA TECHNICAL MEMORANDA SERIES NOS/MEMD

An Illustrated Field and Laboratory Guide to the Seaweeds of Gray's Reef National Marine
Sanctuary

Richard B. Searles

September 1988

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
MARINE AND ESTUARINE MANAGEMENT DIVISION
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This work is the result of research sponsored by the U.S.
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ABSTRACT

This field guide to the seaweeds of Gray's Reef is intended to help visitors and researchers identify the macroscopic or multicellular, benthic (attached) plants living in or near the Sanctuary. These seaweeds belong to four divisions (major groupings) of plants, the Cyanophyta (Cyanobacteria or blue-green algae), the Chlorophyta (green algae), the Phaeophyta (brown algae), and the Rhodophyta (red algae). This flora of the sanctuary was prepared by SCUBA diving to make collections during the winter, spring and summer growing seasons. Sixty-eight species were collected. Dudresnaya georgiana and some of the plants described here, but not placed in a particular species are endemics (known only from this limited area). Many, such as Codium isthmocladum, Sargassum filipendula, and Botryocladia occidentalis are common species of the warm-temperate biogeographic region which lies along the southeast coast of the United States. Identification of the species in the sanctuary raises interesting questions about their life histories, ecology, and biogeography and some of these questions are included in the comments following each species description.

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INTRODUCTION

Gray's Reef National Marine Sanctuary is an area of the seafloor off the Georgia coast (Fig. 1) where the rock of the continental shelf emerges through the overlying sandy sediment in a series of small ledges and flat rock platforms approximately 60 feet below the sea surface. Four different ledges were routinely sampled in preparing this guide (Fig. 2). In addition, rock outcrops further offshore, known locally as "The Snapper Banks" (Fig. 1) were sampled less thoroughly. Latitude, longitude and depths for each of the collection sites are given in Table 1.

This is a precarious habitat for seaweeds. Shifting sediments may cover the rock on which the seaweeds must grow; suspended sediments can obscure much of the light required for their growth and temperatures oscillate with the seasons. In addition to these physical restrictions, there is competition for space with other seaweeds and attached marine invertebrates and grazing by herbivorous animals. In this environment an interesting flora develops in the Sanctuary each year.

During the winter it is a community almost devoid of visible plants. In late winter a few perennial plants such as Sargassum filipendula, Botryocladia occidentalis and Rhodymenia pseudopalma begin regrowth from the remains of the plants which died back the previous fall, but a March collection yielded only seven species (Table 2). By June there are scattered annual algae in evidence and over twenty species. In July and early August there is an abundance of seaweeds (more than 60 species) growing along the ledges, emerging though light sand cover on the flat rock surfaces behind the ledges, and growing attached to larger shell and coral fragments. In late August and September most of these plants die back and disappear for the winter. September collections totaled only ten species.

Considering the small size of the area studied, it has a rich flora. Three species were collected only from the Snapper Banks, which in the limited collections made there did not appear to be nearly as rich in seaweeds as the Sanctuary (Table 2). The remaining sixty-five species all occurred in the Sanctuary. Two species have already been described as new from the Sanctuary, Dudresnaya georgiana Searles (1985) and Dudresnaya puertoricensis Searles and Ballantine (1986). Eight species are included for which no previously description has been located. Some of these will probably have to be published as new species. Two, Lejolesia sp. and Cladophora sp. are most similar to very distant species in Japan (Lejolesia pacifica Itono) and southern Australia (Cladophora bainesii van den Hoek), raising interesting questions about the evolution and biogeography of seaweeds.

The plants are part of a warm-temperate flora of about 300 species which occupies the seacoast of the United States from Cape Canaveral in Florida to Cape Hatteras North Carolina, (see Searles, 1984). A few of the species are endemic to this region, Derbesia turbinata and Giffordia onslowensis for example. Many of the species also occur further south in the Caribbean and in many cases still further south to Brasil. Some appear to be cosmopolitan tropical, or warm-temperate species, although as our understanding of the systematics of the seaweeds improves we will probably recognize regional varieties and populations which are distinct from other populations of these widespread species.

There is much we have yet to learn about these plants. The life histories of several of the species in the Sanctuary are incompletely understood; the tetrasporophyte phases of Dudresnaya georgiana and D. puertoricensis are unknown and the isomorphic tetrasporophyte of D. crassa, which is known from North Carolina and Bermuda, has not been collected here. The gametophyte phases of Derbesia turbinata and Derbesia sp. have

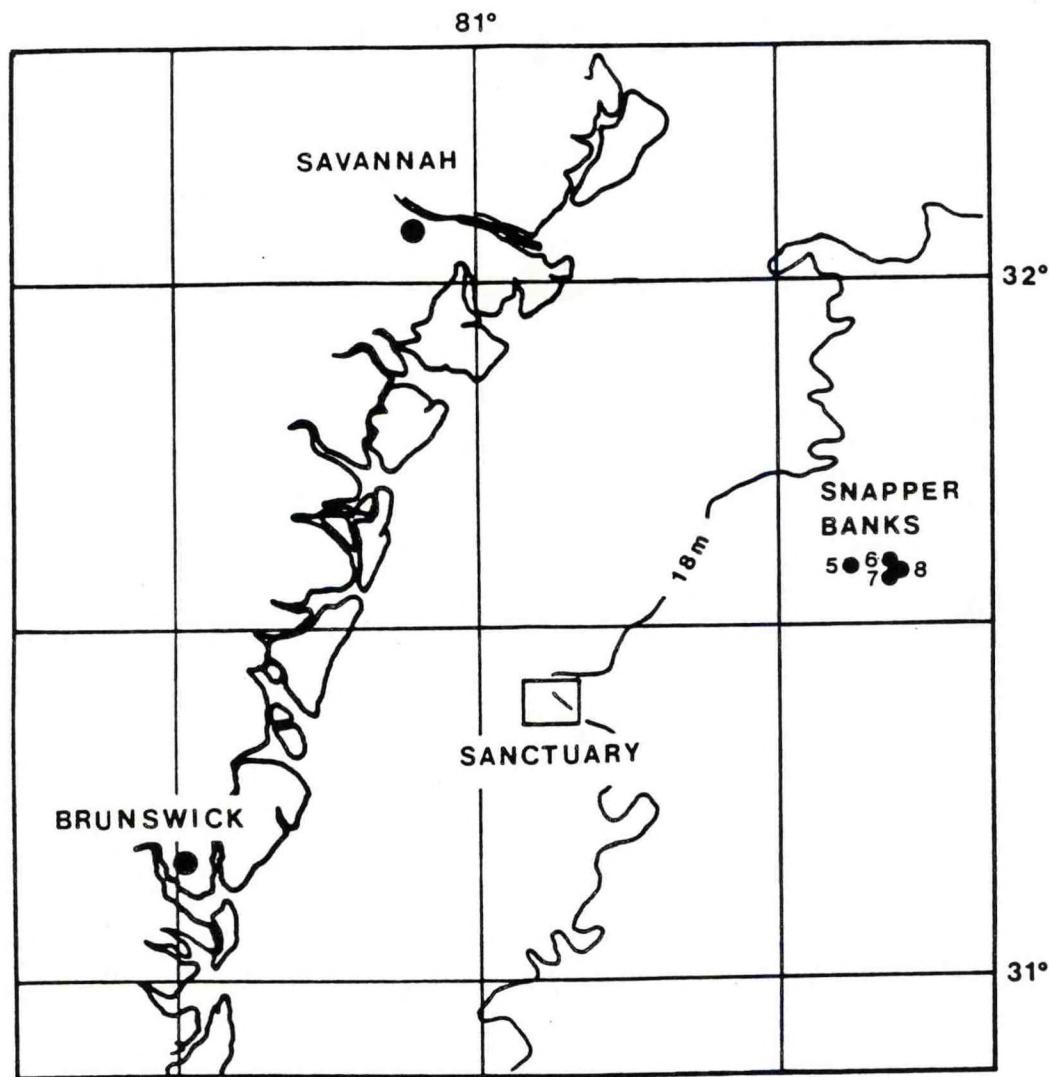


Figure 1. Location of Gray's Reef National Marine Sanctuary and the Snapper Banks dive sites off the Georgia coast. Numbers at the Snapper Bank correspond to the sites as listed in Table 1.

never been observed and in Derbesia marina the gametophyte phase has been observed elsewhere, but not south of New England along this coast.

Hopefully, biologists will be stimulated to pursue algal research here through use of this guide and by visits to the Sanctuary. Further research will help us better understand these seaweeds, their relationships to plants in adjacent parts of the Atlantic, their evolutionary history, and their contribution to the animal populations which depend on them as food and habitat.

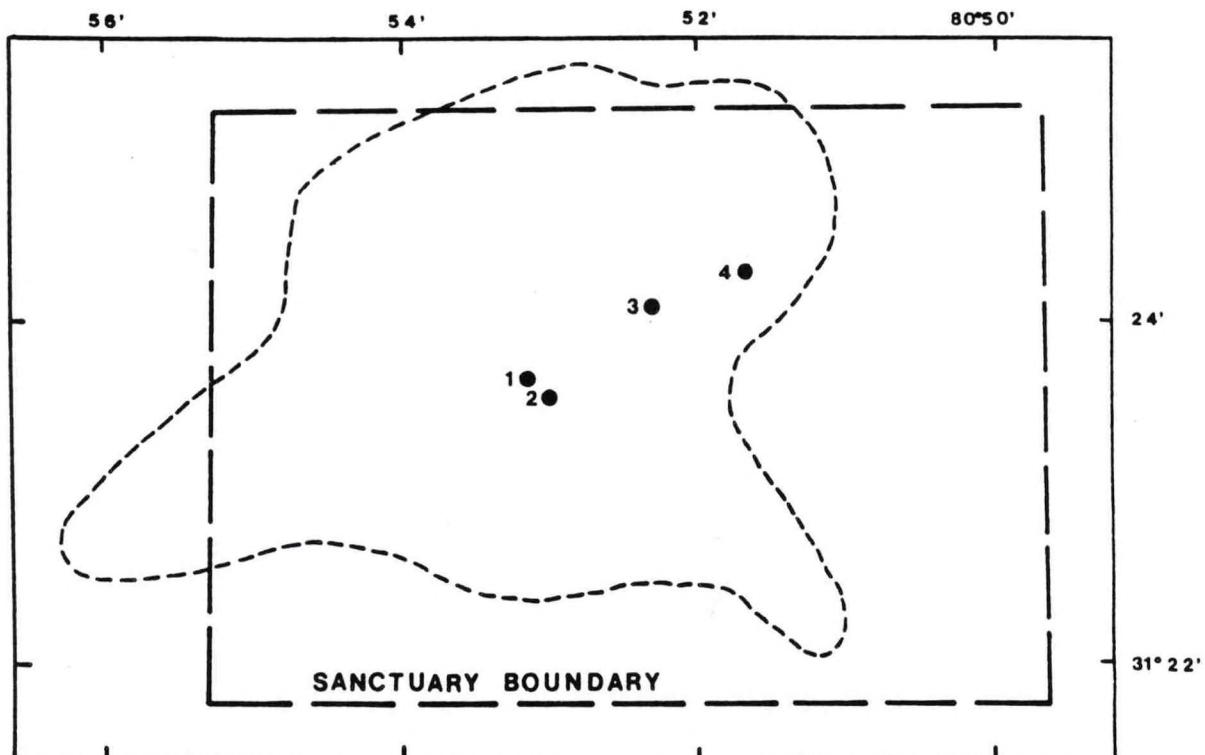


Figure 2. Location of collecting sites in Gray's Reef National Marine Sanctuary. Numbers correspond to the sites listed in Table 1. The irregularly shaped area set off by broken lines is the general area of rocky outcrops and live bottom as suggested by Hunt (1974).

METHODS

COLLECTION SITES

Four sites in the Sanctuary (Fig. 2) were visited occasionally, in June, from 1980 to 1983 and routinely in 1984 and 1985. Four sites at the Snapper Banks area of the continental shelf (Fig. 1) were visited in 1985. The locations and depths of each site are given in Table 1.

COLLECTION AND PRESERVATION

All of the collecting sites in Gray's Reef National Marine Sanctuary lie near a depth of 60 feet (18 meters) (Table 1); additional rock bottom areas such as the Snapper Banks (Fig. 1) are mostly further offshore, in deeper water. Within the sanctuary the only practical method for obtaining seaweeds is to SCUBA dive and collect specimens by hand. A permit is required for making any collections in the sanctuary. Outside of the sanctuary specimens may also be obtained by dragging dredges over the rocks or by trawling with fishing nets. The latter method is only adviseable in relatively flat bottom rocky areas because of potential damage to the nets. Dredging requires a sturdy, geological rock dredge capable of breaking off pieces of rock or scraping plants and animals from smooth rock features. Neither of these methods may be used in the Sanctuary because they are too destructive. Because some of the plants live in the cracks between rocks and are missed by dredges and trawls and because some are soft and delicate, diving is the preferred method of sampling in most instances.

Macroscopic seaweeds grow attached to the exposed rock along the edges of the low ledges, on the flats behind the ledges on areas of bare rock or more typically emerging through a light covering of sand. Occasionally they grow on large pieces of shell. The latter are often found on the lower levels in front of the ledges where smaller sand particles appear to have been winnowed away, perhaps due to the swirling of the currents as they pass over the ledges. Crustose coralline red algae may adhere tightly to the rock and have to be broken off with a chisel and hammer; they may also be found on loose pieces of shell. A knife or chisel is often necessary for removing other algae from the rocks with holdfasts intact. The only other collecting item required is a mesh bag to hold the specimens. It is useful to have a large bag for the big specimens and one or more small, fine-mesh bags into which one can separate the smaller specimens. In addition to obvious large algae, visible to the naked eye, one may collect representative sessile marine invertebrates (bryozoans, hydrozoans, gorgonian corals, molluscs) which will have small, epizoic algae growing on them.

A few living specimens can be returned to the lab in coolers at ambient temperatures as long as they are not crowded. Specimens can be killed and the tissues fixed with a variety of reagents; the specifics depend on the use intended. (See *McCully et al.* 1980 for information on special techniques.) For routine purposes specimens are killed and fixed in formalin-seawater in a ratio of 1:10. This is a noxious reagent and when opening collections in the lab you are advised to work in a ventilated chemical hood and to wear gloves. Specimens in formalin-seawater should be stored in the dark, where they will retain most of their color for long periods of time. After the initial killing and fixing, the plants can be transferred to 1:20 formalin-seawater for storage.

MICROSCOPY

Identification of specimens will often require microscopic examination. Small plants can be placed on slides under a coverslip and examined directly. Larger specimens may require sectioning. Coarse, sturdy plants such as Gracilaria blodgettii can be freehand sectioned with a single-edge razor blade. Smaller plants and membranous plants can be held in a sandwich between two glass slides and thin pieces cut off with a razor blade moved against the end of the top slide as it is moved to expose the plant material. The secret in these hand sectioning techniques is to cut a large number of sections; usually only a few out of 2 or 3 dozen are thin enough to be useful, but only one or two of these are usually necessary to see the diagnostic characteristics of the species. Sections may be cut more accurately with a freezing microtome. The specimens are oriented and frozen on a mechanical stage in a few drops of water, or water and a solute such as gum arabic, and then cut with a microtome knife or razor blade as the block of tissue is moved into the path of the blade in small increments by the microtome. The sections are transferred with a water coloring brush to a slide.

Material can be viewed unstained using brightfield optics. The image may be enhanced with phase optics, differential (Nomarski) interference-contrast optics (Green, 1980) or most commonly by use of stains. A frequently used stain is aniline blue (cotton blue). One of its advantages is that it is water soluble and the specimens do not have to be transferred to a nonaqueous medium. The stain is prepared as a 1% solution in water. After sitting in the stain on a slide for a minute or more, depending on the bulk of the tissue, excess stain is removed and the dye fixed in the cells with a weak acid solution of 1% HCl.

Slides may be made permanent by mounting them in a 1:1, corn syrup:water solution, covering with a cover slip and then periodically replacing the water lost by evaporation with additional corn syrup solution until an equilibrium is established. The process is accelerated by warming the slide mounts on a warming table. The stock corn syrup solution is dilute enough to allow a growth of fungi, so a few drops of phenol per 100 cc of solution are recommended as a fungicide. After the slides have lost all excess water, the coverslip should be ringed with fingernail polish.

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- 4 (3) Diameter of apical cells greater than 20 um 5
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25 (24) Vesicle number greater than 5 per plant, surface of vesicles a continuous or almost continuous layer of small cellsBotryocladia occidentalis

26 (24) Branches with multicellular partitions dividing the hollow spaces at regular intervals.....Champia parvula var. prostrata

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SPECIES DESCRIPTIONS

(In the following account, generic descriptions are provided only where there is more than one species of a genus in the flora.)

CYANOPHYTA

HORMOGONALES

Oscillatoriaceae

SCHIZOTHRIX Kuetzing

Schizothrix mexicana Gomont

Fig. 3 A-E

Unbranched filaments, 4-65 um diam., with or without a distinct sheath of cell wall material. All cells of similar, discoid shape, 2-10 um long, except the terminal cell which is hemispherical. Cell contents homogeneous under the light microscope.

A cosmopolitan species found in fresh and salt water. Common in the Sanctuary growing as an epiphyte on other algae and invertebrates and on rock surfaces where it forms a reddish-brown mat. The taxonomic approach used here is that of Drouet (1981) which views these algae as part of a diverse assemblage of ecotypes of great morphological and ecological variability. Gray's Reef collections have a sheath extending beyond the file of cells and include a range of filament diameters from 10 to 26 um. Under older systems of classification they would be placed in species of the genus Lyngbya. It is of interest that this is the only member of the Cyanophyta encountered in the benthic habitat of these offshore waters.

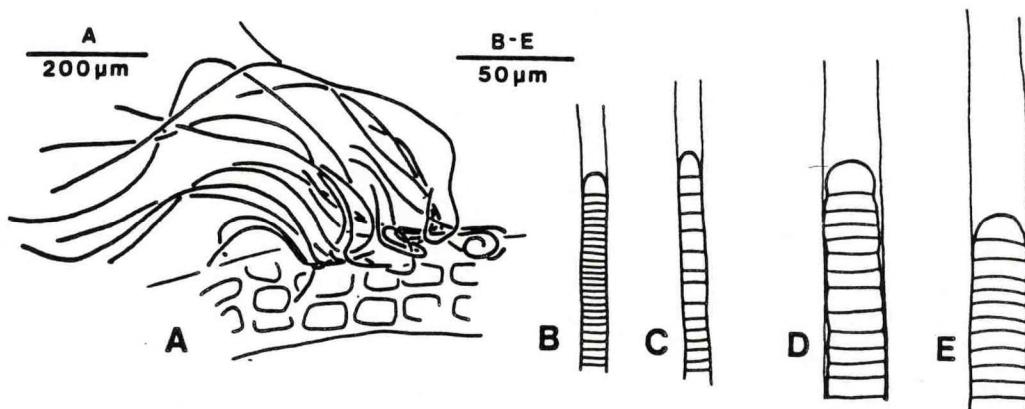


Figure 3. Schizothrix mexicana

CHLOROPHYTA

CLADOPHORALES

Cladophoraceae

CLADOPHORA Kuetzing

Plants erect, occasionally prostrate or loose lying, sparsely to profusely branched, attached by a discoid holdfast or by descending rhizoids. Uniseriate filaments usually decreasing in diameter upward, cell division apical and/or intercalary. Cells multinucleate, often large; chloroplasts many, polygonal, with or without pyrenoids, usually forming a network just inside the cell membrane. Four species were collected in the Sanctuary.

Cladophora sp.

Fig. 4 A-D

Plants medium green, 1-3.5 cm high, erect with one main axis, which may or may not be pseudodichotomously branched in its basal region, and which bears delicate fastigate tufts of densely branching filaments. Growth primarily by cell divisions of the apical cells and by subsequent cell elongation and cell enlargement. Towards the base the internodes may be divided into 2-6 cells by intercalary cell divisions; this is especially the case in the internodes of the basal region. Secondary branches may be produced from intercalary cross walls.

Each new cell after being cut off from the apical cell gives off a branch at its apical pole, which mostly arises two to four cells from the apex. With increasing distance from the apex a cell may give off a second, third, fourth, and rarely and fifth or sixth branch. Each branch is apically inserted with a feebly inclined to almost horizontal cross wall, at an acute angle (30° or less). The basal cells of the laterals are not, or only slightly, fused at their basal poles with adjacent cells of the axes.

Apical cells 12-20 μm in diameter, L/B 7-22, linear to the tapering mucronate apices. Ultimate branch cells 14-24 μm in diameter, L/B 5-11. Basal stipe cells 100-180 μm in diameter, L/B 5-18. Ratio of basal stipe cell to apical cell diameters c. 7-15. Walls 0.5-1 μm thick above, up to 25 μm below.

Upper cell are transformed into zoidangia. Each zoidangia opens by one pore above the midpoint of the zoidangium and the empty zoidangium abscisses near its base.

This is not a common plant here and was only collected twice in the Sanctuary and once at the Snapper Banks. It is an undescribed species, most similar to Cladophora bainesii van den Hoek (1984).

Cladophora dalmatica Kuetzing

Fig. 5 A

Plants medium to light green, forming tufts 1-2 cm tall, much branched from a rhizoidal base. Filaments tapering distinctly, branched from almost every cell above,

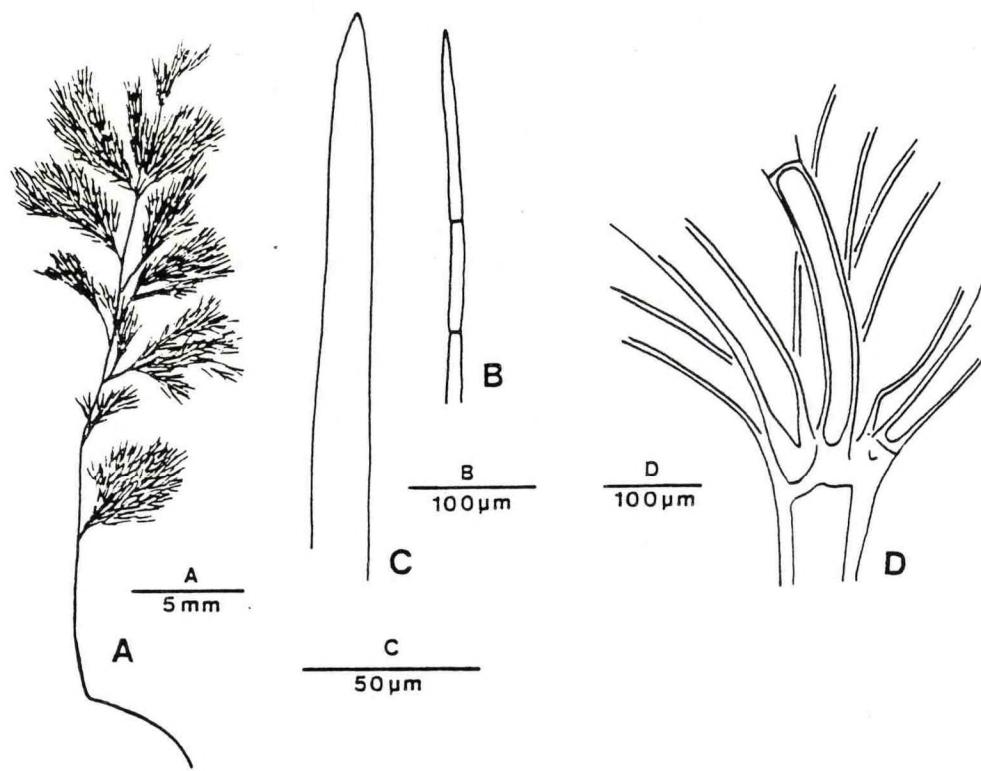


Figure 4. Cladophora sp.

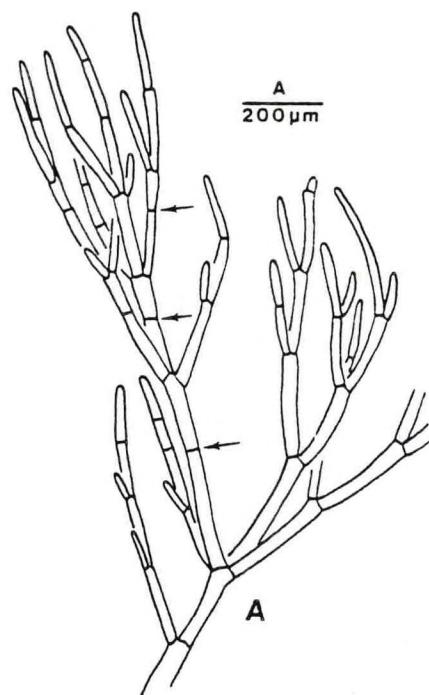


Figure 5. Cladophora dalmatica

usually with falcate, unilateral branchlets. Growth acropetal and mostly apical above, with intercalary divisions in the mid and lower parts so that laterals are separated by 2-5 or more cells with few intercalated laterals below intercalary cross walls; lateral branches 1-3(-5) per parent cell, at 45 degree angle; basal cross walls initially oblique, becoming almost horizontal. Apical cells 15-28 μm diam, length 3-9 times diam, cylindrical to slightly tapered, occasionally broader near the apex, apically rounded; ultimate branch cells 15-32 μm diam, length 4-9 times diam; lower axis cells 65-140 μm diam, length 4-10 times diam; cell walls thin (0.5-2 μm) above, to 10 μm thick below.

Widely distributed in warm temperate and tropical seas, although rare in the Sanctuary. Cladophora dalmatica is commonly a shallow water plant.

Cladophora laetevirens (Dillwyn) Kuetzing

Fig. 6 A,B

Plants light to medium green, 2-10 cm tall, in tufts with pseudodichotomous branching from a small group of rhizoids formed by cells in the basal region. Branched from almost every cell above, branchlets often somewhat falcate and unilateral, filaments only slightly tapering. Growth acropetal and mainly apical above, with intercalary division in the mid and lower parts which separate the laterals by 2-6 cells, but with new laterals often arising below intercalated cross walls; parent cells bearing 1-2(-3) laterals at about 45 degrees; basal cross walls initially oblique, becoming almost horizontal. Apical cells 40-70(-80) μm diam, length 4-11 times diam, cylindrical to slightly broader in upper half, apex rounded; ultimate branch cells 40-75 μm diam, length 4-7 times diam; lower axis cells (100-)120-160(-180) μm diam, length 2-8(-10) times diam; cell walls 2-4 μm thick in apical cells, to 6-10 μm below.

Widely distributed in warm-temperate and tropical seas of America, Europe, W. Africa and southern Australia. More typically a shallow water plant, it was rare in the sanctuary. Cladophora laetevirens is very similar to Cl. dalmatica, but is distinguished by somewhat thicker apical cells and fewer (2-3) laterals per parent cell.

Cladophora pellucidoidea van den Hoek

Fig. 7 A-C

Plants grass-green, 1.5-6 cm tall, forming penicillate tufts of acropetally organized branch-systems without a distinct main axis, but with numerous pseudodichotomies. Growth apical except for the basal internode which divides into 2-3 cells. Lateral branches initiated by subapical cell; 2 or rarely 3 or 4 lateral branches may be initiated by a cell, basal cross wall becoming almost horizontal, branch angle initially 30 degrees or less, becoming 45 degrees or more in more basal parts, the lower branches becoming pseudodichotomous. Apical cells tapering to an obtuse tip, diam. 50-95 μm , length 9-32 times diam; ultimate branch diam. 50-95 μm , length 9-22 times diam; main axis diam. 70-260 μm , length 7-48 times diam; cell wall in apical parts 1.5-4 μm thick, in basal parts 8-16 μm .

Described from plants in North Carolina, Florida and the Netherland Antilles (Hoek, 1982), this is a western Atlantic, tropical and warm-temperate water species. It was earlier reported from the Sanctuary as Cladophora pseudopellucida by Searles (1981). It is the commonest of the Cladophora species in the sanctuary. It grows on rock and small pieces of shell, often emerging through a thin covering of sand in the flats behind

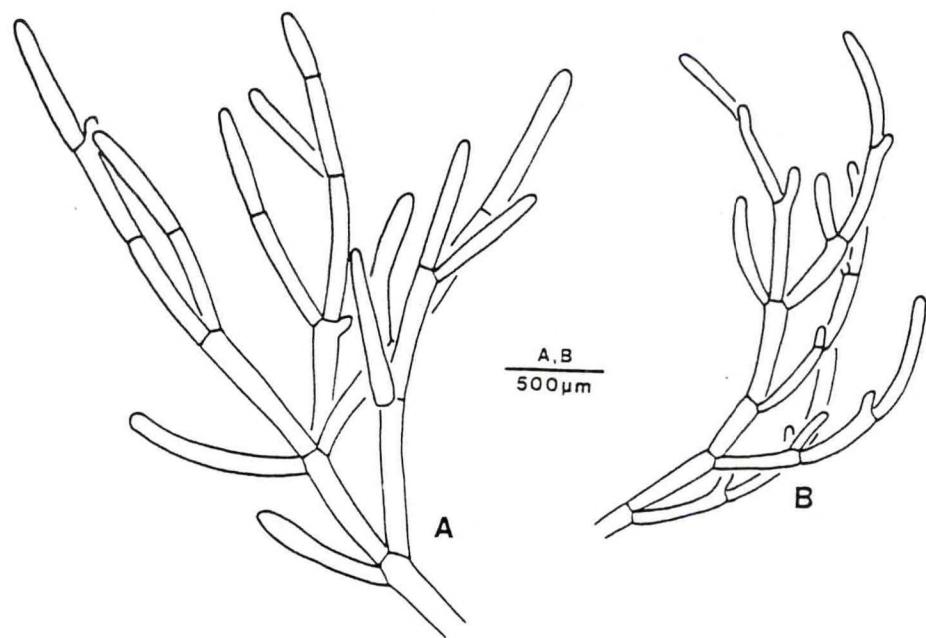


Figure 6. Cladophora laetvirens

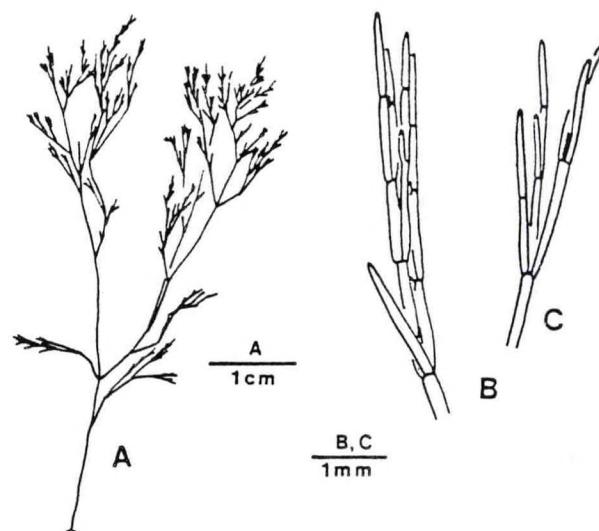


Figure 7. Cladophora pellucidoidea

the edge of ledges.

CAULERPALES

Bryopsidaceae

BRYOPSIS Lamouroux

Bryopsis pennata Lamouroux

Fig. 8 A-C

Erect, dark olive-green plants arising from rhizoidal holdfasts. The erect, tubular, coenocytic axes to 7 cm tall, bearing two rows of determinate pinnules in open cytoplasmic connection with the central axis. The pinnules of equal length, giving the fronds a linear shape except near the tip. Pinnules near the base of axes becoming indeterminate and producing secondary, erect axes. Gametangia or deciduous, vegetative propagula are produced from pinnules by formation of a wall at the base of the pinnule.

This species is wide spread in warm-temperate and tropical waters and is a common plant in shallow water along the east coast of the United States. In the sanctuary it was the dominant plant on parts of the exposed rocks along some of the ledges in July and August.

Derbesiaceae

DERBESIA Solier

Sporophyte plants with tufted, tubular branches; dichotomously to laterally branched. Coenocytic, cross walls only formed occasionally; plastids discoid to ellipsoid, with or without pyrenoids. Sporangia lateral, separated from the vegetative filament by two walls; zoospores stephanokont; in some species zoospores germinate to form "Halicystis", vesicular gametophytes; in other species Bryopsis gametophytes are formed from zoospores or directly from the "Derbesia" filaments. (The names in quotations are generic names which technically no longer are appropriate for the life histories of the taxa referred to, but are useful in designating the alternate generation in the heteromorphic life history.) Three species were collected; one is unnamed and was found only in the Snapper Banks collections.

Derbesia marina (Lyngbye) Kjellman

Fig. 9 A-C

Plants forming olive-green, tufted clumps, 1-3 cm tall, attached by contorted, creeping filaments; branching lateral and dichotomous; filament diam. (12-)25-40(-60) um; plastids ovoid discs, (1-)2.5(-4) um x (3-)5.5(-8) um; sporangia cylindrical, clavate, (60-)77-110(-150) um diam, (144-)170-225((-333)um long.

Reported from cold temperate waters in the North Atlantic, North Pacific and South Australia; in the western Atlantic it has been reported in warmer waters, as far south as Bermuda and North Carolina; this is thus the southern-most record of the species. Rarely

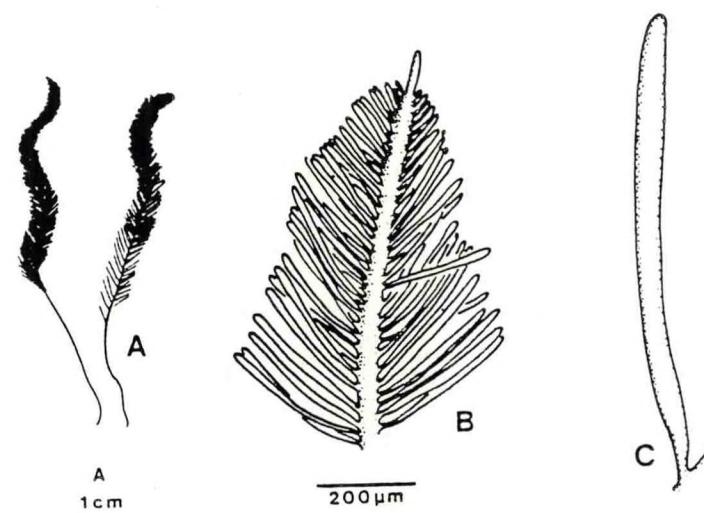


Figure 8. Bryopsis pennata

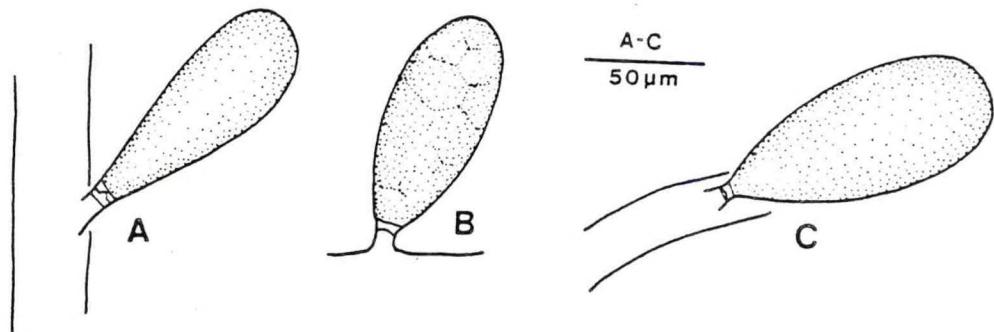


Figure 9. Derbesia marina

found with sporangia, these are the plants with the narrowest filaments among the three local species. The sporangia, when present, are distinctive in that they are most commonly cylinders with a uniform diameter or they are clavate and long relative to their diameter. The other two species typically have turbinate or, very occasionally, subspherical sporangia.

Derbesia turbinata Howe & Hoyt

Fig. 10 A-C

Filaments dark olive-green, forming tangled clumps to 8-9 cm long, the basal parts sometimes resolved into cysts; filaments (16-)40-55(-100) diam, sparingly subdichotomously branched or more often laterally branched, the lateral branches usually without a basal cross wall, the dichotomous branches with or without one or two cross walls above the dichotomy; plastids elliptical or ovate, 5-7 μ m diam, becoming confluent, spindle-shaped. Sporangia shape varied, turbinate, broadly obconic-obvoid, broadly pyriform, pestle-shaped, or rarely spherical, (90-)190 μ m long, excluding stalk, 90-165 μ m diam, diam equal to or generally less than length from septa to end of sporangium.

This alga was originally collected only once, in North Carolina near the beginning of the century (Hoyt, 1920). I have collected plants near Cape Fear, North Carolina which may be the same alga, but most have lacked sporangia. Sears (Sears and Wilce, 1970) cultured plants with similar vegetative characteristics from Cape Lookout jetty, North Carolina, but was unable to produce sporangia in culture. This alga would be of interest to study in culture to determine the nature of the gamete producing stage.

Derbesia sp.

Fig. 11 A-H

Plants epizoic, forming tufts to 5 cm long; branching subdichotomous to lateral, branching angle 45-90 degrees; filaments (36-)44-75(-103) μ m diam, double cross walls formed occasionally; plastids oval, 6-8x4-5 μ m. Sporangia lateral, broadly obconical, turbinate or, more rarely obliquely spheroidal, apex rounded or flat, sporangial diameter, (85-)125-135 μ m, greater than length from basal crosswall to apex, (55-)115-125 μ m.

Known only from the Snapper Bank collections offshore of the Sanctuary in July. It is similar to Derbesia turbinata, but differs in the range of diameters of the filaments and the proportions of the sporangia which are broader than they are long. Taylor (1945) described a species of Derbesia, D. hollenbergii from the Pacific with sporangia of similar shape, but that alga has larger filaments and larger sporangia.

Udoteaceae

BOODLEOPSIS A. and E.S. Gepp

Boodleopsis pusilla (Collins) Taylor, Joly & Benatowicz

Fig. 12 A

Plants filamentous, tubular, coenocytic, uncalcified; the filaments loosely interwoven

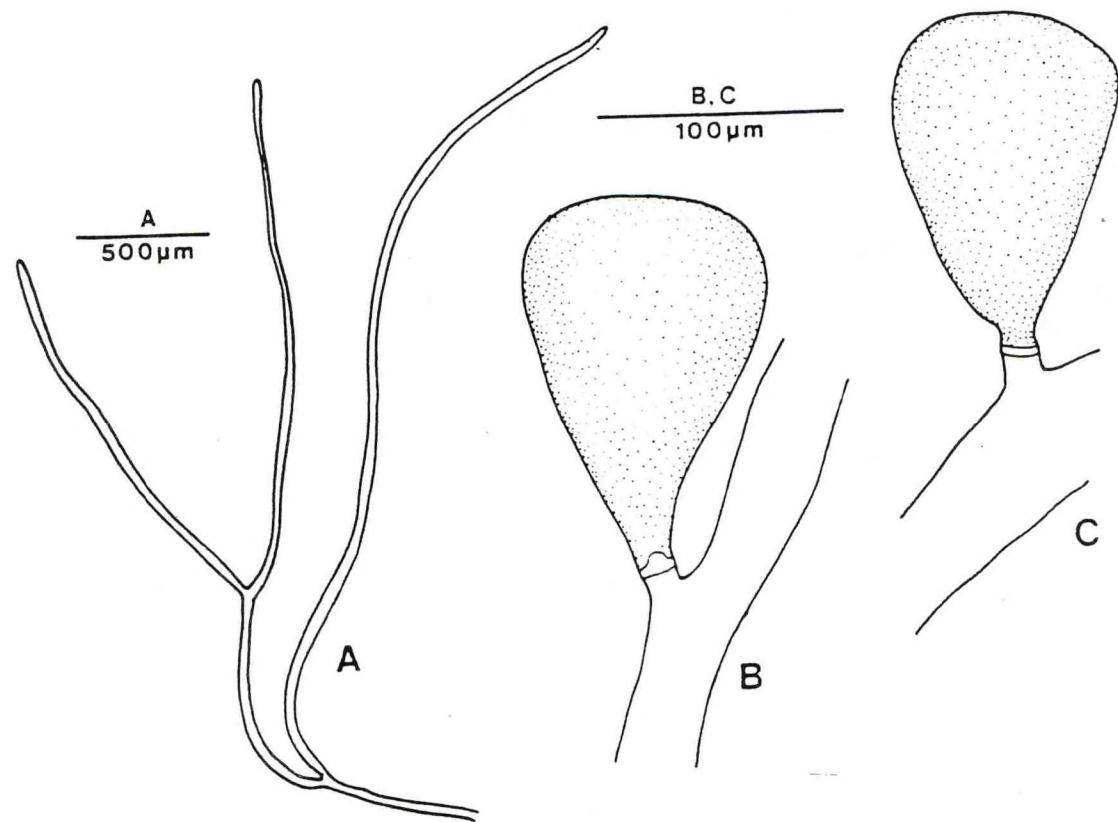


Figure 10. Derbesia turbinata

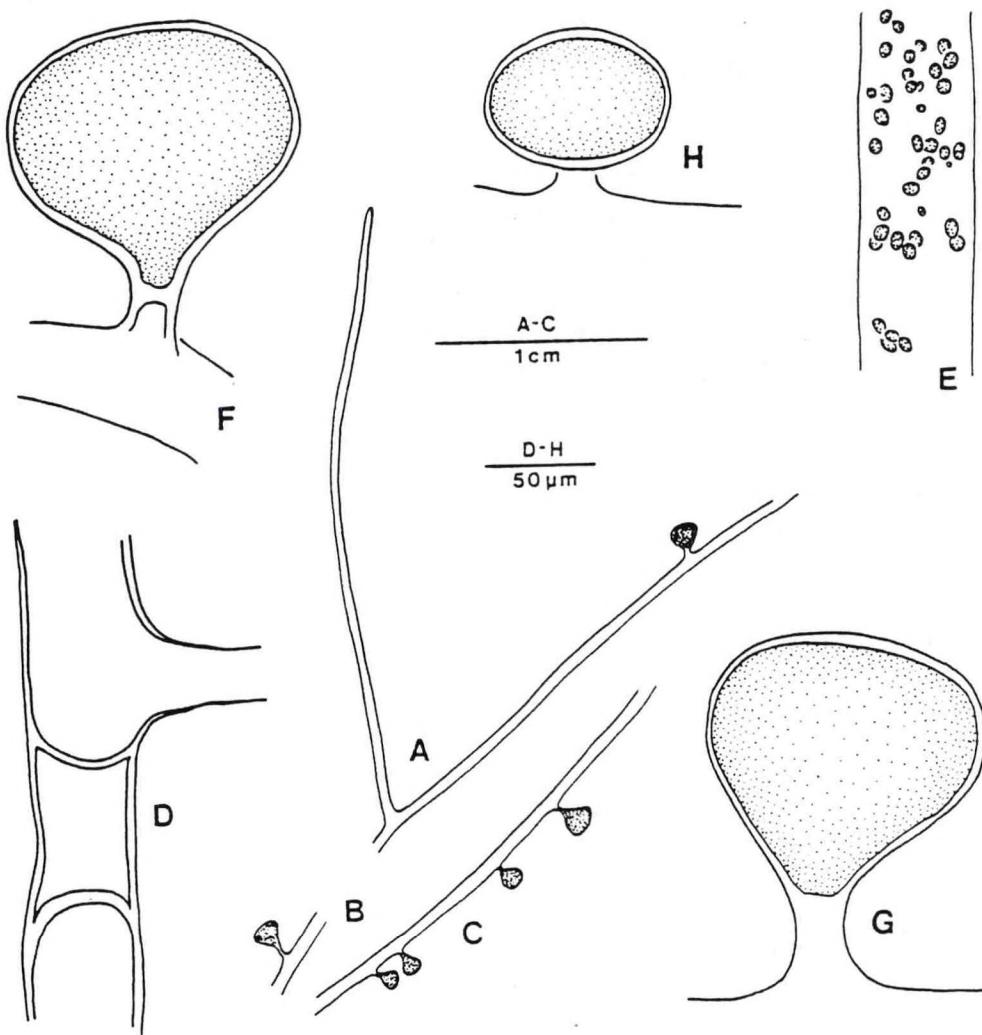


Figure 11. Derbesia sp.

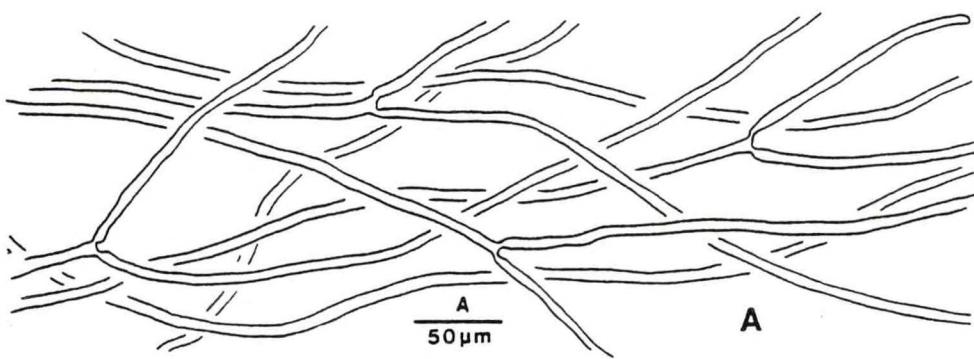


Figure 12. Boodeopsis pusilla

and forming mats; filaments di-trichotomously or irregularly branched, constricted just above the dichotomies; lower filaments to 90 μ m diam, often colorless, of irregular contour, not sharply constricted, though often forming cross walls, narrowing into rhizoids; upper filaments more frequently branched, 23-45 μ m diam, strongly constricted at the base of each branch. Pyriform to subspherical, sporangia-like structures sometimes present, 60-153 μ m diam, 82-207 μ m long.

Distributed through the tropical Atlantic as far north as Bermuda and North Carolina. Boodleopsis pusilla is a very common alga in the Sanctuary where it forms sand-filled mats on the rocks. No sporangia-like structures have been seen on the material from the sanctuary.

Codiaceae

CODIUM Stackhouse

Codium isthmocladum Vickers

Fig. 13 A-C

Erect plants to 20 cm tall composed of dark green, cylindrical branches dichotomously branched (to 12 orders), occasionally proliferously branched. Branches (2-2.5-4-5) mm diam, at times constricted above dichotomies; medulla filamentous, cortex a single layer of utricles (enlarged filament apices). Utricles subcylindrical to clavate or pyriform, 20-350(-475) μ m diam, 460-850 μ m long, often constricted to 130-260 μ m below the apex; apices rounded or truncate.

This is one of the common and conspicuous plants of the Sanctuary. Codium isthmocladum is endemic to the warm-temperate and tropical western Atlantic; its range extends as far north as North Carolina along the southeastern coast of the United States where it occurs occasionally in estuaries and very commonly in offshore waters. It appears that the plants are perennials; battered plants from the previous growing season were collected in the Sanctuary in March at the end of winter. These plants probably rejuvenate and renew growth in the spring.

Caulerpaceae

CAULERPA

Caulerpa mexicana Sonder ex Kuetzing

Fig. 14 A,B

Plants with grass-green erect branches arising from a spreading system of cylindrical, 0.5-1.25 mm diam stolons attached by fine rhizoids. Erect branches stalked, pinnately branched, with a flattened axis bearing flattened, closely spaced, arcuate, 2-10 mm long branchlets which terminate in a small spine.

This species has a tropical western Atlantic distribution ranging from Brasil north to Gray's Reef, which is its northern-most limit. The species has been seen in only one location within the Sanctuary, along the base of a ledge, but in successive years in the same place. This suggests it may be perennial.

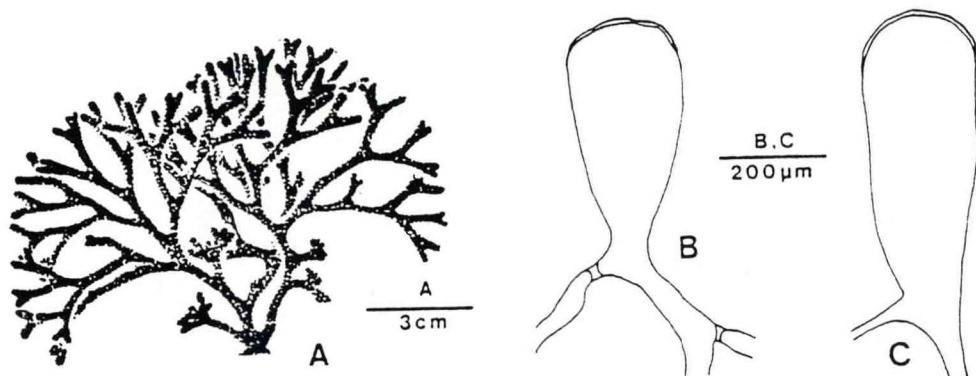


Figure 13. *Codium isthmocladum*

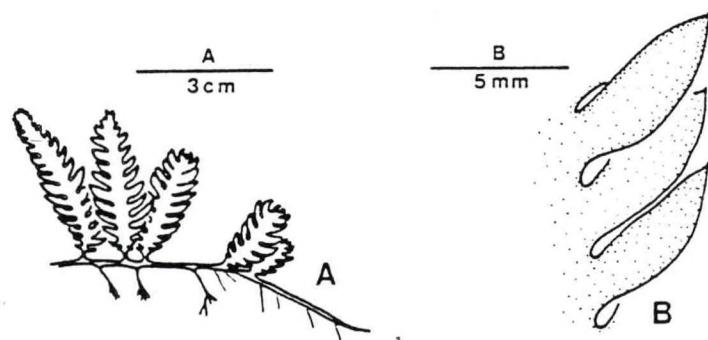


Figure 14. *Caulerpa mexicana*

Ectocarpaceae

PHAEOPHYTA

ECTOCARPALES

GIFFORDIA Batters

Erect, moderately to densely branched, uniserial plants. Branching usually irregular. Epiphytic, epilithic, or epizoic. Attached by rhizoids, prostrate filaments or both. Plastids numerous, discoid, with 0-2 pyrenoids per plastid. Meristems poorly defined or well defined and subtending hair-like filaments. Plurilocular sporangia/gametangia usually sessile. Unilocular sporangia uncommon in most species, typically sessile. Two species are found at Gray's Reef.

Giffordia mitchellae (Harvey) Hamel

Fig. 15 A,B

Plants golden brown, forming discrete tufts to 12 cm long or tangled mats to several decimeters long; attached by a few prostrate filaments or rhizoids; branching dense, irregular to spiral; upper branches ending in hair-like filaments or undifferentiated; main axes (17-)31-50 μ m diam, cells 1-4 diam long; meristematic regions short or indistinct, intercalary, scattered throughout the plant. Plurilocular sporangia sessile or rarely pedicellate, cylindrical or occasionally tapering slightly at apex, 42-220 μ m long, 15-36 μ m diam, locule dimensions usually 4-6 μ m; plurilocular structures of similar size and shape, but with either smaller or larger locules also reported; unilocular sporangia rare, ovate, sessile or on 1-celled pedicels, 50-100 μ m long, 25-50 μ m diam.

Found in warm-temperate and tropical seas world-wide, this species was collected in the sanctuary only once as a tiny, epiphytic plant with plurilocular sporangia. It is a very common plant in shallow water along the eastern coast of the United States during the warm water months.

Giffordia onslowensis Amsler & Kapraun

Fig. 16 A-E

Plants golden brown, epiphytic, forming entangled tufts to 5 cm long on larger algae; lower filaments sparsely, irregularly branched, 15-50 μ m diam, cells to 4 diam long, branches often short, arising in the middle of a cell; upper filaments often profusely branched, 4-22 μ m diam, arising from the upper part of a cell; meristematic regions short, intercalary, scattered, frequently indistinct. Plurilocular sporangia ovate to conical, 22-63(-72) μ m long, 10-23(-27) μ m diam, sessile, or on 1- several celled pedicels.

Giffordia onslowensis was previously known only from Onslow Bay, North Carolina where it is also a plant of deep, offshore waters (Amsler & Kapraun, 1985). Some of the plants from the Sanctuary appear to certainly be this species (Fig. 16 A,C). These were plants tangled in other algae, without any clear attachment and have the branching and meristem characteristics of the species as well as plurilocular sporangia fitting within the described limits of the species. One collection differs in some respects from the species (Fig. 16 B,D,E). It was attached to Dictyota dichotoma blades, not simply entangled; the

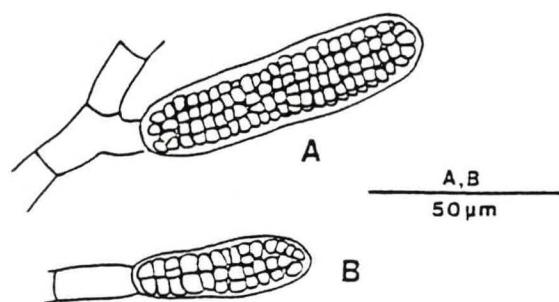


Figure 15. Giffordia mitchellae

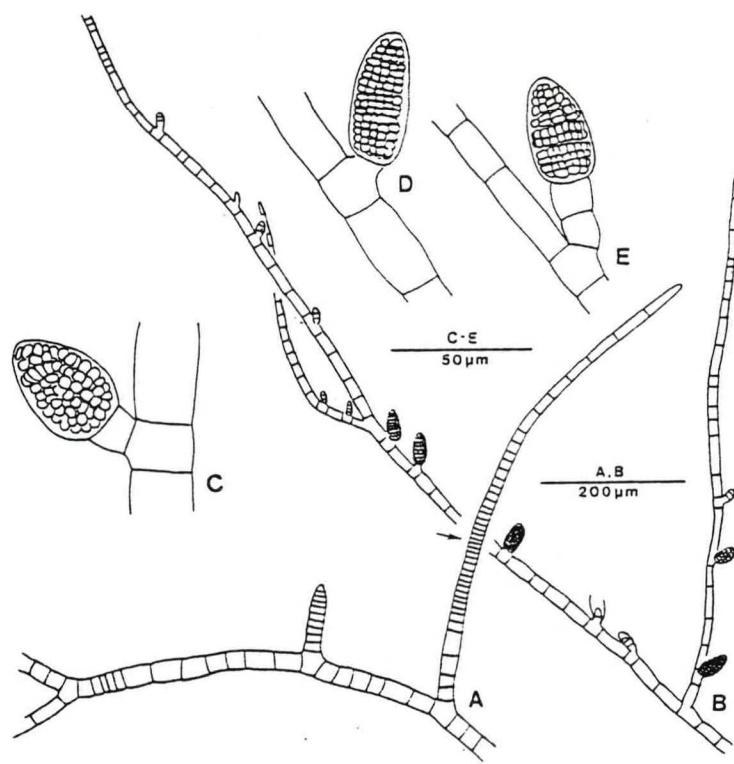


Figure 16. Giffordia onslowensis

filaments were slender, 15-18(-23) μm maximum diameter, whereas the species was described as having filament diameters of 20-50 μm in the lower filaments; some of the plurilocular sporangia were larger, to 63(-72) μm long, 23(-27) diam, than those originally described for Giffordia onslowensis (22-52 μm long by 10-20 μm diam).

SPHACELARIALES

Choristocarpaceae

ONSLOWIA Searles

Onslowia endophytica Searles & Leister

Figs 17 A-D, 36 A

Plants endophytic, filamentous, growth apical; filaments uniserrate, occasionally biserrate, 8-11 μm diam; branching irregularly alternate; emergent filaments forming either multicellular, colorless hairs with basal, trichothallic growth, or stalked, globose cells which divide longitudinally to form a group of 4 cells each of which enlarges and then cuts off a single, lens-shaped cell from its outer surface. These 8 cells and the terminal cell of the stalk form a 9-celled, rectangular, cushion-shaped propagule. The lens-shaped cells and the stalk cell can initiate new filaments.

Initially reported from North Carolina waters (Searles & Leister, 1980), Onslowia endophytica is a common endophyte in Halymenia floridana where it forms golden brown patches of several square centimeters extending under the cortical tissue of the host.

DICTYOTALES

Dictyotaceae

DICTYOTA Lamouroux

Dictyota dichotoma var. mentrualis Hoyt

Fig. 18 A-E

Plants golden brown, to 29 cm tall, branching dichotomous, at 15-45 degrees; blades entire, sometimes twisted, internodes 1-2.5 cm long, to 16 mm broad, progressively narrower in successive internodes from the base; growth apical, from a single prominent apical cell; blades three cells thick, the inner cells large and colorless, the outer cells smaller and pigmented. Dioecious; oogonia and antheridia produced in sori, once per month, at spring tides; sporophytes with scattered tetrasporangia which are produced continuously.

Schnetter *et al* (1986) have reported that the plants of the western North Atlantic and Caribbean are distinct from the species dichotoma and they will publish the new combination recognizing variety menstrualis as a separate species.

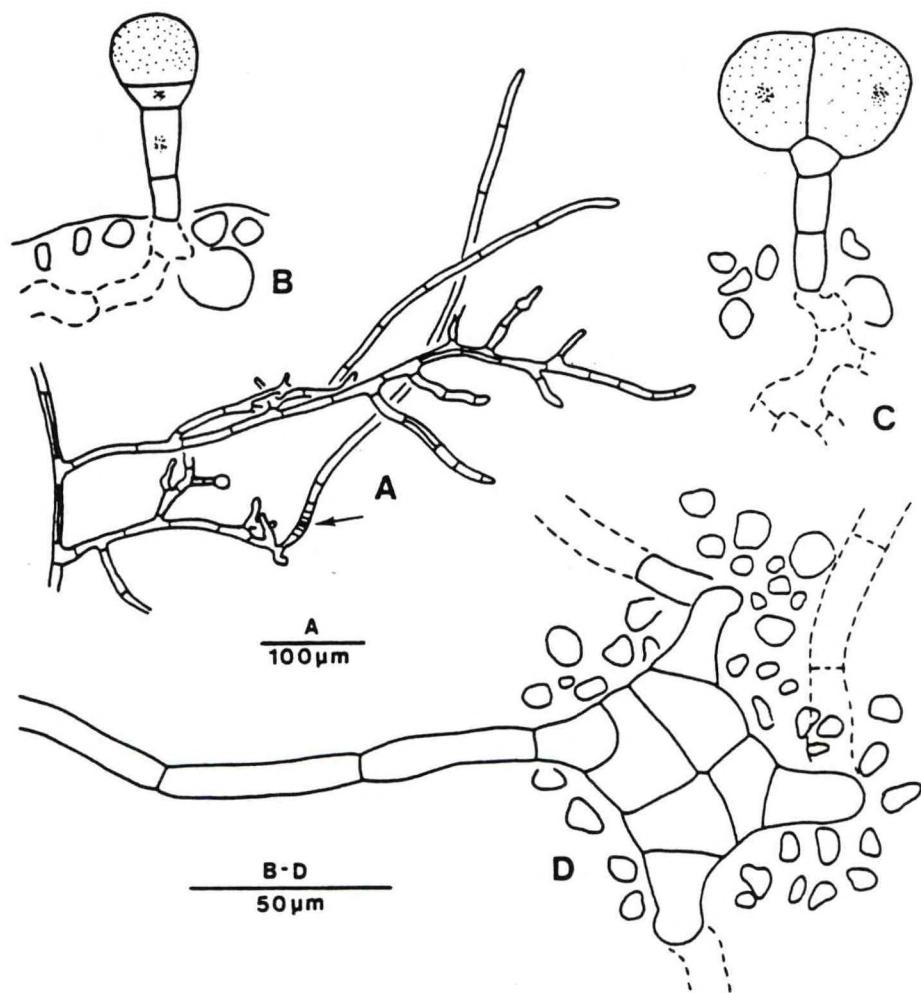


Figure 17. Onslowwia endophytica

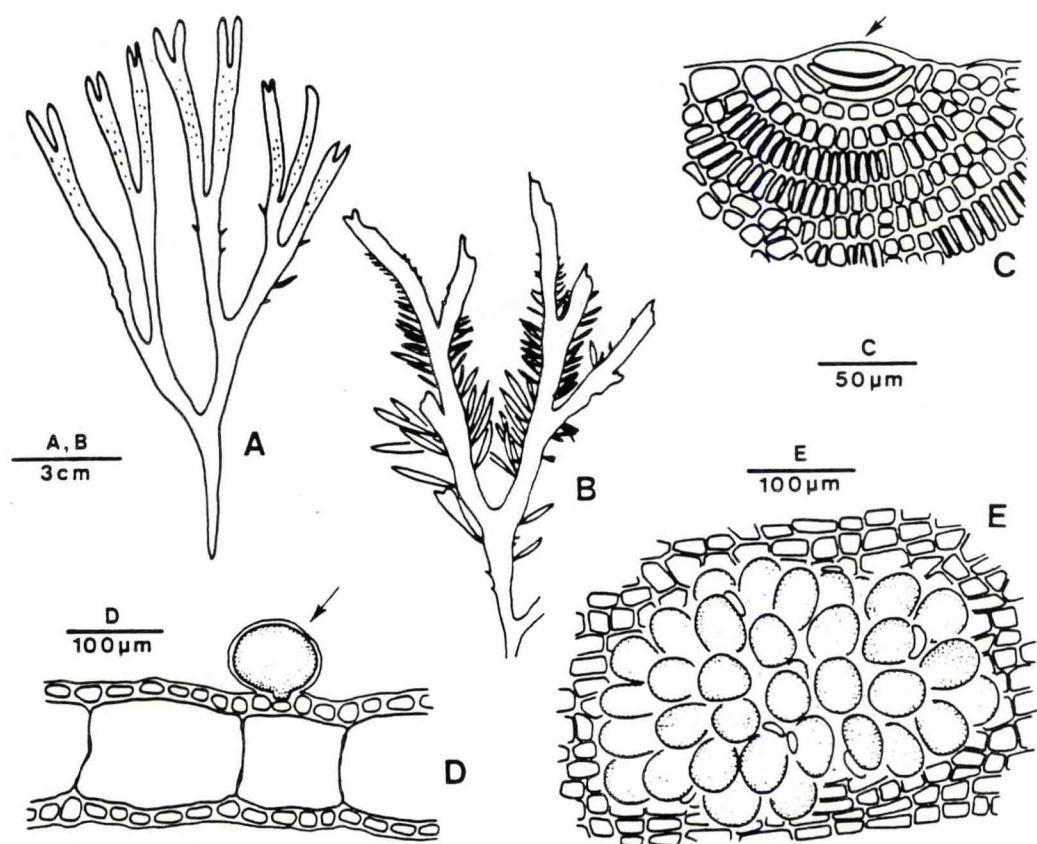


Figure 18. Dictyota dichotoma var. mentrualis

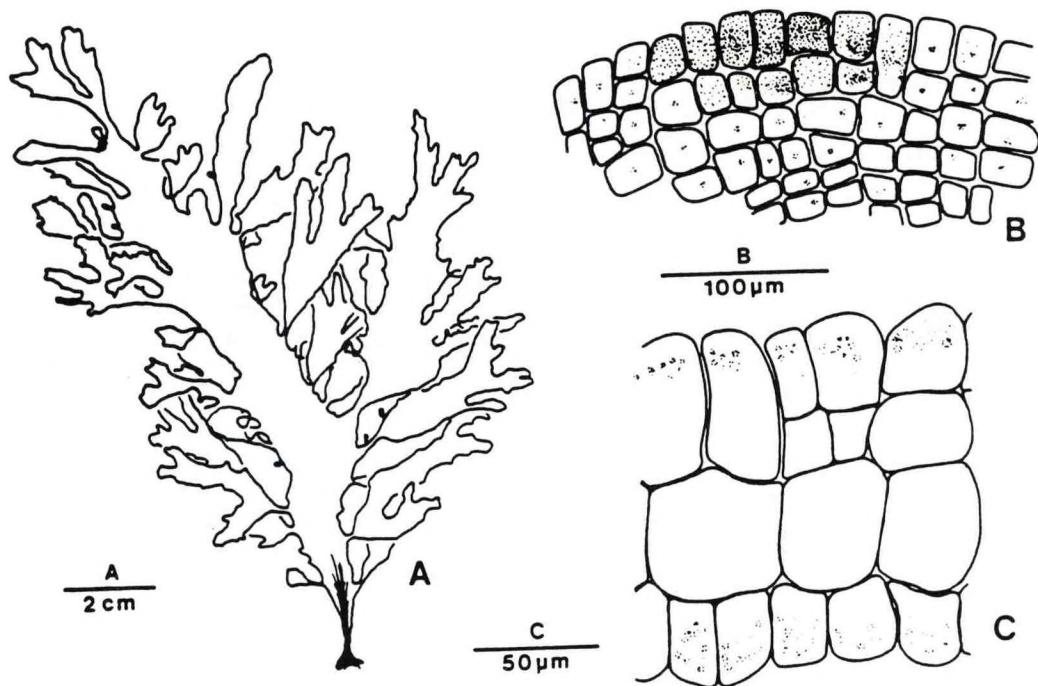


Figure 19. *Spatoglossum shroederi*

SPATOGLOSSUM Kuetzing

Spatoglossum schroederi (C. Agardh) Kuetzing

Fig. 19 A-C

Plants golden brown, to 30 cm tall, older plants stalked; primary branches alternate, subdichotomous, or palmately lobed, 0.5-3(-4) cm broad; margins sometimes undulate, dentate, usually richly proliferous; apices rounded and the apical meristem a marginal row of cells; segments 0.5-2.5(-4) cm broad, 4 or more cells thick, the inner cells larger than the surface layer. Dioecious; oogonia scattered; antheridia in small sori; tetrasporangia scattered.

A plant of the warm-temperate and tropical western Atlantic. Taylor (1960) reports Spatoglossum schroederi as uncommon elsewhere, but it is one of the larger and more common brown algae in the Sanctuary. It is found at the edges of the ledges and emerging through the sand on the flats behind the ledges.

DICTYOPTERIS Lamouroux

Dictyopteris hoytii W. Taylor

Fig. 20 A

Plants golden brown, bushy, to 45 cm tall, attached by a felt-like cushion of rhizoidal filaments, branching dichotomous to subdichotomous; internodes to 8 cm long, 1.4-4 cm broad, 90-150 μ m thick, the margins entire to conspicuously aculeate-dentate, teeth 0.5-1 mm long; apices with a cluster of marginal meristematic cells behind which a prominent midrib forms; blades 90-150 μ m thick with 2-4 layers of large medullary cells and a layer of small cortical cells on the blade surface; delicate lateral veins extending at intervals of 2-3 mm from the midribs. Oogonia scattered singly or in clusters of 2-3 over the blade surface; tetrasporangia in narrow sori parallel to the lateral veins.

Originally reported by Taylor (1960) from North Carolina and Venezuela, and by Wiseman (1978) from South Carolina, the plants in the Sanctuary form the southern limit of distribution of Dictyopteris hoytii in the United States. The species occurs as scattered individuals on the flats just behind the edge of ledges.

SCYTOSIPHONALES

Scytoniphonaceae

ROSENVINGIA Boergesen

Rosenvingia intricata (J. Agardh) Boergesen

Fig. 21 A-C

Plants golden brown, 30-40 cm tall, matted and tangled, soft in texture, usually abundantly branched; branches hollow, interadherent, contorted, 1-10 mm diam, markedly narrowed from the main axis to branchlets, the tips attenuate; cells of the outer cortex pigmented, angular, 9-19 μ m in surface view, inner cells colorless, 28-37 μ m broad, 56-131 μ m long.

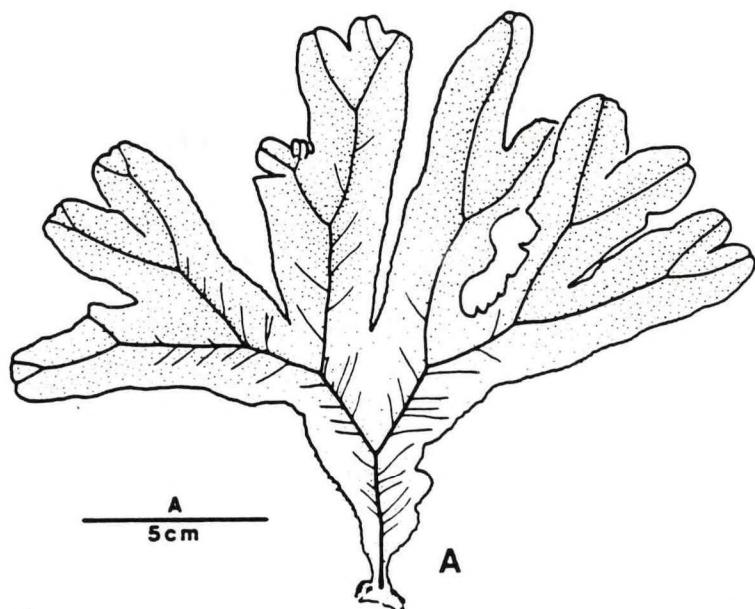


Figure 20. *Dictyopteris hoytii*

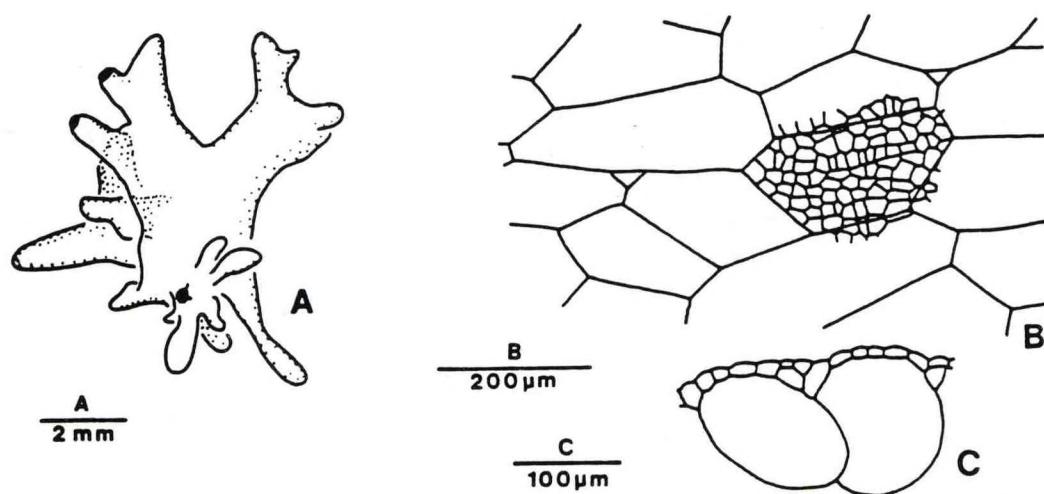


Figure 21. *Rosenvingia intricata*

The species occurs in the tropical western Atlantic in shallow and deep waters. Only a single small, immature plant was collected in the Sanctuary growing on rock at the edge of a ledge and it is only tentatively assigned to this species.

COLPOMENIA Derbes & Solier

Colpomenia sinuosa Derbes & Solier

Fig. 22 A-C

Plants epiphytic or lithophytic, golden brown, globose, or becoming papillate or lobed, to 12(-15) cm diam, initially solid, but soon becoming hollow; vesicle wall 0.3-0.4 mm thick; inner cells colorless, to 180 μ m diam; surface cells pigmented, angular, 4-8(-16) μ m in surface view; colorless hairs in clusters, associated with sori of plurilocular reproductive structures. Plurilocular structures biseriate, 4-8 μ m diam, 18-30 μ m long.

The species is a common plant in warm-temperate and tropical seas world wide. In the Sanctuary it is an occasional epiphyte on larger brown algae.

FUCALES

Sargassaceae

SARGASSUM C. Agardh

Sargassum filipendula C. Agardh

Fig. 23 A,B

Plants golden to dark brown, to 100(-200) cm tall, attached by a conical, lobed, spreading holdfast; primary axis smooth, sparingly forked, branchlets bearing stalked leaves alternately; leaves serrate to subentire, 5-8(-13) mm broad, 3-8 cm long, linear-lanceolate, simple, or those in lower parts of plant sometimes forked; midrib distinct, cryptostomata present, scattered; floats spherical, 3-5 mm diam, sometimes apiculate, stalked, the stalks to 5 mm long. Receptacles simple, forked or sparsely racemosely branched, axillary in the upper parts of the plant, the raceme 0.3-0.5 as long as the subtending leaf.

Sargassum filipendula grows north as far as Massachusetts and south to Brasil. It is a conspicuous plant in the Sanctuary where it grows along the ledges and on the flats behind the ledges. It often has many epiphytic algae and invertebrate animals on the older stems and leaves. It appears to be a perennial plant which dies back in the fall to a few leaves, the basal stems and one or two enlarged, spindle-shaped branch ends, which may function as storage structures. Plants with fresh, new leaves and old stems were collected in early March.

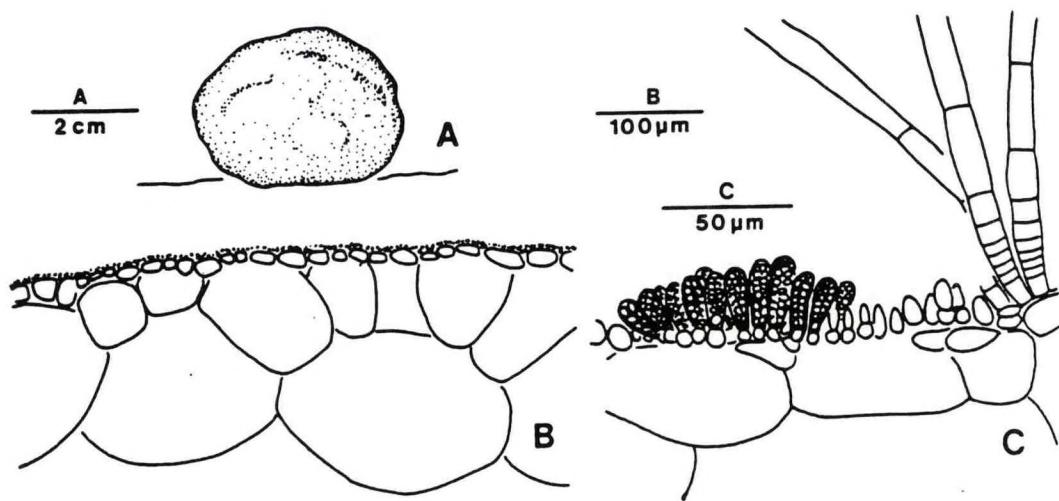


Figure 22. Colpomenia sinuosa

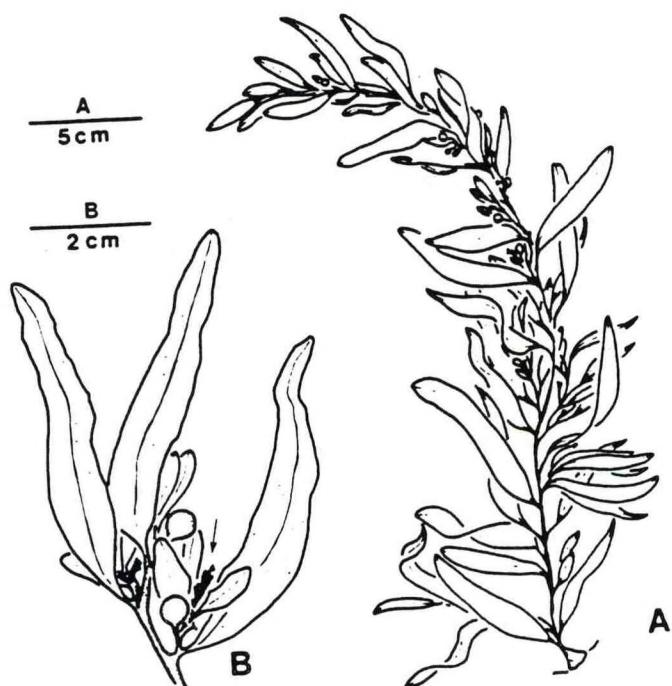


Figure 23. Sargassum filipendula

RHODOPHYTA
PORPHYRIDIALES

Goniotrichaceae

STYLONEMA Reinsch

Stylonema alsidii (Zanardini) Drew

Fig. 24 A

Plants epiphytic, to 6 mm tall, but usually 1 mm or less, attached by simple basal cells. Pseudofilaments simple or more commonly subdichotomous to irregularly branched, uniserial, 12-35 μ m diam above; loosely and irregularly organized below, to 50 μ m diam. Cell shape varied, commonly spherical, ellipsoidal or cylindrical, 6-13 μ m diam, 4-13 μ m long, each with a single stellate plastid with a single pyrenoid. Monospores dispersed by breakdown of the gelatinous wall.

Cosmopolitan in temperate and tropical seas. Seen occasionally on larger algae in the Sanctuary. Usually reported as Goniotrichium alsidii (Zanardini) Howe; Wynne has recently (1985) argued for replacement of the species in the genus Stylonema.

ERYTHROPELTIDALES

Erythropeltidaceae

ERYTHROCLADIA Rosenvinge

Erythrocladia irregularis f. subintegra (Rosenvinge) Garbary

Fig. 25 A

Plants epiphytic or epizoic, to 300 μ m across, forming a compact, uni- multistratose disc. Marginal cells forked; central cells rectangular to oblong, irregular, 2-5 μ m broad, (2-)7-13 μ m long. Monosporangia formed from central disc cells by oblique, curving walls, globose to subglobose, 3-5 μ m diam; sexual reproduction unknown.

A cosmopolitan species. It is common in the sanctuary where it is frequently encountered on the blades of dictyotalian brown algae and some red algae. It is often referred to as the species Erythrocladia subintegra Rosenvinge rather than as a form of E. irregularis (Taylor, 1960).

ERYTHROTRICHIA Areschoug

Erythrotrichia carneae (Dillwyn) J. Agardh

Fig. 26 A,B

Plants epiphytic, to 8 cm tall, but usually less than 0.5 cm long; uniserial below, occasionally becoming bi- multiseriate above, 15-60 μ m diam; basal cell with lobed

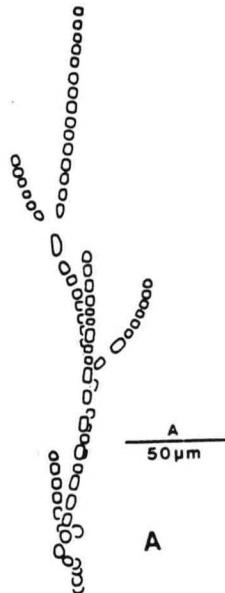


Figure 24. Stylnonema alsidii

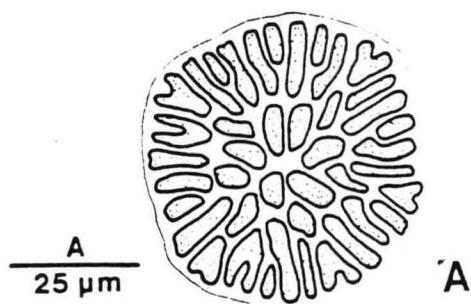


Figure 25. Erythrocladia irregularis f. subintegra

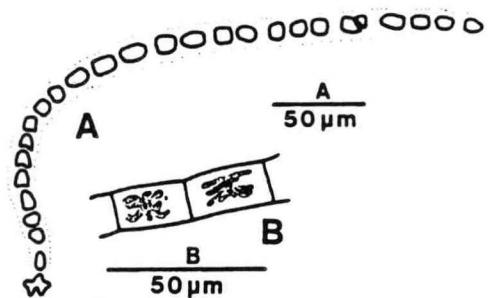


Figure 26. Erythrotrichia carneae

rhizoidal attachments or occasionally a minute, prostrate disc. Cells of the filament swollen, rectangular to irregular, 15-20 μm diam, 12-25(-32) μm long above, 9-13 μm diam, 12-40 μm long below. Monosporangia cut off by an unequal, curved, oblique division, globose, 13-18 μm diam.

Widespread in temperate and tropical seas. In the Sanctuary it is an infrequent epiphyte. All the examples seen were strictly unisexual and lacked sporangia.

NEMALIONALES

Acrochaetiaceae

AUDOUINELLA Bory

Plants endo- or epiphytic, less frequently on rocks, developing from a persistent, undivided spore, a basal spore with accessory cells, a prostrate filamentous system, or a parenchymatous disc. Erect filaments unisexual, cells with 1- several plastids, with or without pyrenoids. Gametophytes with spermatangia and sessile or pedicellate carpogonia; carposporophytes naked. Asexual reproduction by mono- bi- tetra- or polysporangia.

The algae in this family have been the subject of much study resulting in different taxonomic interpretations. They are treated here as a single, very probably polyphyletic, genus. Some of them are probably stages in the life histories of algae placed in other genera. Schneider (1983) has recently reviewed the taxonomy of the species in nearby North Carolina. Three species are reported here from the Sanctuary.

Audouinella bispora (Boergesen) Garbary

Fig. 27 A

Plants epi- endophytic, to 1.5 mm tall, arising from irregularly ramified, spreading prostrate filaments; prostrate cells cylindrical to irregular, to 17.5 μm in greatest dimension, all capable of producing erect filaments. Erect filaments radially to irregularly branched and rebranched, branches infrequent below, more abundant above, narrowly angled from the axes which bear them, tapering toward the apices; cells cylindrical, 2.5-8 μm diam, 10-32 μm long in the main axes, 1-3 μm in the ultimate segments, occasionally ending in long, multicellular, lightly pigmented hair-like extensions, each cell containing a well developed parietal plastid with a single large pyrenoid. Gametangia unknown; monosporangia terminal or lateral on short branches to adaxial on longer axes, sessile or on 1-celled pedicels, single or paired, narrow, ovoid to oblong, 5-6 μm diam, 9.5-12.5 μm long; bisporangia situated as monosporangia, single or paired, broad, ovoid to ellipsoidal, 7.5-11.5 μm diam, 12.5-17.5 μm long.

Previously reported only from the Virgin Islands and North Carolina. Noted here growing on Plenosporium boergesenii and Dictyota dichotoma. No bisporangia were seen, only monosporangia. In treatments recognizing the genus Acrochaetium (e.g. Taylor, 1960) this species is listed as Acrochaetium bisporum Boergesen.

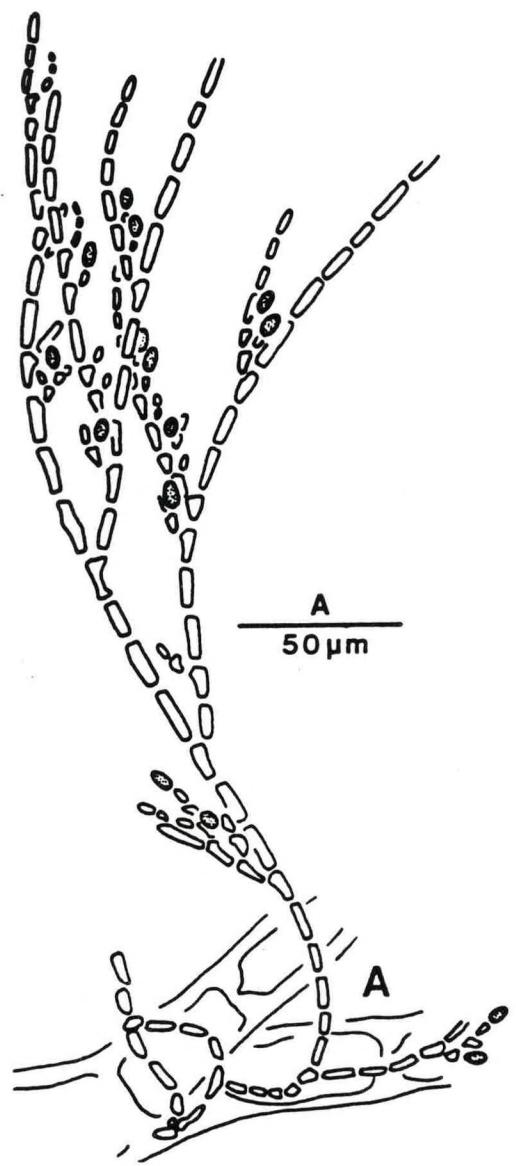


Figure 27. *Audouinella bispora*

Audouinella hoytii (Collins) Schneider

Fig. 28 A

Plants epiphytic, 0.2-1.3 mm tall, from a persistent large, globose spore; spore superficial to slightly embedded in host tissue, 9-15(-28) μm diam including a 2-3 μm thick wall, elongating to 30 μm , clearly broader than the 1-2(4) erect filaments it produces, or the 1-few accessory cells which are rarely formed. Main axes cylindrical, branching infrequent to frequent, often secund, cells 5-7 μm diam, 10-20 μm long, each with a single parietal plastid with a large central pyrenoid; ultimate branches tapering to 2-3 μm diam. Monosporangia secund or lateral on upper parts of the plant, sessile or on 1-celled pedicels, oblong, 5-7.5 μm diam, 11-15 μm long; carposporophytes rare, borne on short pedicels near the base of branches.

Previously known from North Carolina and South Carolina, the sanctuary records are a slight southern extension of its range. It is observed as an epiphyte on dictyotalian algae.

Audouinella ophioglossa Schneider

Fig. 29 A-E

Plants epi- endophytic, 1-3.2 μm tall, arising from a persistent, large, globose spore, 7.5-12.5 μm diam, which produces 1-2 erect, branched axes and usually, but not always a single branched or unbranched penetrating, endophytic filament. Endophytic filament, contorted, often forked, 2-4 μm diam. Erect branching secund to alternate and opposite, more common above; cells of erect branches cylindrical, 4-5 μm diam, 45-55 μm long in lower segments; each cell containing a single lobate to spiral parietal plastid with a single inconspicuous pyrenoid; unicellular hairs terminal or lateral, to 2 mm long, often associated with gametangial branches. Monoecious; spermatangial branches in a whorl of 4, in opposite pairs, or less commonly single, in long series in the upper parts of the plant; spermatangia paired on one-cell pedicels, globose, 2.5 μm diam; carpogonia lateral, opposite or adjacent to a monosporangium, occasionally forming in a whorl of spermatangial branches, producing only one carposporophyte per node, often in long interrupted series; carposporangia terminal, globose, 10-15 μm diam; tetrasporangia unknown; monosporangia terminal on short branches, or lateral, secund to alternate or opposite, sessile or on 1-celled pedicels, single or in pairs, ovoid to ellipsoid, 6-12.5 μm diam, 12.5-20 μm long, commonly associated with gametangia.

Previously known only as an epiphyte of Dudresnaya crassa in North Carolina (Schneider, 1983), it occurs commonly in the sanctuary on that species and less frequently on Dudresnaya puertoricensis.

Chaetangiaceae

SCINAIA Bivonia

Scinaia complanata (Collins) Cotton

Fig. 30 A,B

Plants pale pink to rosy-red, erect from a small, discoid holdfast, to 8 cm tall, 7-9 times dichotomously branched. Branches 1-6 mm diam, turgid-gelatinous, smooth,

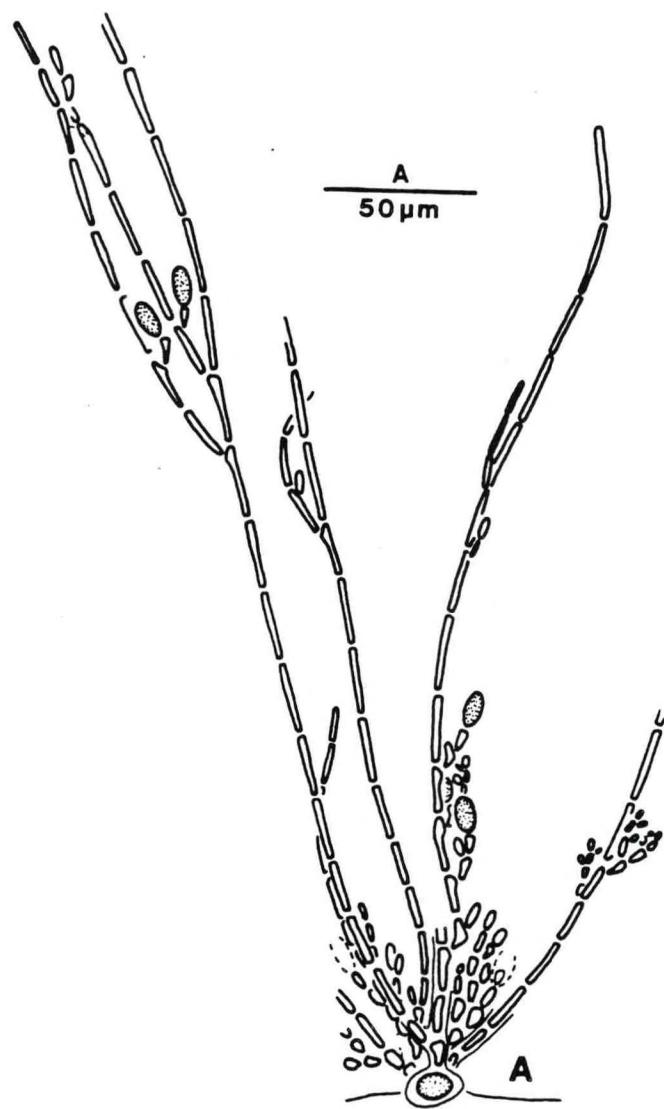


Figure 28. *Audouinella hoytii*

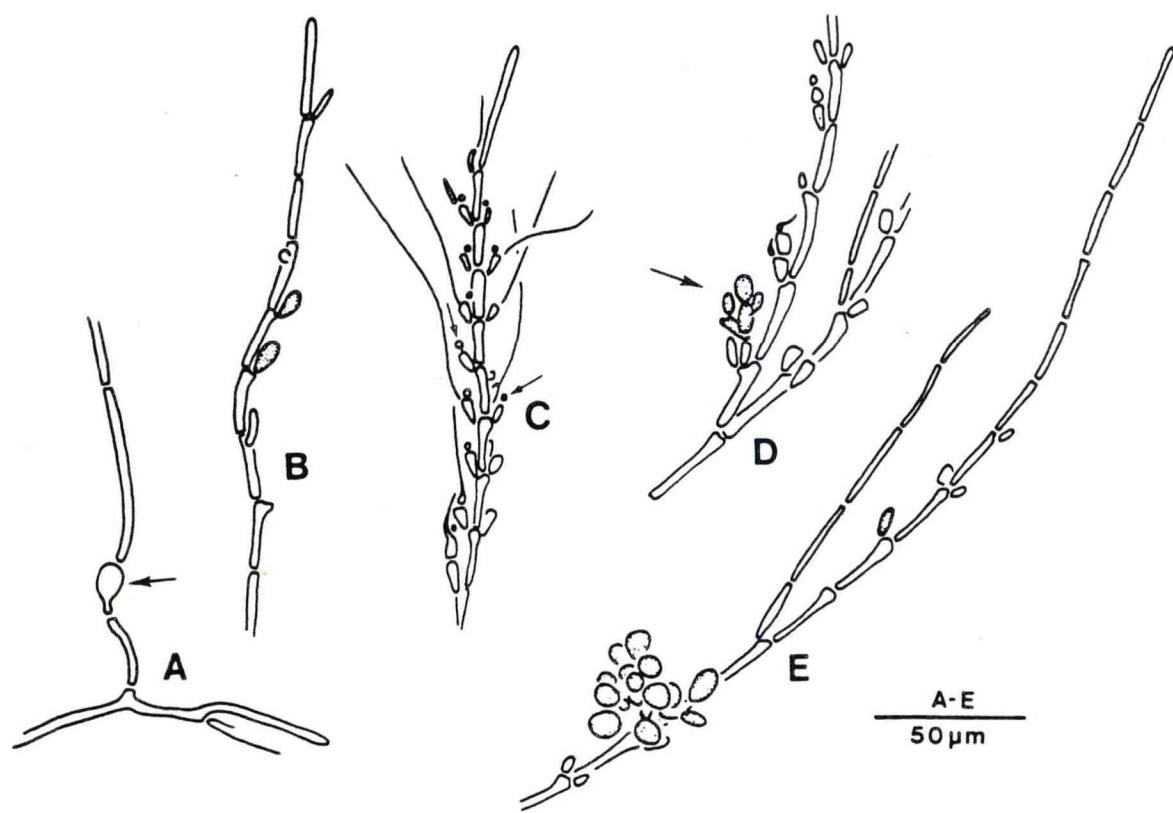
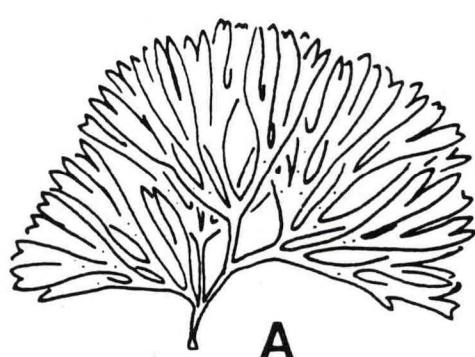


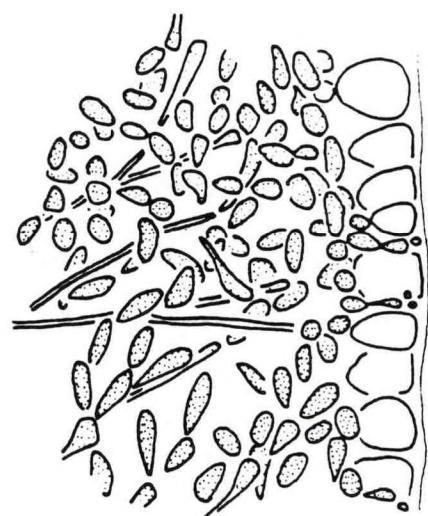
Figure 29. *Audouinella ophioglossa*



A

A
2 cm

B
100 μ m



B

Figure 30. Scinaia complanata

cylindrical to slightly flattened, if flattened, especially so below the nodes, rarely constricted at the nodes, internodes 4-7 times as long as broad, the ultimate segments fusiform, broader at the distal end; growth multiaxial, usually with a macroscopically visible central strand composed of up to 30 longitudinal filaments; epidermal cells hyaline, in surface view polygonal, triangular to subcircular and 12-44 μ m in greatest dimension, subquadrate to elongate rectangular in section, occasionally interspersed with smaller, pigmented cells; subsurface tissue composed of fusiform, pyriform or subglobose, darkly pigmented cells, loosely arranged. Monoecious; spermatangia globose, 2.5-7.5 μ m diam, single or in patches of 2(-4) between epidermal cells, formed over broad parts of the plant; cystocarps immersed, visible macroscopically, 145-350 μ m diam, 130-220 μ m tall, carposporangia narrowly obovate to ellipsoid, 4-5 μ m diam, 7.5-12.5 μ m long, in a terminal series of 2-3.

Known from North Carolina south to Brasil and from the Mediterranean, Japan and the eastern tropical Pacific. In the Sanctuary it is a fairly common seaweed growing along and just behind the ledges. Boergesen (1917-20) described a variety intermedia which is not recognized here, but is close to the Sanctuary plants in having mostly cylindrical branches, 1-2 mm diam, and having a distinct axial strand of 20-30 filaments.

Bonnemaisoniacae

FALKENBERGIA Schmitz

Falkenbergia hillebrandii (Bornet) Falkenberg

Fig. 31 A

Plants forming irregularly branched, creeping, tangled filaments attached by branched holdfasts; apical cells prominent, axes 30-80 μ m diam, a slender axial cell and three pericentral cells per segment, the pericentral cells rotated 60 degrees in successive segments.

Widespread in the tropical western Atlantic. In the Sanctuary and on the Snapper Banks it was a rare plant, growing intermingled with other small algae. This is the northern-most record of the species in the United States. Members of the genus are tetrasporophytes; Falkenbergia hillebrandii is placed in the Bonnemaisoniacae on the expectation that it is the tetrasporophyte stage of Asparagopsis taxiformis (Delile) Collins & Hervey, however the plants collected are sterile and, since Asparagopsis is not known this far north along the American coast and the plants collected are not forming sporangia, the tetrasporophyte is possibly persisting through fragmentation and vegetative propagation.

GIGARTINALES

Dumontiaceae

DUDRESNAYA Bonnemaison

Gametophyte plants erect, growth uniaxial, the apical cell exserted or inconspicuous and hidden among the vegetative filaments at the branch apex; axial cells in some species containing crystals; typically, but not exclusively with whorls of 4 determinate branches per axial cell; the flattened or cylindrical axes soft and mucilaginous. Carpogonial branches and auxiliary cell branches borne on inner cells of vegetative determinate

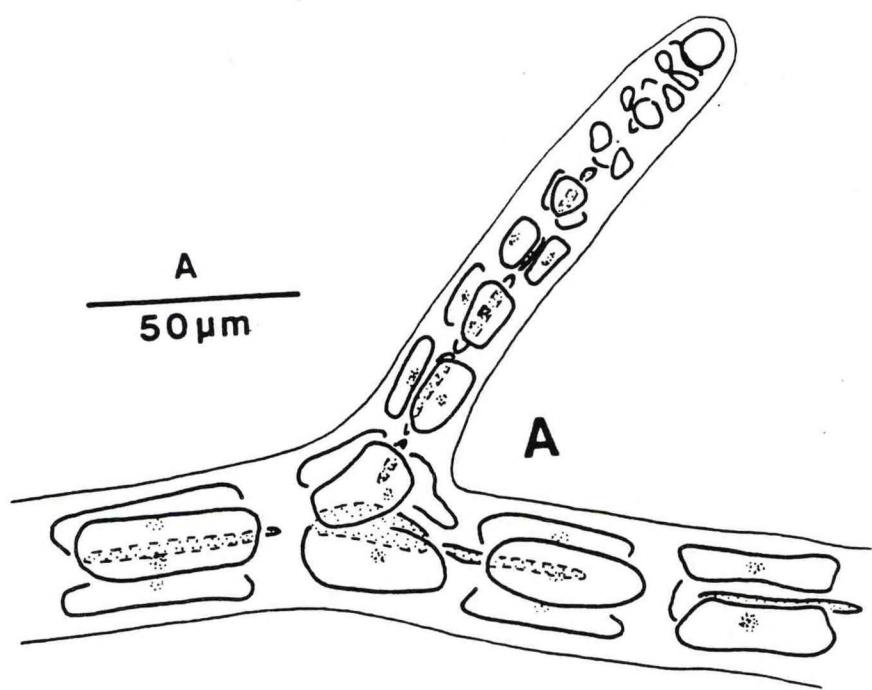


Figure 31. Falkenbergia hillebrandii

branches, carpogonial branches recurved, the carpogonium fusing with cells of the carpogonial branch after fertilization; auxiliary cell an intercalary cell, gonimoblast filaments produced from the connecting filament near the auxiliary cell, carposporophytes without pericarp or involucre, but buried among the determinate vegetative branches. Tetrasporophytes where known isomorphic with gametophytes or forming inconspicuous crusts; tetrasporangia divided zonately. Three species occur in the Sanctuary.

Dudresnaya crassa Howe

Fig. 32 A-E

Plants to 18 cm tall, branching radial, often crowded; axes cylindrical, to 5 mm diam, cortical branchlets in whorls of 4, distal assimilatory cells cylindrical; axial cells lacking crystals, to 165 μ m diam, surrounded by descending rhizoidal filaments. Dioecious; spermatangial plants smaller, and less robust than carpogonial plants; carpogonial branches 6-10 cells long, the third and fourth cells below the carpogonium fusing with the carpogonium after fertilization; auxiliary cell branch with 6-13 enlarged, deep staining cells near its base, the distal part of the branch reduced, or resembling vegetative branches, the auxiliary cell one of the enlarged cells or a smaller cell among the larger cells. Tetrasporangial plants isomorphic, tetrasporangia terminal on the assimilatory branches.

A species of the western tropical and subtropical Atlantic, it was originally described from Bermuda. Examination of Bermudian plants indicates some differences with those from the sanctuary and other localities in the prominence of the apical cell. These differences suggest a close, but diverging evolutionary history which will require further study. It is a common species in the Sanctuary growing along the ledges and on the flats behind the ledges. The plants are the largest and most conspicuous of the three Dudresnaya species which occur there.

Dudresnaya georgiana Searles

Fig. 33 A-E

Plants to 4 cm tall, lax, villose; apical cell exserted; axial cells without internal crystals, bearing whorls of four determinate lateral branches to 600 μ m long; the basal cells of lateral branches with up to 5 secondary laterals, some of which form descending rhizoidal filaments; branching of determinate branches lateral to subdichotomous distally, the cells cylindrical to ellipsoidal and progressively smaller toward the branch tips. Monocious, spermatangial mother cells lateral on distal cells of determinate branches; carpogonial branches (6-)8(-9) celled and often with short lateral filaments from the lower cells of the branch; auxiliary cell branches 10-12(-14) cells long, distal cells small and cylindrical, proximal cells large, deep-staining, and subspherical, one of these serving as the auxiliary cell, often with short lateral filaments from the lower cells of the branch; carposporophytes to 120 μ m diam. Tetrasporophytes unknown.

Reported only from the sanctuary (Searles, 1983) where it grows on the rock ledges and on large pieces of shell.

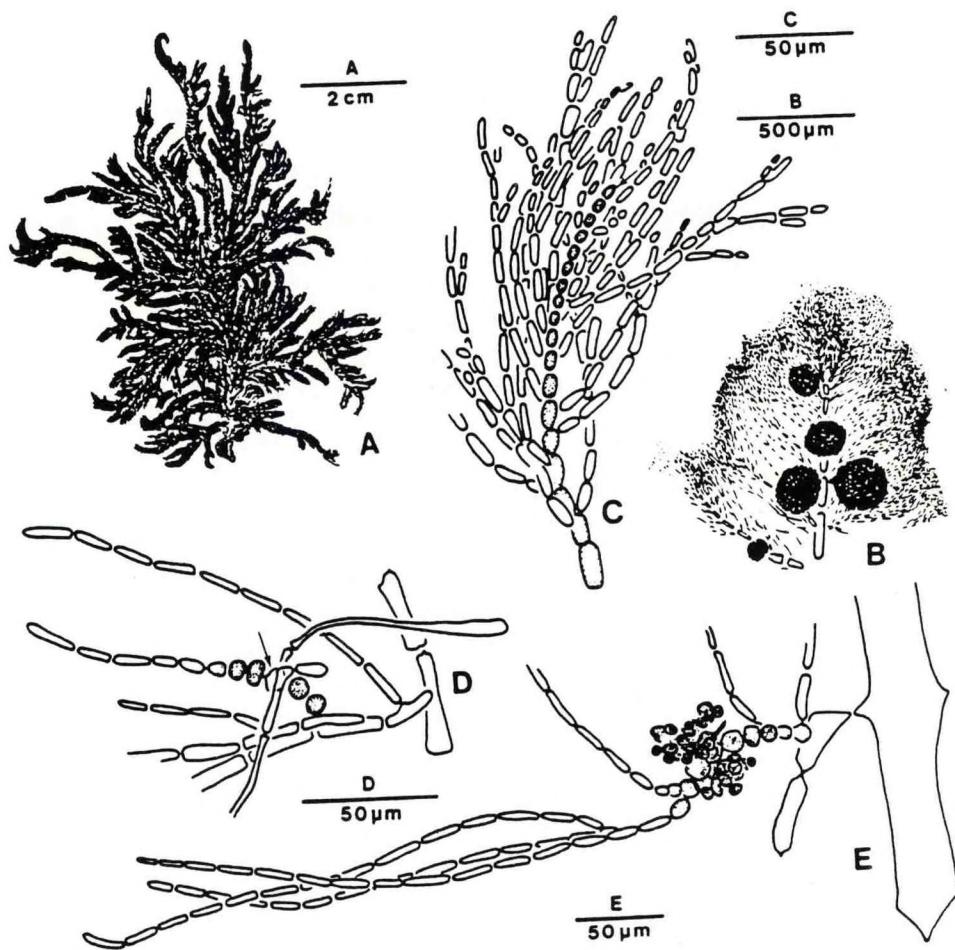


Figure 32. Dudresnaya crassa

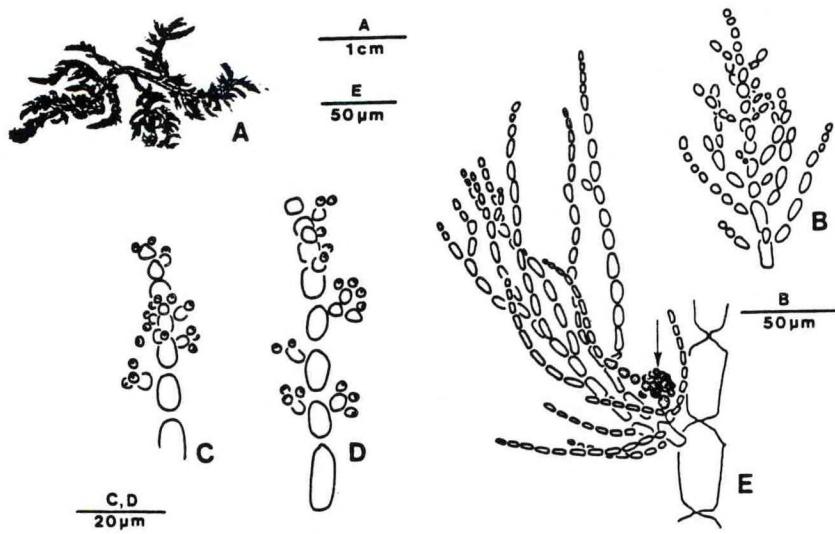


Figure 33. Dudresnaya georgiana

Dudresnaya puertoricensis Searles & Ballantine

Fig. 34 A-F

Plants epiphytic or on rocks, to 8 cm tall; axes soft, villose and sometimes annulate above, firmer and more distinctly cylindrical below, to 1.3 mm diam; apical cell exserted; axial cells 600-700 μ m long and forming elongate hexagonal to irregularly shaped crystals; determinate branches (3-)4(-5) per axial cell with elongate proximal cortical cells and ellipsoidal distal cells. Monoecious; spermatangia borne on terminal or subterminal cells of the subdichotomously branched determinate branches, spermatangia ovoid to spherical and 3 μ m diam; carpogonial branches 7-9 cells long, sometimes with a short sterile filament from the base; auxiliary cell branches with 4 or more large, deep-staining, subspherical cells near the base, one of which is the auxiliary cell, the branches terminate with cylindrical, weakly staining cells, short lateral branchlets form at the base of the branch and sometimes in the middle of the branch; carposporophytes to 140 μ m diam, carospores obovoid, pyriform to angular and to 9 μ m diam; tetrasporophytes unknown.

Originally discovered in Puerto Rico (Searles & Ballantine, 1986) and almost simultaneously in the Sanctuary where it grows primarily on unattached pieces of shell or coral skeleton. The species is very similar to D. georgiana which was originally described from small plants without clearly defined axes. D. puertoricensis is, however, larger, has less villose lower axes, has crystals in the axial cells, and has spermatangia restricted to terminal and subterminal cells of the subdichotomously branched determinate branches.

Cryptonemiaceae

HALYMENTIA C. Agardh

Plants erect, attached by a small discoid holdfast, variously branched, firmly gelatinous in texture and slippery to the touch; medulla filamentous, the filaments widely spaced in a gelatinous matrix, subcortical cells stellate in some species, cortex pseudoparenchymatous. Cystocarps buried, surrounded by a thin pericarp, discharging through a well defined pore; tetrasporangia cruciately divided, scattered among the cortical cells. Three species occur in the Sanctuary.

Halymenia agardhii De Toni

Fig. 35 A,B

Plants to 20 cm tall, attached by a discoid holdfast, dichotomously branched above a short stipe, branches cylindrical to 7 mm diam, narrowing in the upper segments and tapered to a point at the apex. Surface cells rounded-angular, (2-)4-10(-13) μ m diam. Tetrasporangia ovoid, to 23 μ m long.

Reported from Bermuda, North Carolina, Florida and south into the Caribbean. Halymenia agardhii is a common plant in the Sanctuary along ledges. This is the only local species in the genus with cylindrical branches. It resembles Sebdenia polydactyla in external appearance more than it does its sister species. It is distinguished vegetatively from S. polydactyla by its tapering branches and the absence of gland cells on the medullary filaments.

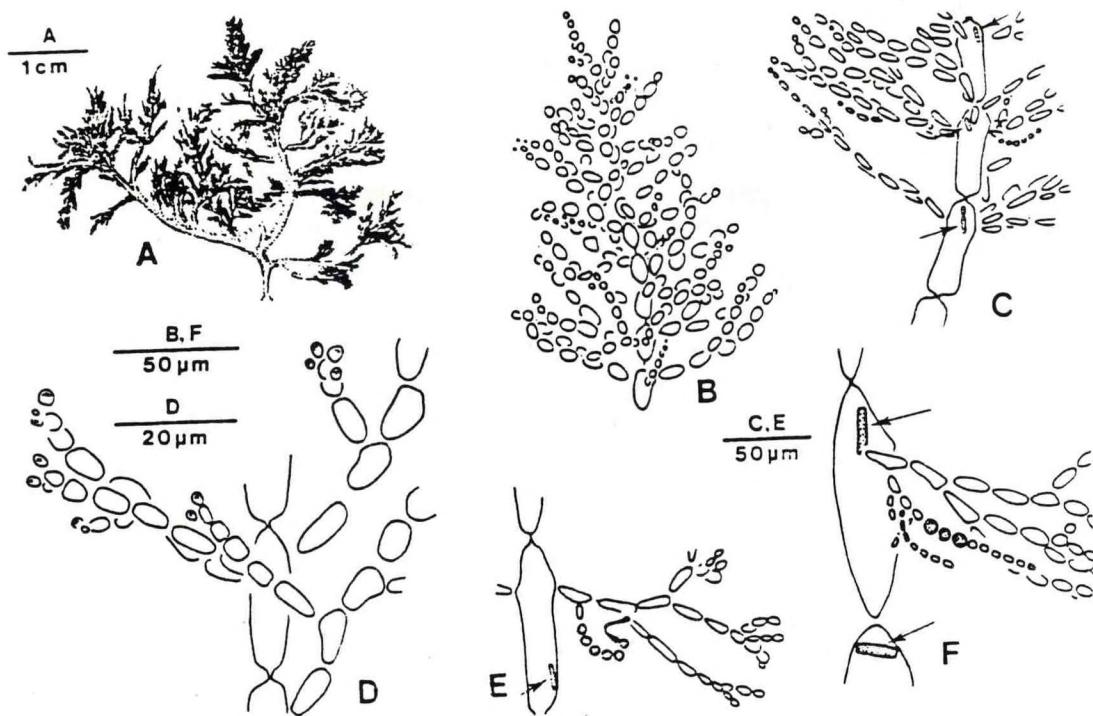


Figure 34. Dudresnaya puertoricensis

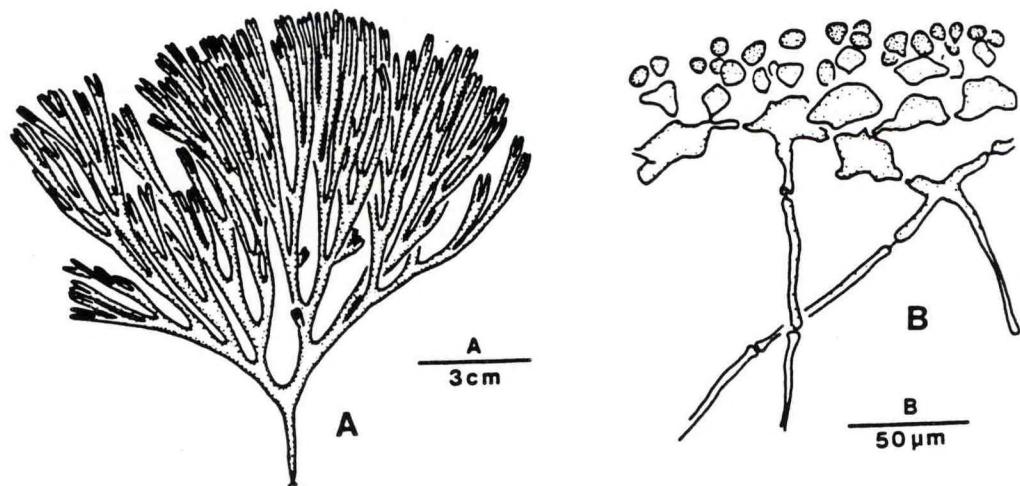


Figure 35. Halymenia agardhii

Halymenia floridana J. Agardh

Fig. 36 A-D

Plants to 20 cm tall with a short, cylindrical stipe and broad membranous blades; blades with a cuneate base, smooth or sometimes wrinkled, simple or divided into two or more lobes, thickness varying widely among plants from 60-600 μ m; cortex 1-4 cells thick, cells rounded in surface view; subcortical, stellate cells sometimes conspicuous. Cystocarps scattered, to 240 μ m diam; tetrasporangia to 13 μ m diam, 26 μ m long.

Reported from North Carolina south to Brasil. It is a conspicuous plant in the sanctuary where it grows on the flats behind the ledges where the rock is covered by a thin layer of sand as well as growing along the ledges. It is a highly variable plant in its shape and texture. Halymenia gelinaria Collins & Howe, described in 1916 as a distinct species, is here considered conspecific, exemplifying the morphological diversity of H. floridana. Many of the specimens are discolored and brownish due to extensive growths of the endophyte Onslowia endophytica. In older specimens, some epiphytic plants, particularly members of the Ceramiaceae, establish themselves on the blades in spite of the blades' slippery, mucilaginous surface.

Halymenia hancockii Taylor

Fig. 37 A-C

Plants to 10 cm tall with slender, 1-3 mm long stipes tapering into oblanceolate to somewhat linear blades with rounded apices; blades sometimes proliferating from the otherwise entire margins, rarely forked, to 40 μ m thick; cortex 1 cell thick, stellate, subcortical cells lacking. Cystocarps scattered in upper 3/4 of blades, to 280 μ m diam, with a large space, loosely filled with filaments, between the pericarp and the carposporophyte; tetrasporangia scattered, to 17 μ m diam in surface view.

Reported from Columbia and North Carolina. These are smaller, more delicate plants than Halymenia floridana. They were collected only once in the sanctuary in a sheltered spot at the base of a cleft between large rocks.

Gymnophylaceae

PREDAEA De Toni fil.

Predaea feldmannii Boergesen

Fig. 38 A,B

Plants to 30 cm tall, softly gelatinous, pale pink; irregularly branched and lobed, the axes cylindrical to broadly flattened. Medulla of slender filaments in a gelatinous matrix; cortical filaments dichotomously branched, the cells ovoid to cylindrical, 4-6 μ m diam and 3-7 times long as broad; rhizoidal filaments originating at the base of the cortical fascicles. Carpogonial branch 3-celled; auxiliary cell a large, intercalary, subspherical, deep-staining cell of the cortex associated with clusters of nutritive cells borne on the cells of the cortical filament adjacent to the auxiliary cell. Tetrasporangial plants microscopic, filamentous; branching irregularly alternate; tetrasporangia terminal, 12-19-(24) μ m long, 7-13 μ m diam, division of sporangia irregular, cruciate or zonate.

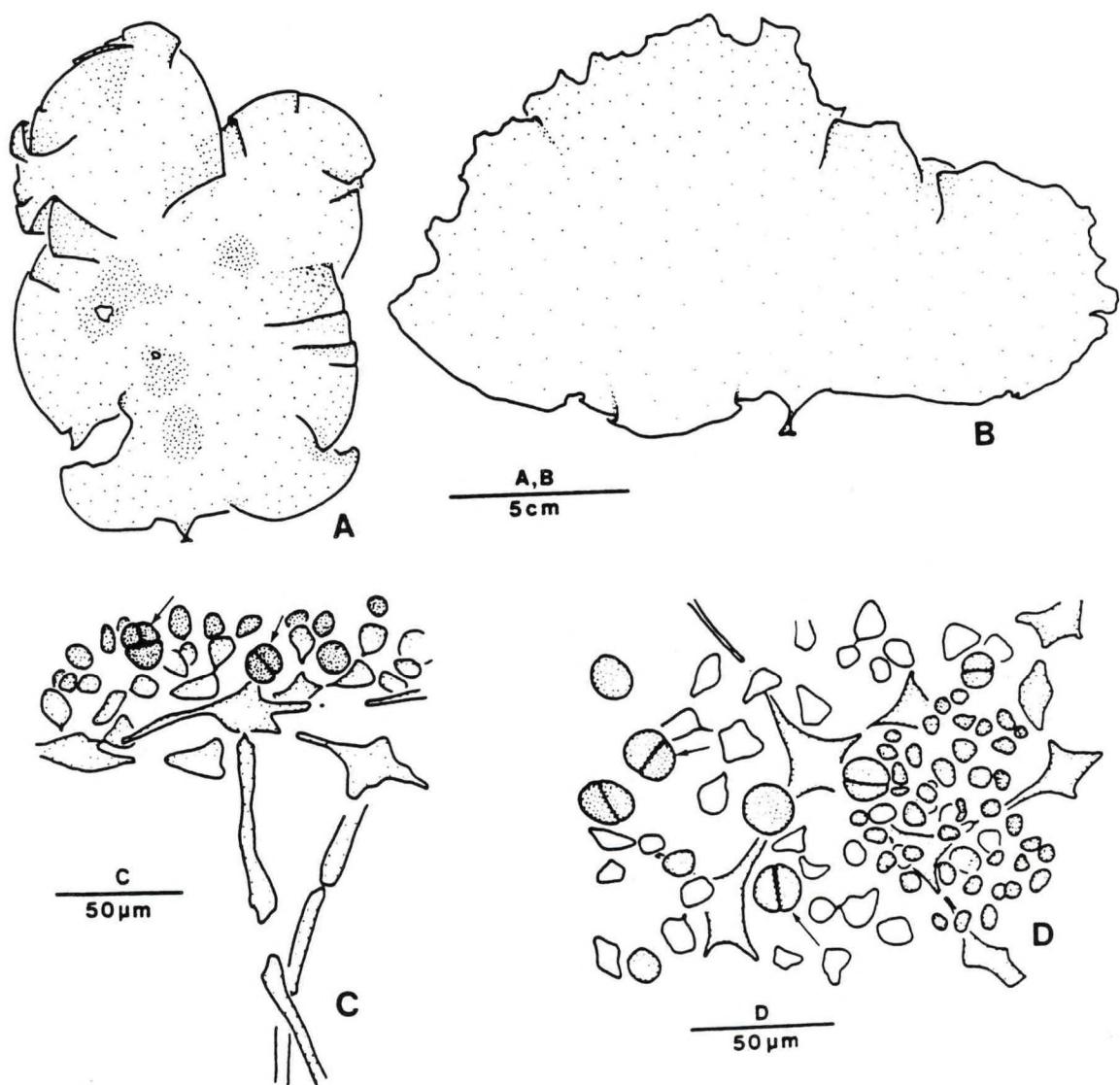


Figure 36. Halymenia floridana

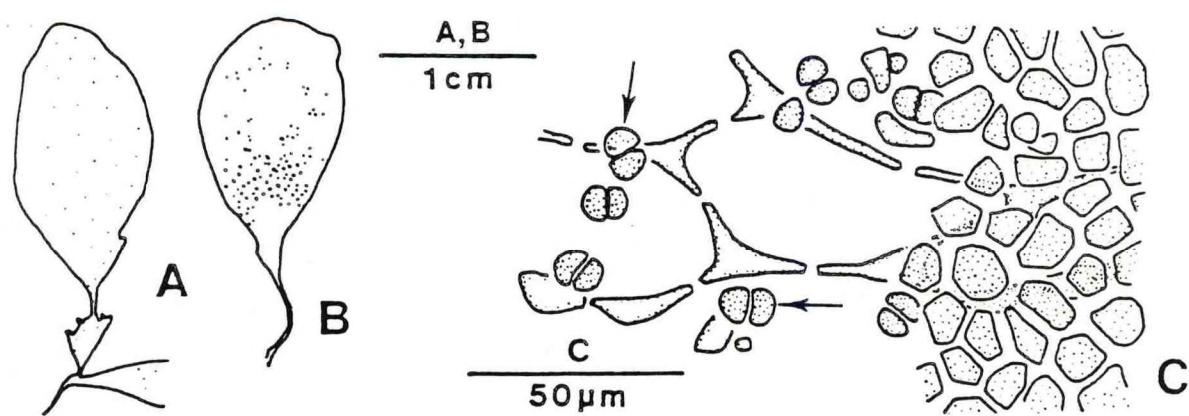


Figure 37. Halvmenia hancockii

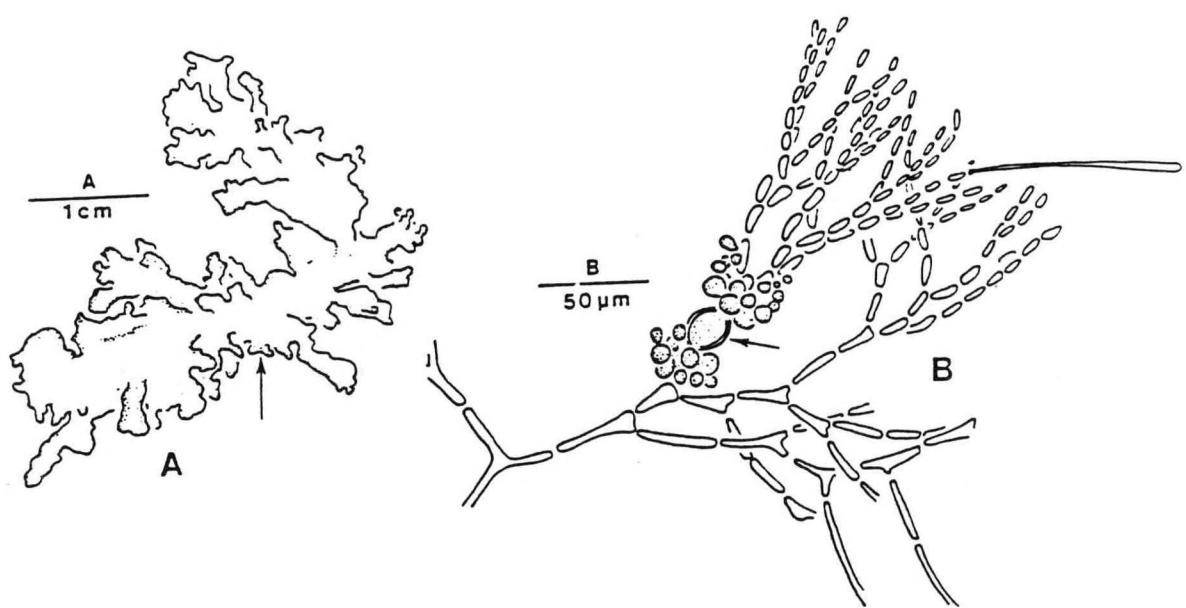


Figure 38. *Predaea feldmanni*

Originally described from St. Helena (Boergesen, 1950), this species was subsequently reported in North Carolina, Ghana and Venezuela and is probably wide-spread in deep water in the tropical and warm temperate Atlantic. Lemus & Ganesan (1977) have recently cultured carpospores and described the tetrasporophyte generation.

Solieriaceae

SOLIERA J. Agardh

Soliera filiformis (Kuetzing) Gabrielson

Fig. 39 A-D

Plants to 20 cm tall, branches cylindrical, to 1-3 mm diam, attached by a discoid holdfast, later by fiberous outgrowths from the lower branches; branching alternate and radial or secund, branches slightly constricted at base, tapering to the apex; growth multiaxial, a cluster of apical cells, each initiating distinct longitudinal sectors of the axis. Medulla loosely filamentous; cortex of large, unpigmented inner cells grading into smaller, pigmented surface cells. Cystocarps rare, protruding slightly, with a central fusion cell and a distinct ostiole; tetrasporangia also rare, zonately divided.

Reported in deep water from North Carolina south into the Caribbean and Brasil and east to Ghana in Africa. It is not a common plant in the Sanctuary. Plants are generally sterile and only a single, fertile, tetrasporic, plant was collected in August in preparing this guide. The proper naming of this species has been a problem; see Gabrielson (1985) for a discussion of its nomenclatural history.

Sebdeniaceae

SEBDENIA Berthold

Sebdenia polydactyla (Boergesen) Balakrishnan

Fig. 40 A-C

Plants to 18 cm tall, a single dichotomously branched axis arising from a discoid holdfast. Branches cylindrical, 3-10 mm diam, with little tapering or change in diameter among the segments; growth multiaxial, apices bluntly rounded. Medulla filamentous, the cells stellate, with slender, extended arms, each cell bearing a single, deep-staining gland cell; cortex more pseudoparenchymatous, the surface cells rounded, 3-9 μ m diam in surface view. Tetrasporangia spherical to ovoid, to 18x30 μ m.

Originally described by Boergesen as a species of Halymenia from India and subsequently reported from North Carolina by Schneider and Searles (1975), it had been transferred to Sebdenia by Balakrishnan in 1959. It is a common plant growing on rocks along the edges of the ledges.

Gracilariaeae

GRACILARIA Greville

Plants attached by a discoid holdfast, variously branched, axes terete or flattened,

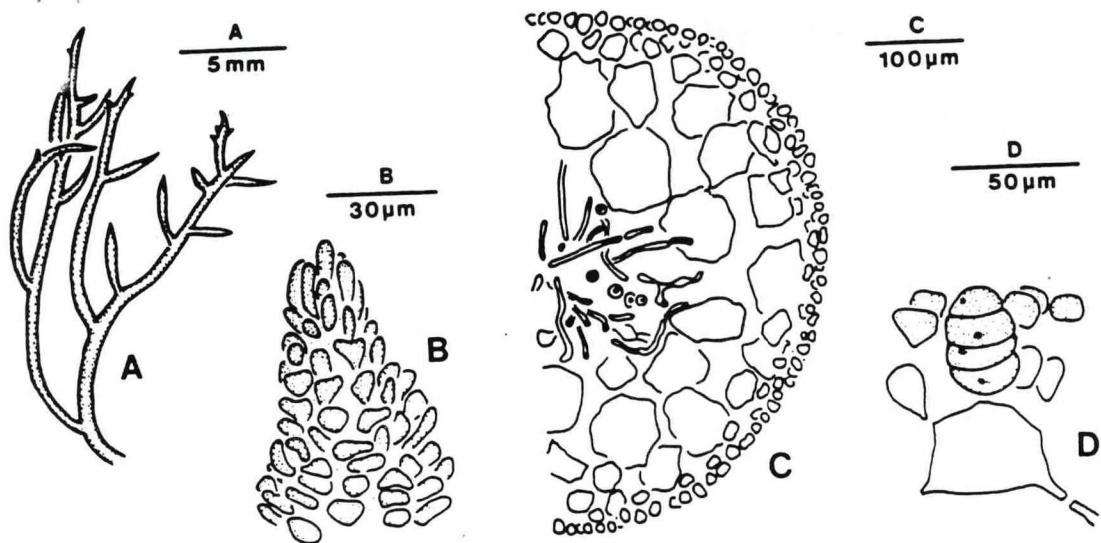


Figure 39. Soliera filiformis

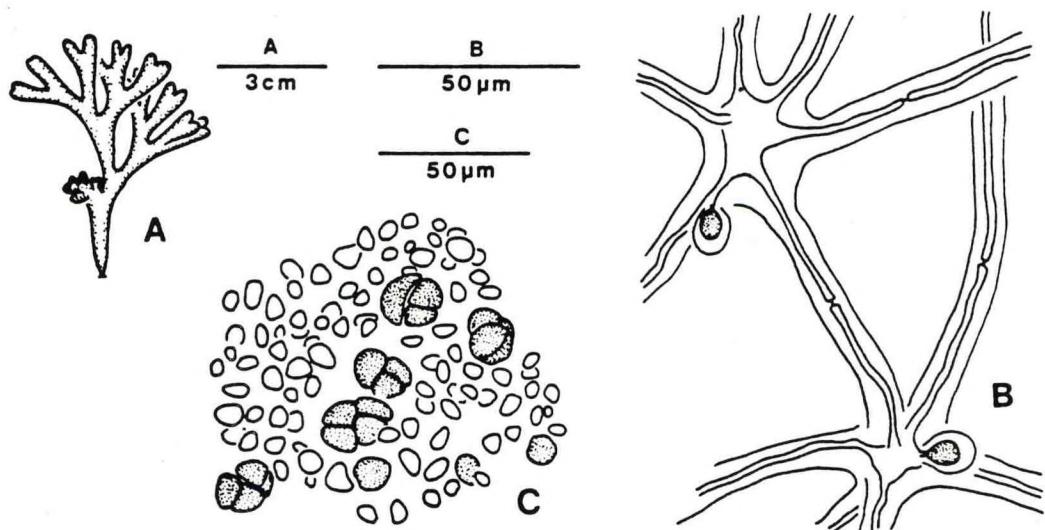


Figure 40. Sebdenia polydactyla

medullary tissue pseudoparenchymatous, the cells large, thin-walled, colorless, grading into a small-celled, pigmented cortex. Dioecious; spermatia in sori on the surface of the plant or lining small, simple cavities in cortex; carpogonial branches 2-celled, supporting cell bearing one or more sterile cells or branches, one cell of which is presumed to function as the auxiliary cell; carposporophytes with a central core of pseudoparenchymatous, sterile tissue; pericarp thick, with a well developed pore; tetrasporangia cruciately divided. Two species occur in the Sanctuary.

Gracilaria blodgettii Harvey

Fig. 41 A-C

Plants to 20 cm tall, branches cylindrical, abundant, branching radial, alternate, main axes to 2 mm diam, lesser branches 0.5-1.0 mm diam, tapering at the tips and narrowed at the base; medullary cells to 930 μ m diam, without a sharp distinction between the medulla and cortex, the outer layer of which is composed of cells 12-20 μ m diam. Cystocarps abundant, projecting; tetrasporangia on ultimate branchlets, to 30 μ m diam. Distribution from North Carolina to the Caribbean. Gracilaria blodgettii is a plant of deep-water throughout its range. In the Sanctuary it is a rare plant, collected only twice in preparing this guide.

Gracilaria mammillaris (Montagne) Howe

Fig. 42 A-D

Plants to 10 cm tall; blades flat, subdichotomously to subflabellately branched, the segments 3-5(-10) mm broad, cuneate below, linear or tapering above, medullary cells to 125 μ m diam, the medulla usually two cells thick; cortex 1-3 layers of small cells. Cystocarps hemispherical to conical, scattered over the blades and along their margins.

Reported from North Carolina south into the Caribbean. It appears to be a rare plant in the Sanctuary, but sterile plants are difficult to distinguish from the very similar Rhodymenia pseudopalmata (see below). The latter is more common, or at least reproductive plants of R. pseudopalmata are noted more frequently, and G. mammillaris is perhaps mistaken for it in the sterile condition.

CORALLINALES

Corallinaceae

The only members of this order in collections from the Sanctuary are non-jointed, crustose, calcified plants which belong to the subfamily Melobesiaeae. The collections are not extensive enough to allow even generic identification of some of the taxa, and in the case of the tiny epiphytic plants it is difficult, with certainty, to link germling vegetative plants seen in surface view with mature plants sectioned on the hosts. The descriptions of the plants are therefore incomplete and identifications await further study.

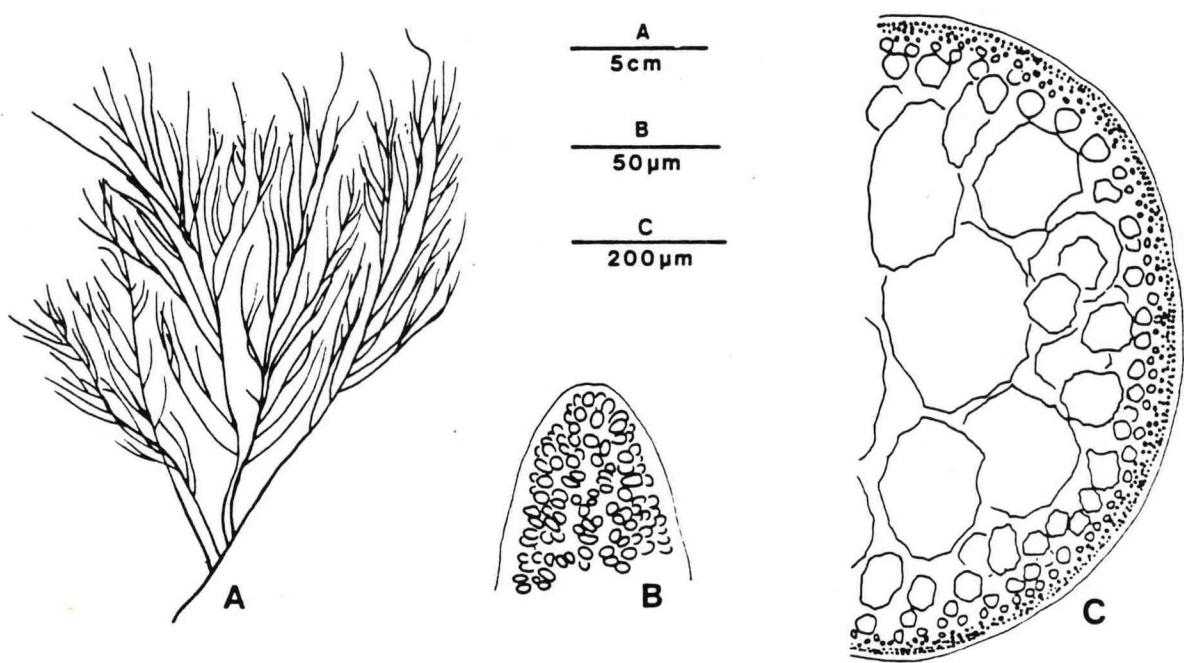


Figure 41. Gracilaria blodgettii

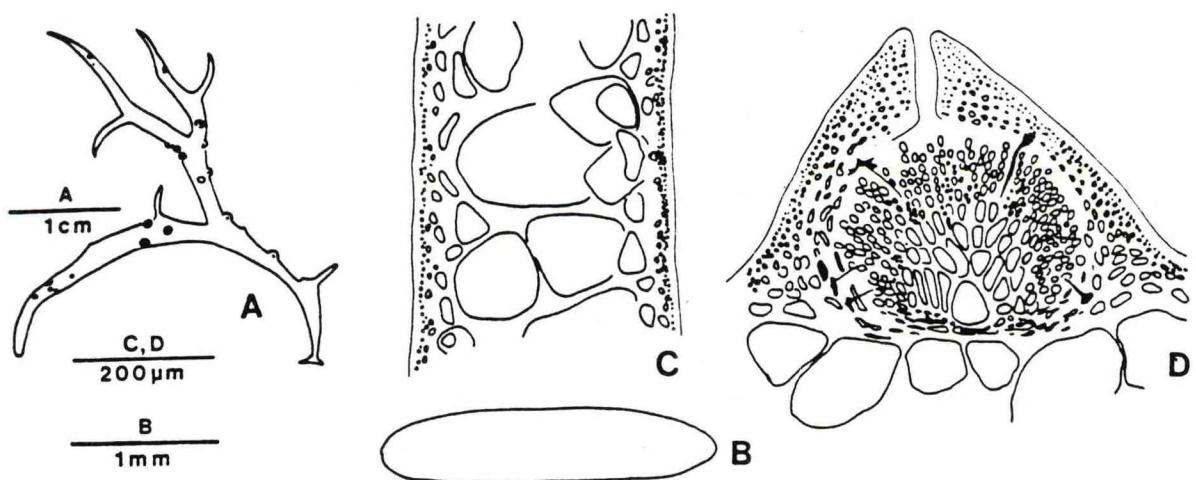


Figure 42. Gracilaria mammillaris

LEPTOPHYTUM Adey

Leptophytum sp.

Fig. 43 A-D

Plants crustose, well calcified, tightly adhering to rocks or shells, 100-210 μm thick, surface smooth; hypothallus to 40 μm thick, 4-6 cells deep, not coaxial, cells ovoid, 10-15 μm long, 4-7 μm diam; perithallus cells ovoid, 5-8(-10) μm tall, 3-6 μm diam, cell fusions common; epithallus cells flat, to 6 μm diam, to 2 μm thick. Spermatangial and carposporangial conceptacle roof raised above the crust 100 μm or more, conical; spermatangial conceptacle cavity to 100 μm diam, spermatangia on floor, walls and roof of conceptacle; carposporangial conceptacle to 200 μm internal diam; tetrasporangial conceptacle slightly raised above surface of vegetative crust, 250-325 μm internal diam; tetrasporangia to 80 μm tall, each with an individual pore in conceptacle roof.

Described from a single collection in the Sanctuary. It is similar in vegetative characteristics to Leptophytum foecundum (Kjellman) Adey. A clear distinction is, however, the height of the tetrasporangial conceptacle which, in that primarily arctic species, is 125-170 μm (Adey, 1966).

PNEOPHYLLUM Kuetzing

Pneophyllum sp.

Fig. 44 A-K

Plants epiphytic, forming thin, lightly calcified crusts on blades of Rhodymenia pseudopalmata; crusts consisting of a single layered hypothallus bearing epithallial cells. Spore germination producing two parallel series of four cells, the second and third sets of cell divisions parallel to each other. Hypothallial cells rectangular in surface view, (5-)8-13(-15) μm long, (3-)5-8 μm broad, cell fusions common; trichocysts intercalary in the hypothallus. Conceptacles hemispherical; spermatangial conceptacles with a snout; carposporangial conceptacle internal diam 54-70 μm , top of conceptacle 47-54 μm above conceptacle floor; tetrasporangial conceptacle inside diam 54-63 μm , top of conceptacle 63-67 μm above conceptacle floor, tetrasporangia 32-40 μm tall at maturity.

These plants grow on the surface of the host Rhodymenia plants with Fosliella plants see (below). Sporelings of the Pneophyllum type (Chamberlain, 1983; Jones & Woelkerling, 1984) were abundant on the hosts; intercalary trichocysts were infrequent. The plants are similar in their conceptacle characteristics to Pneophyllum confervicolum (Kuetzing) Y. Chamberlain, as described by Chamberlain (1983), but the hypothallial cells in that species are almost square in surface view. Hypothallial cells in plants from the Sanctuary are variable in shape and some approach being square, e.g. Fig. 44 H, but most are one and a half to two times as long as broad.

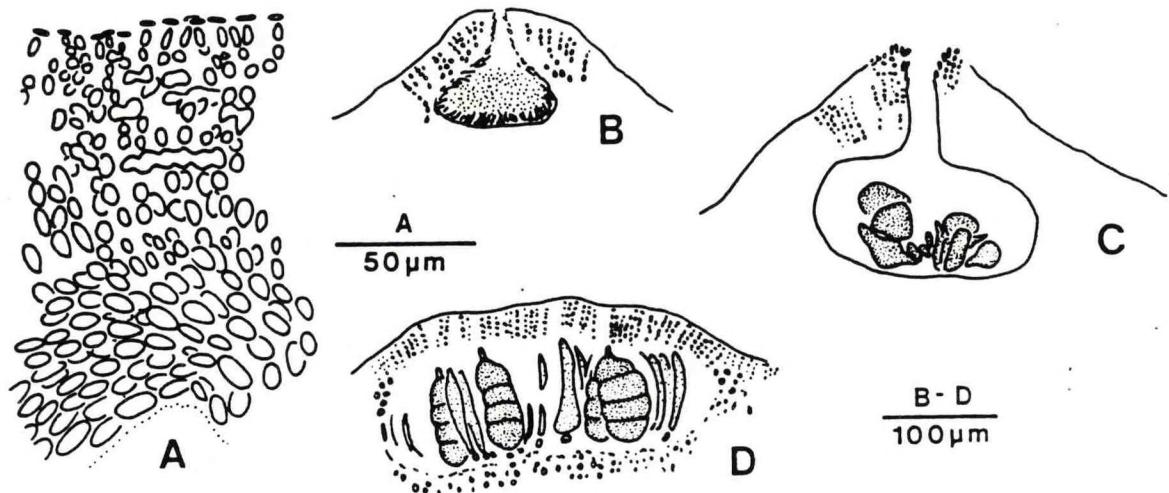


Figure 43. Leptophytum sp.

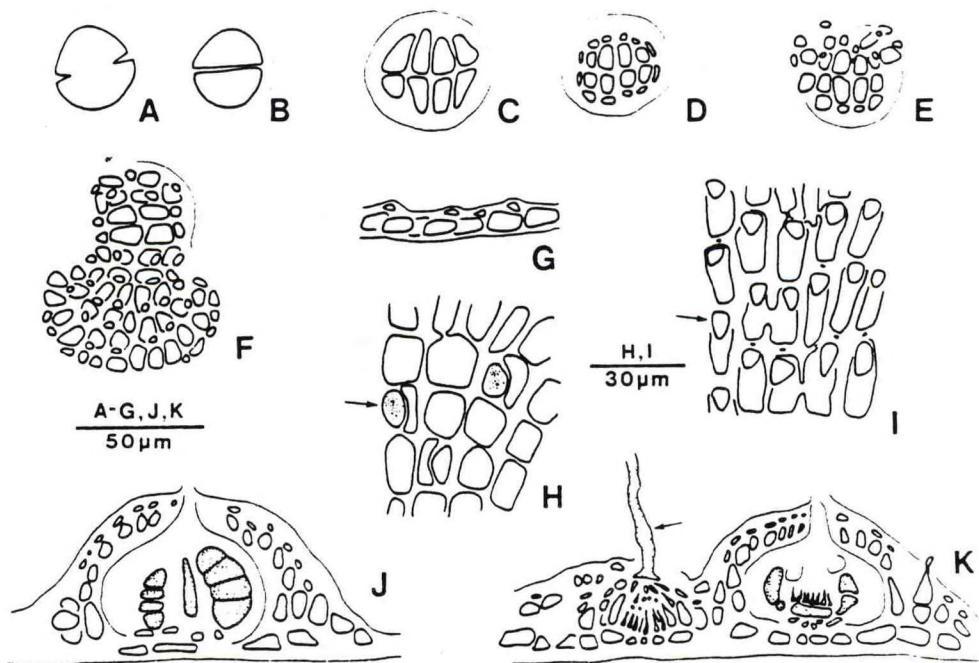


Figure 44. Pneophyllum sp.

FOSLIELLA Howe

Fosliella farinosa (Lamouroux) Howe

Fig. 45 A,B

Plants epiphytic on Rhodymenia pseudopalmata. Spore germination with third set of cell divisions parallel to the outside edge of the four-celled disc, producing two concentric circles of four cells at the eight-celled stage. Subsequent is growth filamentous.

These germlings have been observed, but not linked to any mature crusts. The germination type is that which characterizes the genus Fosliella (Chamberlain, 1983; Jones & Woelkerling, 1984). The plants are assumed to be young Fosliella farinosa, the single species of the genus which occurs along the southeastern, Atlantic coast of the United States.

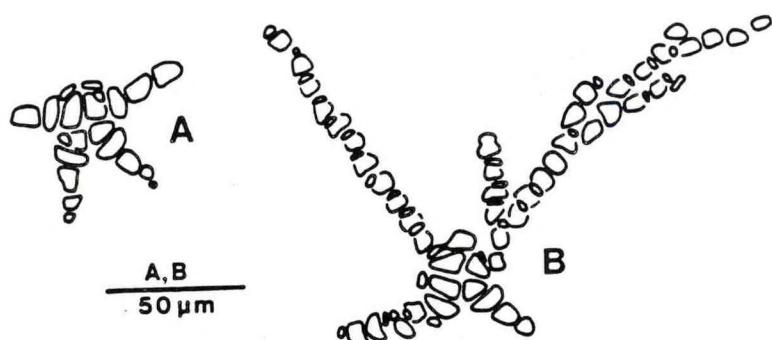


Figure 45. Fosliella farinosa

RHODYMENIALES

Rhodymeniaceae

BOTRYOCLADIA Kylin

Plants with erect or creeping, branched, cylindrical, solid, axes bearing stipitate vesicles. Vesicle cavity filled with mucilage; vesicle medulla one or more layers of large cells some of which have dark-staining gland cells on their inner faces; vesicle cortex one or more continuous or discontinuous layers of smaller cells. Cystocarps, spermatangia and tetrasporangia formed in the cortex, on the surface of the vesicles. Two species occur in the Sanctuary.

Botryocladia occidentalis (Boergesen) Kylin

Fig. 46 A-C

Plants to 25 cm tall, axes alternately, radially branched and bearing many ovoid-pyriform to subspherical vesicles to 5 mm long. Vesicle medullary cells 55-110 μ m diam; 1-2 gland cells on inner face of some medullary cells; surface cortical cells 8-14 μ m diam with an inner layer of intermediate size cells above the anticlinal walls of the medulla; surface cortical cells covering the entire outer face of most, but not all inner cortical cells.

Wide spread in warm-temperate and tropical waters. Originally described by Boergesen (1913-20) as a variety of Chrysymenia uvaria, this is one of the commonest species in the Sanctuary where it grows on rocks along the ledges and emerges through the sand from the flats behind the ledges. The plants in the Sanctuary and elsewhere on this coast appear to be perennials. In the winter and early spring they are found as reduced stems with a few vesicles; the branches regenerate in the summer. Early in the season the vesicles on some of the smaller, younger plants are large and ovoid to pyriform in shape. Regenerating plants and all plants later in the growing season have smaller, subspherical vesicles. In August and September, when most other species have disappeared, B. occidentalis plants attain their maximum size.

Botryocladia wynnei Ballantine

Fig. 47 A-J

Plants 6-12(-15) mm tall, one to four branches 1-2(-3) mm long arise from a basal disc and each form 1(-5) vesicles; vesicles 11(-14) mm long, to 5 mm diam, pyriform, clavate or obovate, length 3-5 times diam; medulla a single layer of polygonal cells 30-90 μ m diam in surface view, 25-90 μ m thick in section; cortex an incomplete layer of cells 7-40 μ m diam formed above the anticlinal walls of the medullary cells and sometimes completely covering the gland bearing medullary cells; (1)-2-6(-17) pyriform to ovoid gland cells 17-26 μ m long by 25-33 μ m diam formed on inner face of some medullary cells; gland bearing cells' shape similar to other medullary cells or irregular and stellate. Monecious; spermatangia 2-3 μ m diam, formed in clusters by small cortical cells; cystocarps 440-670 μ m diam; tetrasporangia scattered, 18-24 μ m diam.

Recently described from Puerto Rico (Ballantine, 1985) the population in the

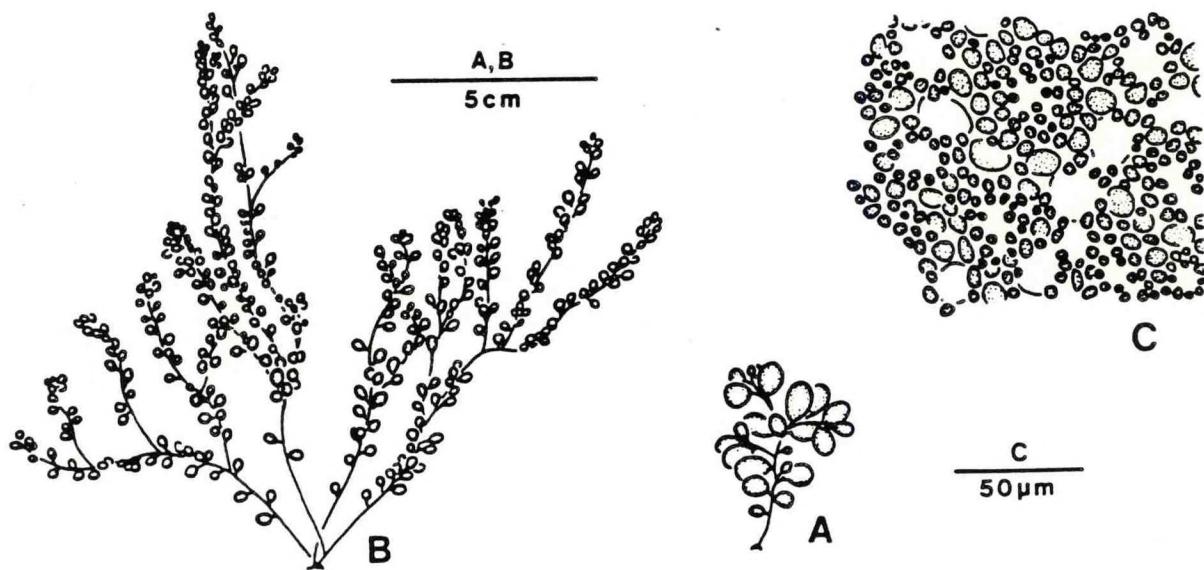


Figure 46. Botryocladia occidentalis

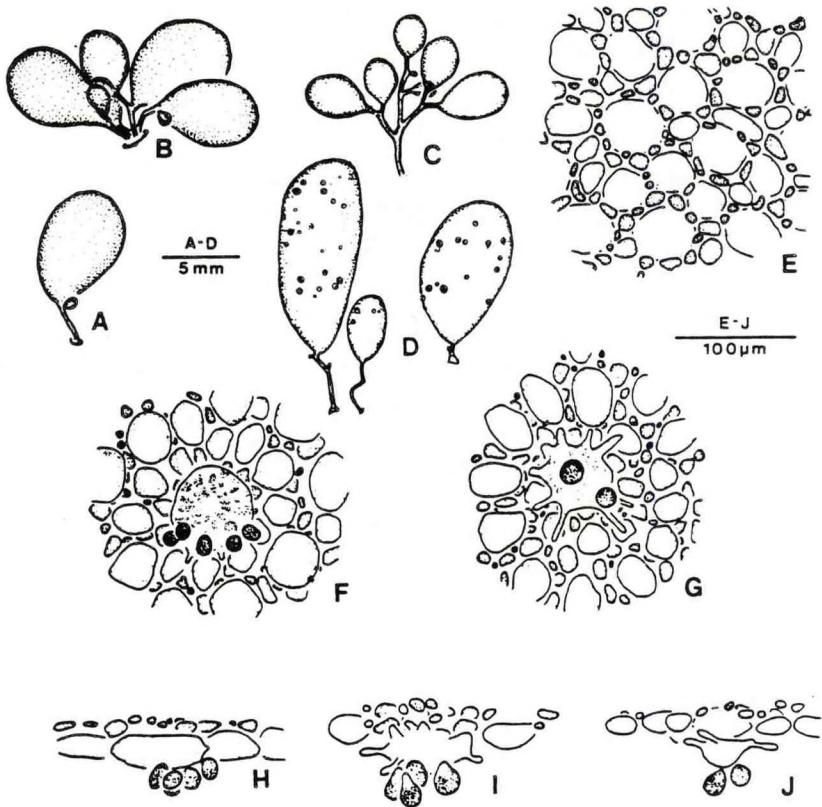


Figure 47. Botryocladia wynnei

sanctuary is the second record of the species. The earlier report of Chrysymenia enteromorpha Harvey from Gray's Reef (Searles, 1981) was a misidentification of Botryocladia wynnei. Plants in the Sanctuary grow on rocks along the ledges. No spermatangia or tetrasporangia were seen in the sanctuary collections. Ballantine indicates that spermatangia are formed after the female reproductive structures.

RHODYMENIA Greville

Rhodymenia pseudopalmata (Lamouroux) Silva

Fig. 48 A-F

Plants to 12 cm tall; stipe cylindrical, short or to 4 cm long, dichotomously branched, the branches forming flat, tough, smooth blades to 12 cm long, 1-10 mm wide; bases of the blades cuneate, margins entire, apices spatulate to subacute; inner medulla pseudoparenchymatous, usually two layers of large, colorless cells; cortical cells much smaller, pigmented. Cystocarps hemispherical, sessile, marginal or occasionally on blade surface near the margins, opening by a distinct pore; tetrasporangia in sori just behind apices of blades, (18-)22-27 μ m diam in surface view.

Reported from North Carolina, South Carolina and Brasil from the shallow subtidal and deeper waters. In the Sanctuary and in the deep waters of the Carolinas this is a common plant, particularly in the crevices between rocks along the edges of ledges where it appears to be perennial. Taylor (1960) described a variety caroliniana from South Carolina for plants with very short stipes, blades 3.5-6 mm broad and up to 12 cm long, branches spreading at angles of 30-110 degrees, and up to 7 orders of branching. However, the diversity of plants collected in the sanctuary and elsewhere along the coast of the Carolinas shows a continuum from caroliniana-like plants to those with characteristics of the species. The vegetative plants can be very similar to plants of Gracilaria mammillaris and the two species are probably often misidentified.

Champiaceae

CHAMPIA Desvaux

Champia parvula var. prostrata L. Williams

Fig. 49 A-C

Plants in clumps or creeping over rocks or other algae, to 10 cm tall; branching alternate, branches 0.5-2 mm broad, hollow, interrupted by cellular diaphragms; the hollow segments flattened, pinched in at the diaphragms, 1.0-1.5(-5.0) diam long; wall of segments formed by a layer of large, flat, polygonal cells bearing a few, small, spherical cells to the outside and lined on the inside by slender, longitudinal filaments each bearing a deep-staining gland cell. Spermatangia in patches on the surface of the branches; cystocarps sessile, ostiolate, with a short neck, the base hemispherical; tetrasporangia tetrahedrally divided, scattered among the cortical cells.

This species is widely distributed in tropical seas. The variety is described from North Carolina. It differs from the species in the flattened rather than cylindrical shape of the branch segments. It is a common plant in the Sanctuary along the ledges.

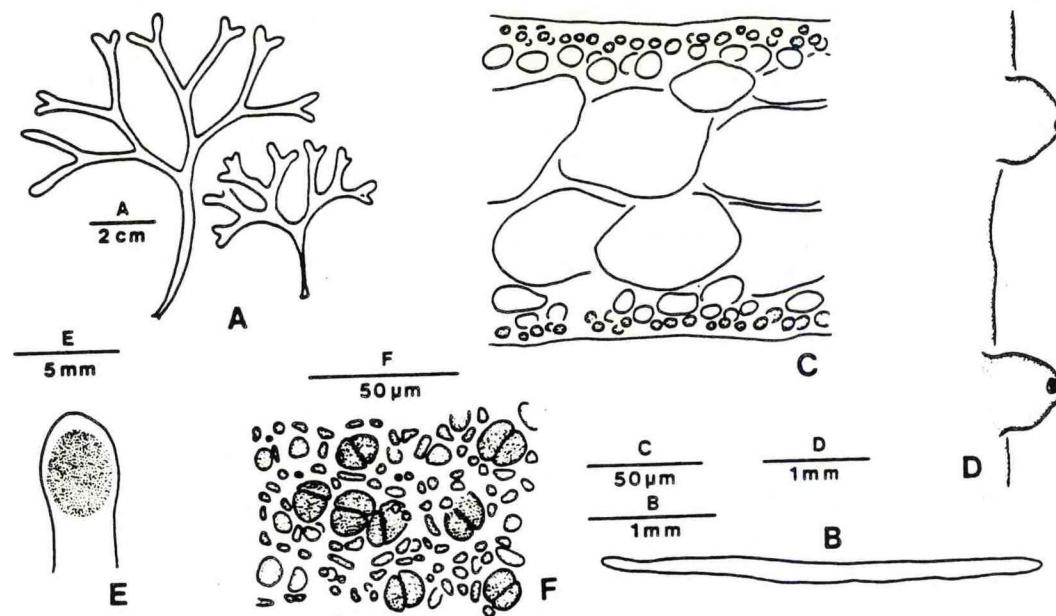


Figure 48. Rhodymenia pseudopalmata

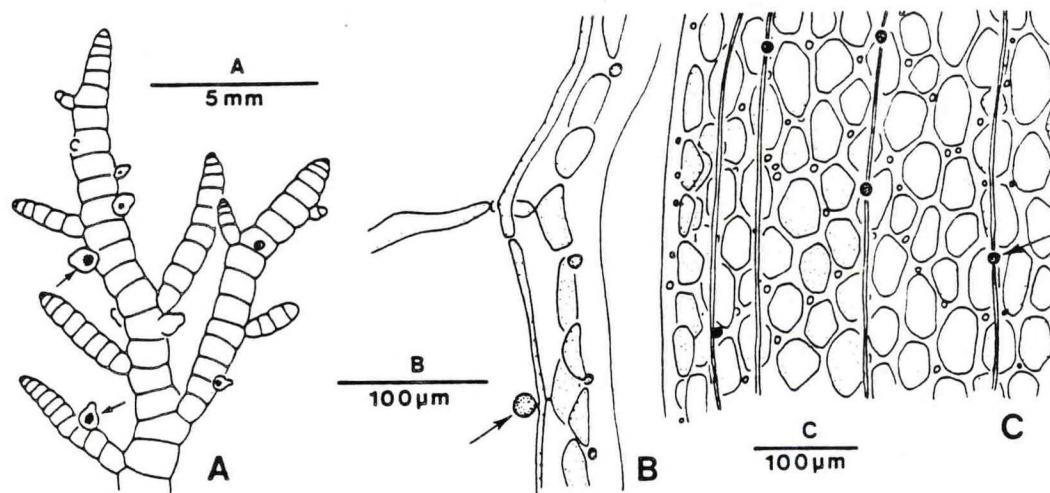


Figure 49. Champia parvula var. prostrata

LOMENTARIA Lyngbye

Lomentaria baileyana (Harvey) Farlow

Fig. 50 A-C

Plants epiphytic or on rocks, tufted or creeping, to 3-7(-20) cm tall; densely to sparingly branched, branching irregularly alternate; branches hollow, a diaphragm at the base of branches, cylindrical, 0.5-1.5 mm diam, tapering from the middle to a rounded apex and toward the base. Cystocarps globose, sessile, with a protruding ostiolate tip; tetrasporangia 30-55 μ m diam, scattered in erect branchlets.

Distributed south from North Carolina and Bermuda to Florida and reappearing in Brasil. It is a very common plant in the Sanctuary where it grows primarily on the rocks along the ledges, but because of its small size and creeping habit it is not very conspicuous.

CERAMIALES

Ceramiaceae

CALLITHAMNION Lyngbye

Callithamnion halliae Collins

Fig. 51 A-E

Plants erect, to 2.5 mm tall, epiphytic, attached by a multicellular, branched holdfast. Branching alternate, the apical cell dividing by an oblique wall, the branch axis zigzagging with lateral branches developing on the shoulder of the axial cells. Indeterminate branches replacing determinate branches. Axial cells to 60 μ m diam, length 2-3.5 times diam. Gametophytic plants less robust. Spermatangial mother cells cut off by the proximal 2-3 cells of lateral branches, forming a pad of cells abaxially; procarps formed laterally on axial cells, a second, extra vegetative lateral branch sometimes formed by the axial cell below the fertile segment; tetrasporangia tetrahedrally divided, ovoid, 32-45x40-63 μ m, sessile on the abaxial side of determinate lateral branches.

This is one of the more common epiphytes in the sanctuary. Vegetatively it is very similar to Plenosporium boergesenii (see below), but the procarps are on axial cells of indeterminate branches (Fig. 52 D) rather than being subterminal on determinate lateral branches, and it forms only tetrasporangia not polysporangia.

ANTITHAMNIONELLA Lyle

Plants erect or prostrate and erect, filamentous, ecorticate, branched to 2-4 orders; axes uniserrate, bearing whorls of 1-4 branches on each axial cell, basal cell of branch similar in length to cells distal to it; cells uninucleate with small discoid or band-shaped plastids; gland cells present or lacking, usually adaxial. Dioecious; spermatangia clustered on specialized branched axes, adaxial, replacing ultimate branches; procarps borne singly on basal cells of immature determinate branches at apices of indeterminate axes, carpogonial branches 4-celled; fertile axes cease to elongate after fertilization, carposporophytes appearing terminal, producing successive gonimolobes, naked; carposporangia developing from most gonimoblast cells; tetrasporangia cruciate or tetrahedral, sessile or pedicellate on inner cells of determinate branches.

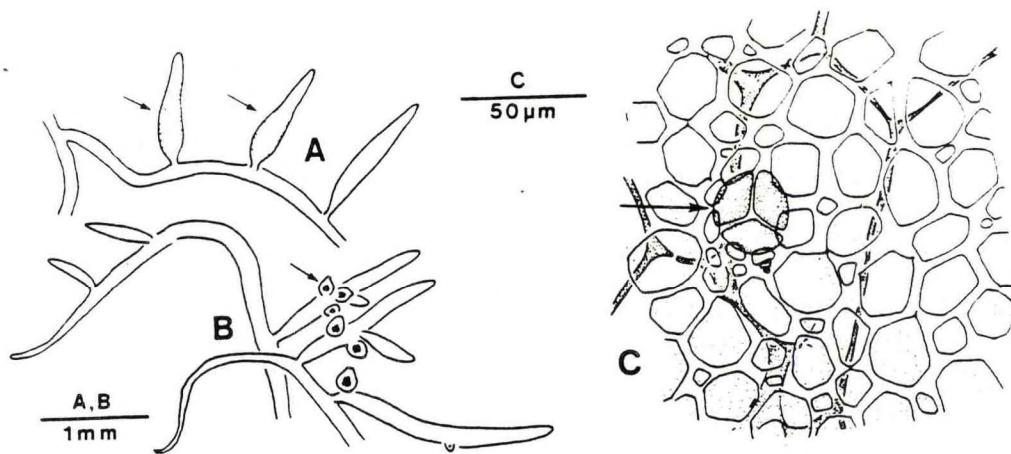


Figure 50. Lomentaria bailevana

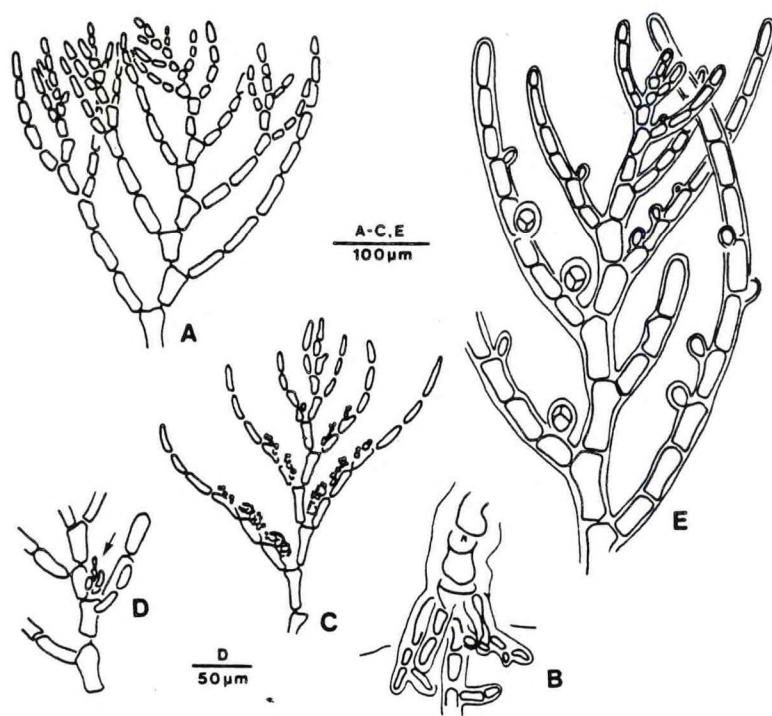


Figure 51. Callithamnion sp.

Two species are reported here from the Sanctuary.

Antithamnionella breviramosa (Dawson) Wollaston in Womersley & Bailey

Fig. 52 A-E

Plants epiphytic, prostrate, with erect axes 0.5-3.0(-5) mm tall, rosy-red, attached by numerous unicellular and multicellular rhizoids produced from the basal cell of determinate branches in prostrate axes or replacing determinate axes in an opposite pair or whorl of 3; indeterminate axes with (1-2-)3 whorled, determinate branches from the distal end of each axial cell, if 1-2 then usually basal and not always in a distichous arrangement, the tips crowded with determinate branches on non-elongating axial cells; determinate branches 5-10 cells long, adaxially curved, simple to usually branched 1-3 times, branches often ending in long, unicellular hairs; cells of the main prostrate axes 25-35(-50) μ m diam, 70-150 μ m long; cells of the erect axes 20-33 μ m diam near the base, determinate branches from 8.5-10.0(-15) μ m diam and tapering slightly toward the tips; gland cells usually covering all of the basal cell of lateral branchlets of a determinate branch and sometimes an outer cell of the branch. Spermatangia adaxial near the distal ends of cells of determinate branches, formed in opposite pairs near the tips of indeterminate axes; carposporophytes forming 2(-more) gonimolobes to 63 μ m diam; tetrasporangia tetrahedral, cruciate or irregular, ellipsoidal to obovoid, 18-28 μ m diam, 25-40 μ m long, sessile, borne singly on the basal cells of determinate branches.

Distributed from North Carolina to Brasil and elsewhere in tropical and warm temperate seas, it was not a common epiphyte in the Sanctuary. No male plants were observed. The gland cells observed are characteristic of the species in shape and coverage of the cells which bear them, but are formed more randomly on the determinate branches than the consistent position on the basal cell of the laterals described for the species.

Antithamnionella spirographidis (Schiffner) Wollaston

Fig. 53 A,B

Plants epiphytic, with creeping axes bearing erect branches to 1 cm long; axial cells 3-6 times as long as broad, 180-230 μ m long, 30-50 μ m diam, with (1-)2(-3) opposite, unbranched, distichous determinate lateral branchlets. Determinate branchlets 250(-380) μ m long, unbranched or infrequently with one or two lateral branchings. Indeterminate branches replacing determinate branchlets on every (3rd-)4th axial cell. Gland cells, 10-12 μ m diam formed on upper side of 2nd and/or 3rd cell of determinate branchlets in upper part of plant. Attachment by rhizoidal filaments produced from basal or occasionally from 2nd cell of a determinate branchlet, branching at point of attachment. Spermatangia formed on special short branchlets produced on abaxial side of the proximal cells of determinate lateral branchlets. Procarps and carposporophytes developing on two-celled determinate branchlets near a branch tip; development of the carposporophyte terminates growth of the branch, growth may be continued by a lateral below the carposporophyte. Tetrasporangia sessile, tetrahedrally divided, ovoid, 40-48 μ m long, 30-35 μ m diam, borne singly on basal or occasionally on 2nd cell of branchlets.

Originally described from the Adriatic Sea and subsequently from Britain, France and Australia. Assignment of plants from the Sanctuary to this species is provisional. The alga in the single collection is sterile and differs from the species as described by Wollaston (1968) in often having three rather than two determinate branchlets per axial cell and in having the gland cells formed on the 4th as well as the 2nd and 3rd cell of

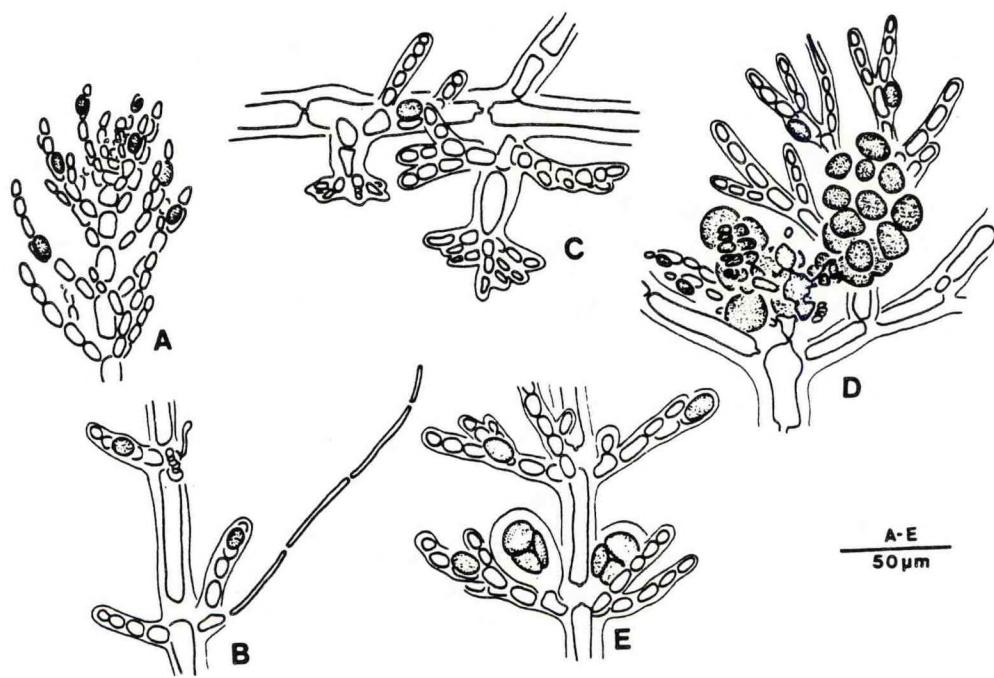


Figure 52. *Antithamnion breviramosa*

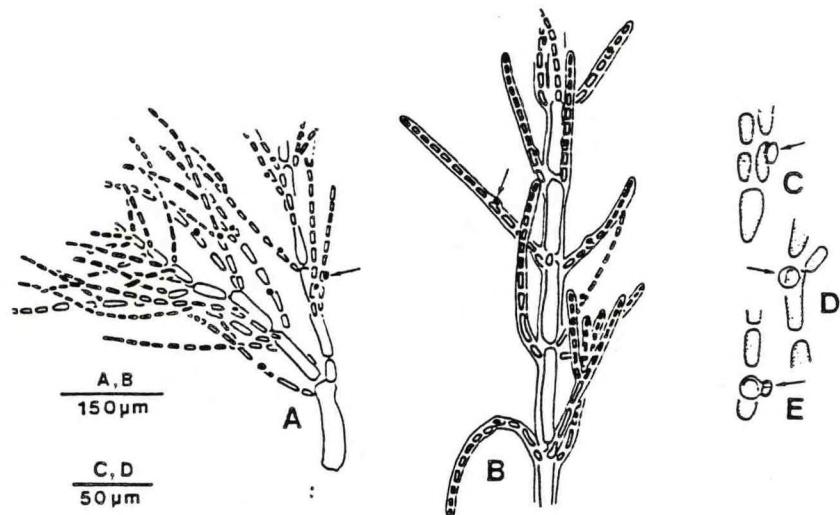


Figure 53. *Antithamnion spriographidis*

the determinate branchlets.

CERAMIUM Roth

Ceramium fastigiatum forma flaccidum H. Peterson in Boergesen

Fig. 54 A-G

Plants epiphytic, epizoic and on rocks, with prostrate and erect axes, to 7 cm tall; branching fastigate, regularly pseudodichotomous, with occasional adventitious branches, usually widely spaced; attached by simple rhizoids from the base as well as nodes of prostrate axes; rhizoids with or without expanded haptera; apices straight to incurved; nodes corticated by 1-2 transverse bands, the lower larger than the upper, gland cells lacking. Spermatangia covering the nodes; carposporophytes generally with 3 gonimolobes, overtopped by similarly corticated involucres; tetrasporangia tetrahedrally and cruciately divided, subglobose, to 60 μ diam including thick cell walls, single and scattered to clustered and seriate, prominently projecting, subtended by a few short cortical cells.

Distributed from Newfoundland to Venezuela, Atlantic Europe and the Galapagos Islands. This is the most common epiphytic and epizoic alga in the Sanctuary. Though very small, the plants form a reddish fuzz over the surfaces of many algae and sessile, colonial, marine invertebrates.

SPYRIDEA Harvey in Hooker

Spyridia hypnoides (Bory in Balanger) Papenfuss

Fig. 55 A-D

Plants epiphytic or on rocks, erect or entangled in other algae, to 5-10(-25) cm tall; axes cylindrical to somewhat flattened, 1-2 mm broad; indeterminate and determinate branches alternately radial, occasionally distichous, gradually tapering from base to acute apices, some indeterminate branches ending in hooks, but some plants without such tips; indeterminate branches fully corticated by transverse series of elongate, pigmented cells over the internodes, with shorter ovoid to rectangular cells over the nodes; axial cells to 500 μ long; determinate branches deciduous in lower parts of plants and on hooked tips, simple, incurved, 0.3-2.0 mm long, 30-50 μ diam proximally, tapering to 20-30 μ diam a few segments below the apices, tips with terminal, acuminate spines, with or without one or more lateral recurved spines on the first and second nodes, corticated at the nodes by small pigmented cells. Spermatangia formed on corticated nodes of determinate branches; procarps on short indeterminate branches, whose axes cease elongation after fertilization; carposporophytes 2-3-lobed, surrounded by an incurved involucre; tetrasporangia globose to subglobose, 50-85 μ diam, 1-3 on the lower nodes of determinate branches.

Distributed from North Carolina south to Brasil, and in northwest Africa, South Africa, the Mediterranean Sea, Red Sea, Indian Ocean and central Pacific. This species is also referred to in Taylor (1960) and elsewhere as S. aculeata (Schimper) Kuetzing and S. filamentosa (Wulff) Kuetzing, but those are here considered synonyms. It is a rare plant in collections from the Sanctuary and was not fertile.

CALLITHAMNIELLA Feldmann-Mayzoyer

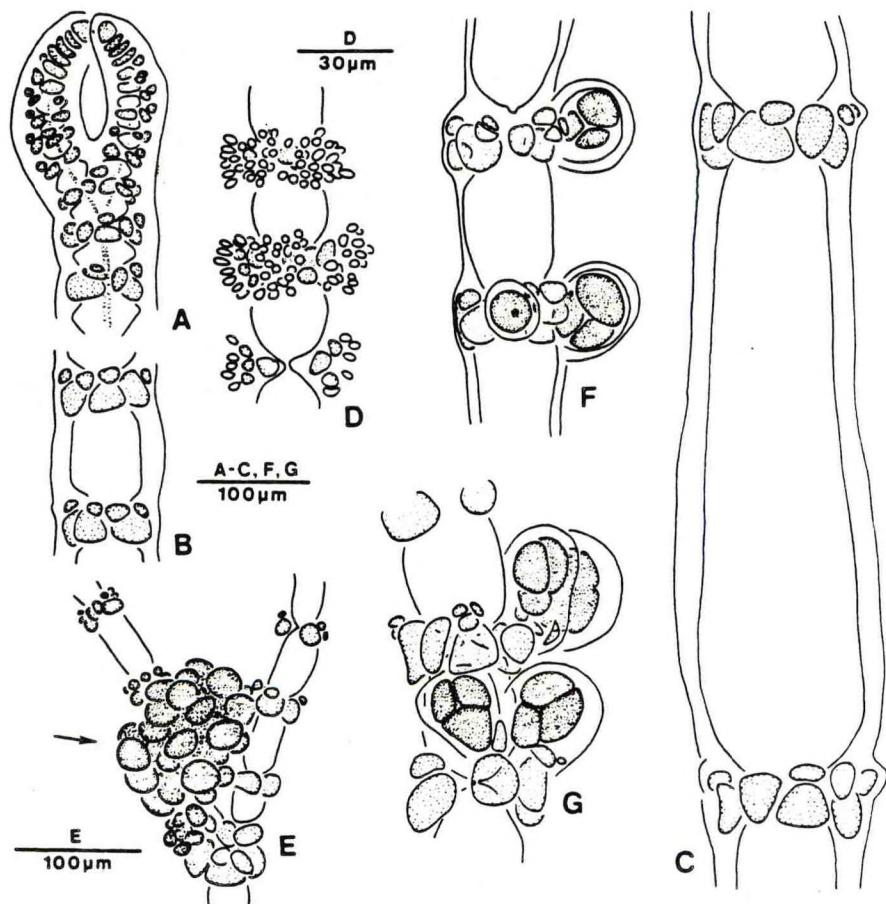


Figure 54. Ceramium fastigiatum forma flaccidum

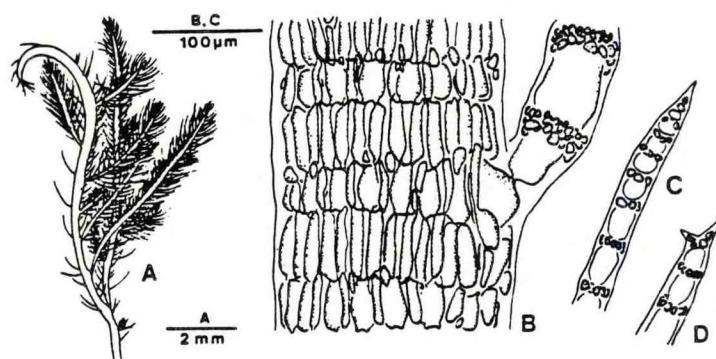


Figure 55. Spyridia hypnoides

Callithamniella sp.

Fig. 56 A-E

Plants epizoic, prostrate, with erect indeterminate branches to 5 mm tall; axes to 38 μ m diam; branching alternate, radial, secondarily distichous in erect branches; basal cell of branches shorter than adjacent distal cells in erect axes, in prostrate axes 1(-3) small cells at base of indeterminate branches may bear multicellular, distally branched holdfasts, the indeterminate branch and sometimes a rhizoidal filament; determinate branches to 20 cells and 0.7 mm long, simple or with 1-3 adaxial branchlets, incurved and overtopping the shoot apex. Gametangia unknown; sporangia ellipsoidal, to 23 μ m diam, contents undivided, borne proximally on 2nd and 3rd cells of determinate branches.

Placement of these collections is uncertain due to lack of all stages of reproduction. They are tentatively assigned to Callithamniella on the basis of the uniserial, ecorticate, prostrate and erect branches; spiral branching, origin of erect indeterminate branches from the basal cell of the holdfast branches, and the pedicellate sporangia. They differ from the other species of the genus in the multicellular structure of the holdfasts, which are more typically single cells, and in the position of the sporangia on the determinate branches rather than on cells of the indeterminate axis.

PLENOSPORIUM (Nageli) Hauck

Plenosporium boergesenii (Joly) R. Norris

Fig. 57 A-G

Plants epiphytic, erect, to 2 cm tall, attachment by branched, uniserial, determinate laterals; branching alternate, clearly distichous above in vegetative and tetrasporangial plants; cells of indeterminate axes to 200 μ m diam including a thick wall, cylindrical, length of cells 3-4 times diam, determinate branches mostly simple, occasionally with an adaxial branchlet, to 15 cells long, basal cell of determinate branches similar in length to other cells. In lower parts of axes determinate laterals markedly thinner than main axes. Spermatangia covering short, to 70 μ m long, branchlets on axial cells of indeterminate branches and proximal cells of determinate branches; procarps formed on the subterminal segment of 3-celled branchlets of determinate branches; the supporting cell is the axial cell of the subterminal segment and it bears the 4-celled carpogonial branch and the apical cell; the hypogynous cell cuts off 2 sterile cells; tetrasporangia and polysporangia sessile, ovoid, polysporangia 41-47 x 54-72 μ m.

Reported from Brasil and North Carolina. Similar to Plenosporium flexuosum in vegetative morphology, but spermatangial heads are terminal and polysporangia are larger, 65-110 x 85-130 μ m, in that species. It is a common epiphyte in the Sanctuary and is easily confused with Callithamnion sp. if reproductive cells are lacking.

ANOTRICHIUM Nageli

Anotrichium tenue (C. Agardh) Nageli

Fig. 58 A,B

Plants epiphytic or on rocks, erect to 7 cm, in tufts, or prostrate, attached by unicellular rhizoids near the base and from prostrate axes; branching lateral to subsecund

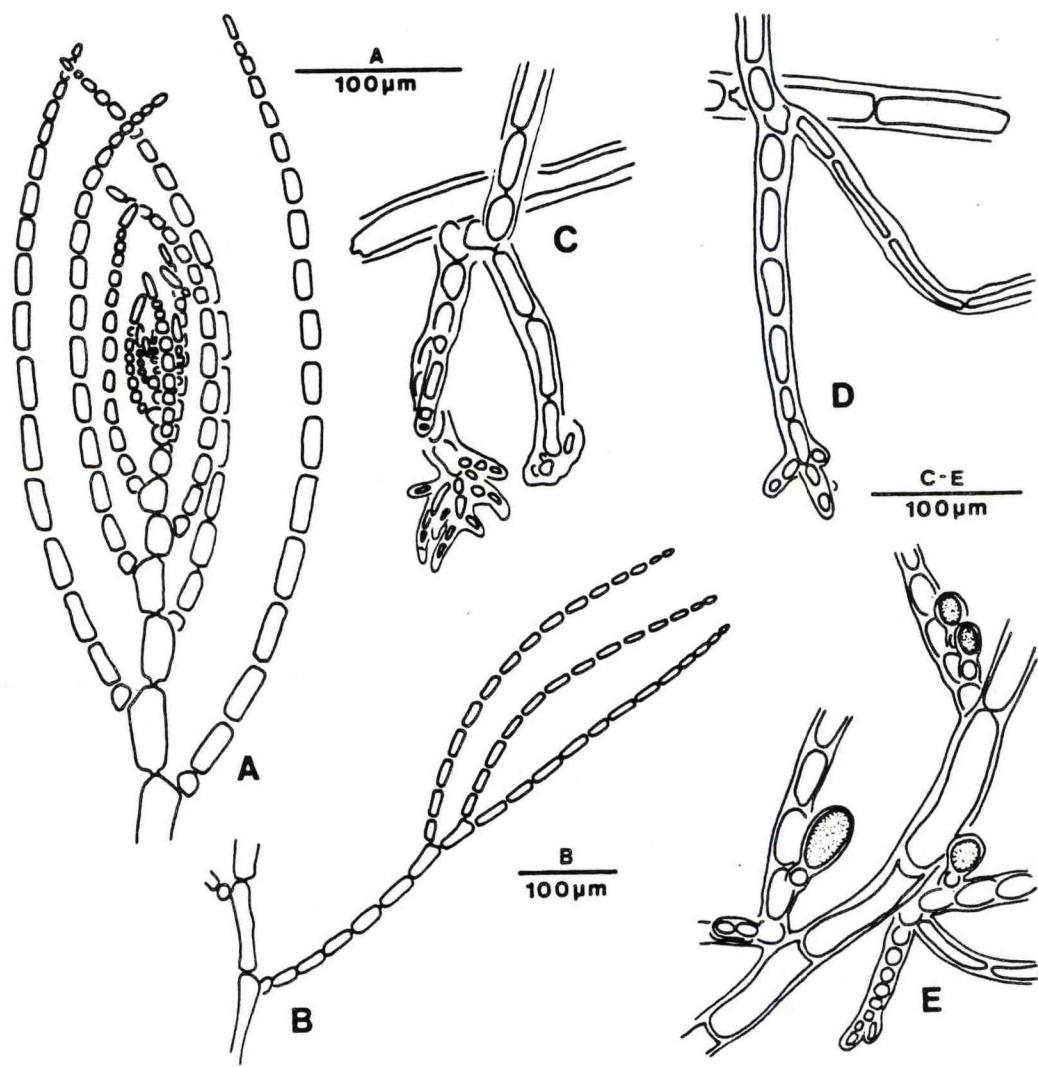


Figure 56. Callithamniella

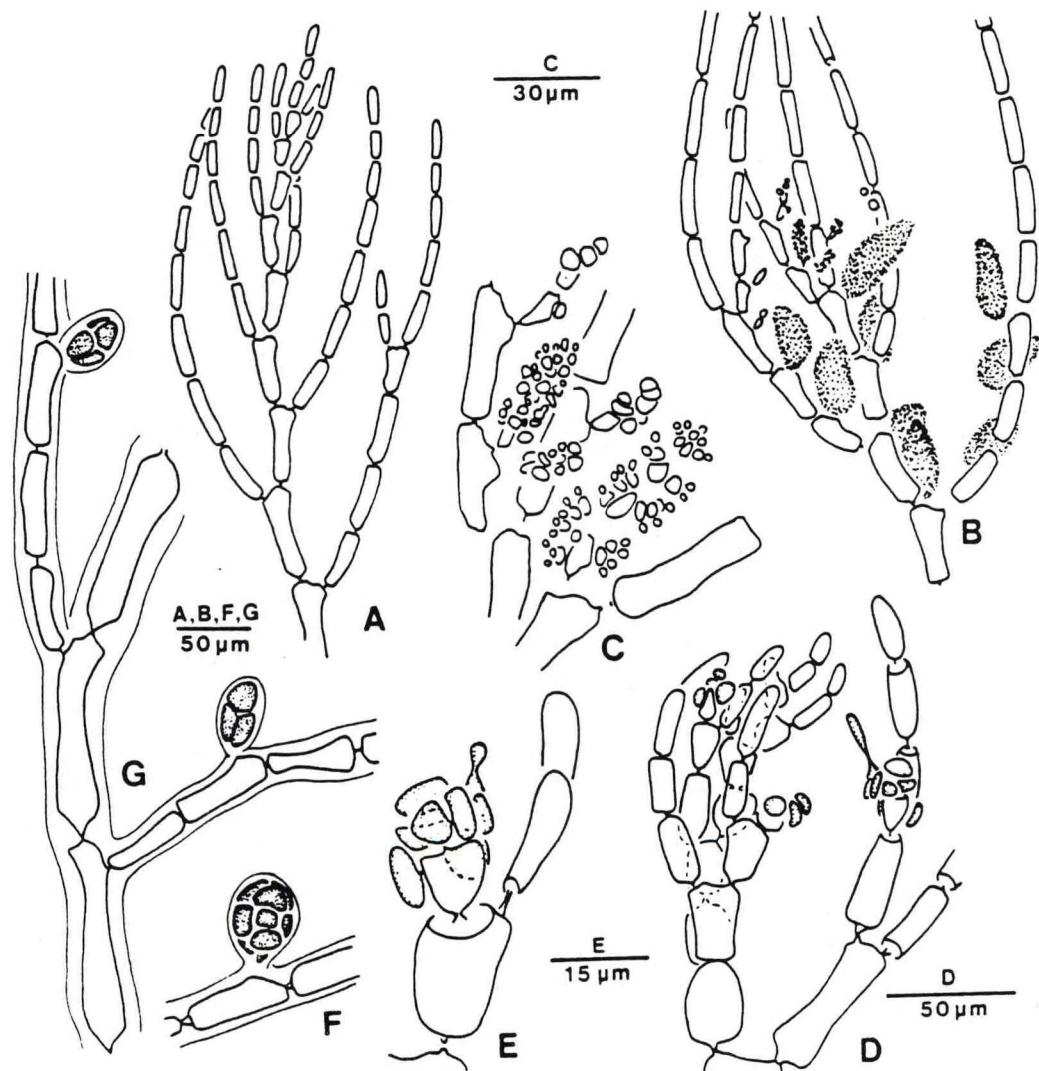


Figure 57. *Plenosporium boergesenii*

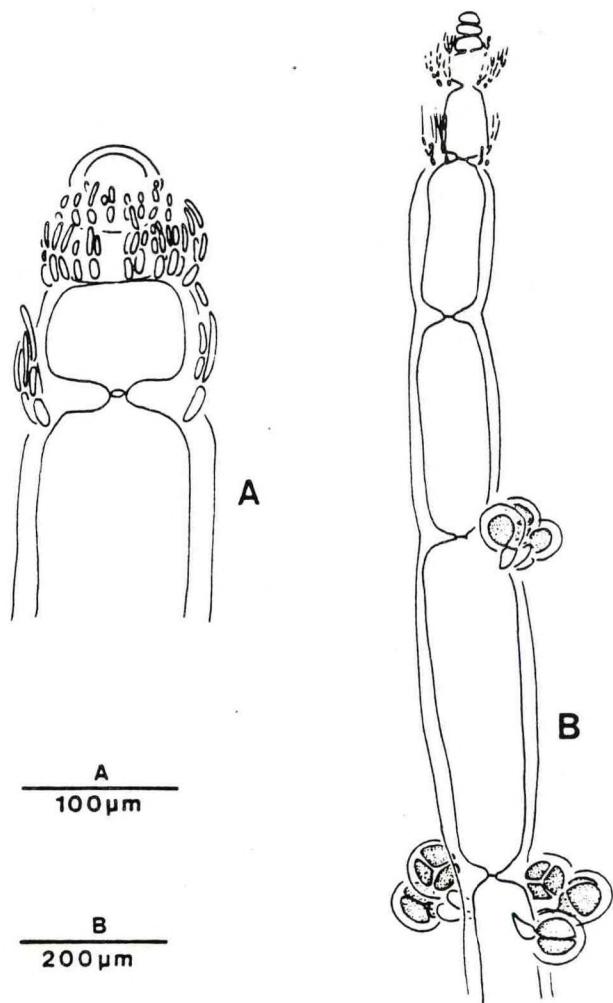


Figure 58. Anotrichium tenue

and irregular; cells multinucleate, cylindrical, 200-300 μm diam, 0.5-1.1 mm long below, the terminal 5-6 cells of a branch successively shorter, apical cell cap-like; trichoblasts of vegetative axes short, only present on the distal nodes, longer and more persistent on reproductive axes. Dioecious, spermatangia borne terminally on 1-3-celled whorled branches, 1-7 per node, pyriform to subglobose, 3 μm diam; procarps produced apically, becoming displaced laterally; carposporophytes with a large fusion cell, 1-3 gonimolobes, borne on a prominent 1-celled stalk, the majority of cells becoming carposporangia, surrounded by a whorl of 6-13, large, incurved involucral cells; tetrasporangia globose, 50-100 μm diam, borne terminally on 1-celled pedicels, without involucre, in whorls of up to 15 on the upper shoulder of distal axial cells.

Distribution from southern Massachusetts to the Caribbean and in tropical to temperate seas worldwide. Not as common in the sanctuary as the similar Griffithsia globulifera from which it is vegetatively most readily distinguished by its cylindrical rather than ellipsoidal to spherical cells (see below).

This species is listed as Griffithsia tenuis by Taylor (1960).

GRIFFITHSIA C. Agardh

Griffithsia globulifera Harvey ex Kuetzing

Fig. 59 A-C

Plants epiphytic or on rocks, erect, in tufts or tangled in other algae, to 6.5 cm tall, attached by numerous rhizoids from basal cells; branching subdichotomous, fastigiate, occasionally proliferous; branches appearing segmented to moniliform, the cells clavate near the base, 0.5-0.9 mm diam, 0.6-3.2 mm long, pyriform to globose near the apices, to 1.4 mm diam and 2.1 mm long; polychotomous trichoblasts in whorls around the summit of distal cells. Female and gametangial plants tapering abruptly to the apex, male plants with the largest diameter cell of the branch at the apex. Dioecious; spermatangia in cap-like sori on the flat end of apical cells, sometimes in smaller quantities on the 1-2 cells below the apex; procarps mostly at the upper nodes, carposporophytes with a central fusion cell and radiating gonimoblast filaments, most cells becoming ellipsoidal, ovoid, subglobose to irregular, carposporangia 15-40 μm diam; carposporophyte surrounded by incurved, sausage-shaped involucres; tetrasporangia globose to ovoid, 40-110 μm diam, whorled at the nodes, usually borne 3 per 1-celled branch, surrounded by numerous, incurved sausage-shaped involucral cells.

Reported from southeastern Canada to Brasil, Griffithsia globulifera is a common plant in the Sanctuary. It grows on rock, but is also a frequent colonizer of colonial invertebrate skeletons.

PTIOTHAMNION Thuret

Ptilothamnion sp.

Fig. 60 A-G

Plants epiphytic, with creeping and erect, uniseriate axes, attached by unicellular, digitate holdfast cells. Prostrate axes to 28 μm diam, erect axes to 23 μm diam, each prostrate axial cell producing at most one erect branch; erect branches determinate, to 1 mm long, or potentially indeterminate and becoming secondarily prostrate. Spermatangia

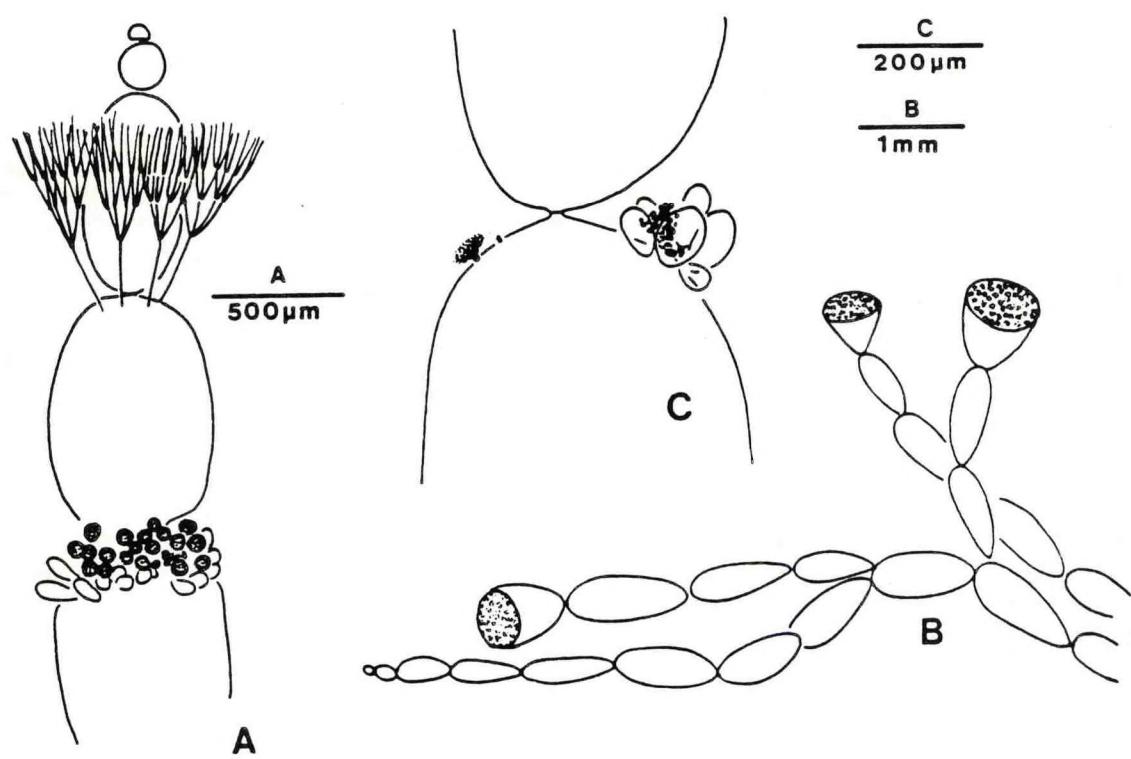


Figure 59. Griffithsia globulifera

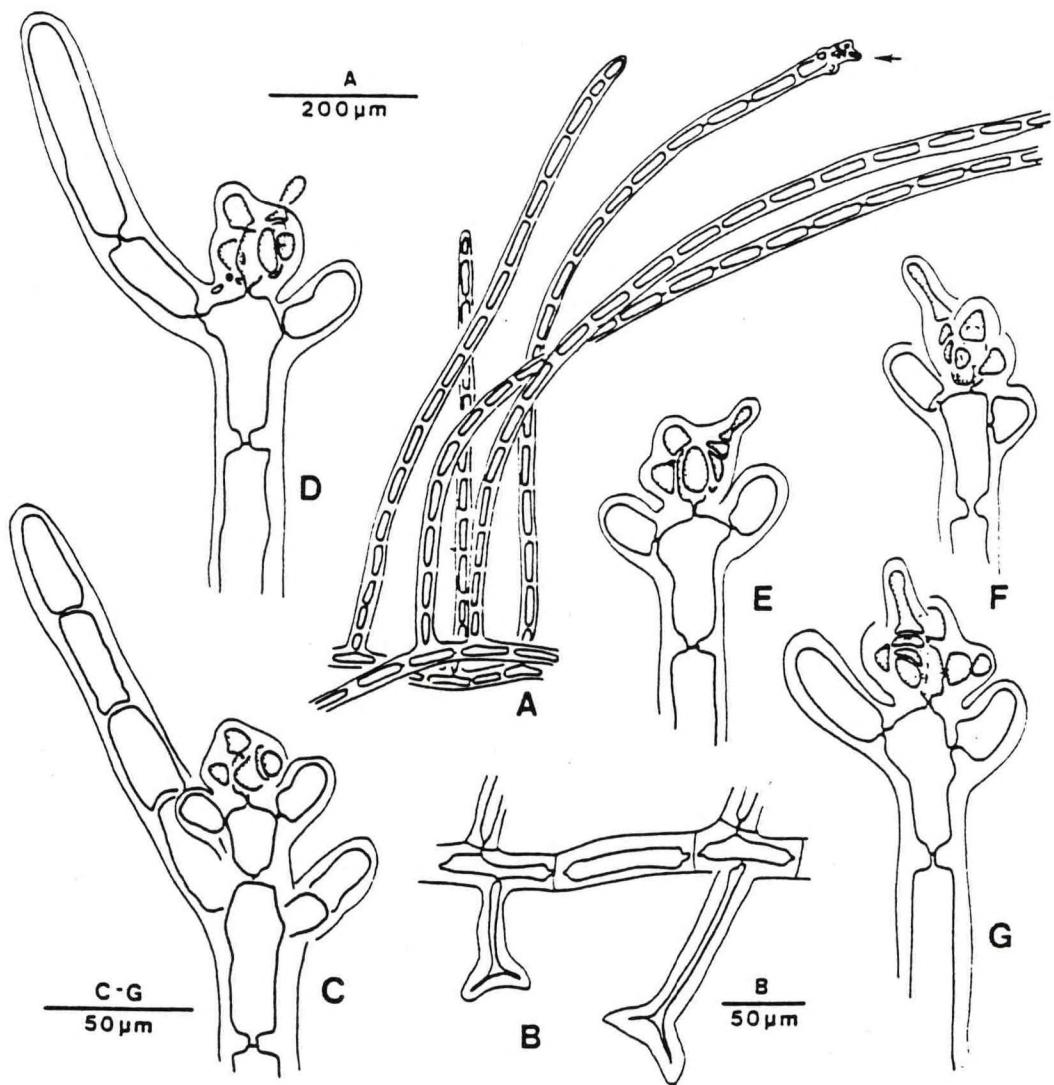


Figure 60. *Ptilothamnion* sp.

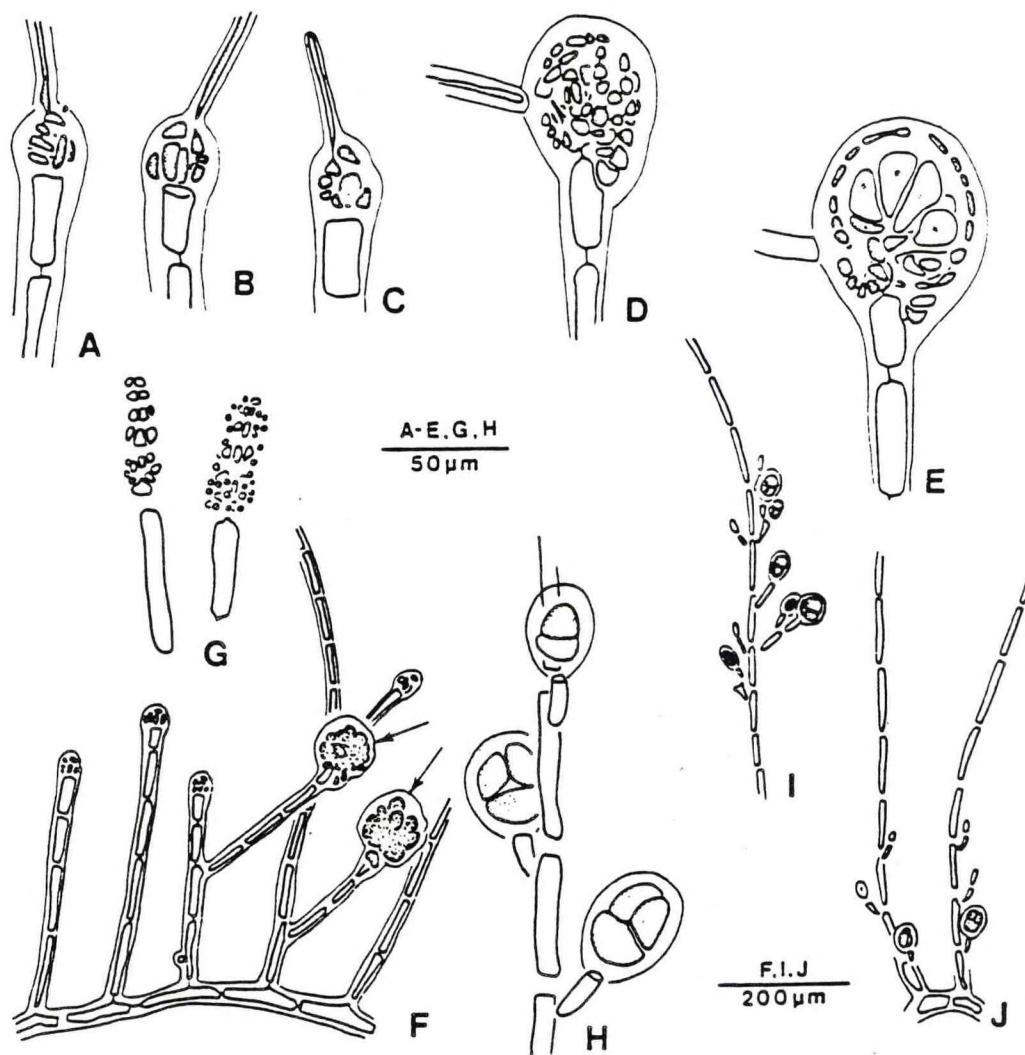


Figure 61. *Lejolesia* sp.

and tetrasporangia unknown; procarps formed on the subapical cell of erect branches; subapical cell with 3 pericentral cells, one of which is the supporting cell of the carpogonial branch and, potentially, produces the auxiliary cell; a second pericentral cell divides once to form a 2-celled filament; involucre of filaments initiated before fertilization from the 1(-2) cells below the fertile segment, each forming up to 2 filaments, 1-4 cells long.

This genus has not been reported from the east coast of North America. The type species, P. plumula (Dillwyn) Thuret, is from Europe and other species are reported from California, Japan, New Zealand and a freshwater species from British-Guayana. The single collection from the sanctuary is female and there are no carposporophytes. The vegetative structure and position and organization of the procarps subtended by the beginnings of involucres suggest placement in Ptilothamnion. It was collected growing epizoically in the Sanctuary and once at the Snapper Banks.

LEJOLESIA Bornet

Lejolesia sp.

Fig. 61 A-J

Plants epiphytic, with prostrate and erect axes; prostrate axes attached by 1(-2), unicellular, digitate holdfast cells per axial cell; prostrate axes 18-37 μ m diam, cells 3.5-4.5 times as long as broad; erect axes 1-2.5 mm tall, 21-24 μ m diam, cells 3-4 times as long as broad in lower parts, 9-12 times as long as broad in upper parts, simple or sparsely branched, tapering slightly toward their apices. Spermatangial heads terminal on erect branches, ovoid, to 54 μ m long, 27 μ m diam; cystocarps terminal on erect axes, carposporangia few; pericarp 86-113(-123) μ m diam and 90-117(-122) μ m long, formed from sterile cells of the fertile segment, the apical cell and 1-3 cells cut off of the hypogynous cell; tetrasporangia tetrahedrally divided, ovate, 33-42 by 41-54 μ m, terminal on upwardly curved, short, lateral branches.

Plants from the Sanctuary agree in most characteristics with those described by Itono (1977) for Lejolesia pacifica. However, Itono indicated that the pericarp is produced from a filament originating from the segment of the branch axis below that bearing the procarp. In the plants from the Sanctuary, that cell produces a short filament of 1-3 cells, which may often be incorporated into the base of the pericarp, but the largest part of the pericarp is formed from cells derived from sterile cells associated with the procarp segment and from the apical cell. The development of the pericarp in the sanctuary plants is like that reported for L. aegagrophila (J. Agardh) J. Agardh by Gordon (1972). The cystocarps in the Japanese species are also smaller, with a maximum diameter of 90 μ m. The differences in origin and size of the pericarp and the long distance between the populations would probably justify recognition of a new species for the Georgia plants.

Delesseriaceae

BRANCHIOGLOSSUM Kylin

Branchioglossum minutum Schneider in Schneider & Searles

Fig. 62 A-D

Plants erect, pinkish-red, attached by common discoidal or rhizoidal holdfasts;

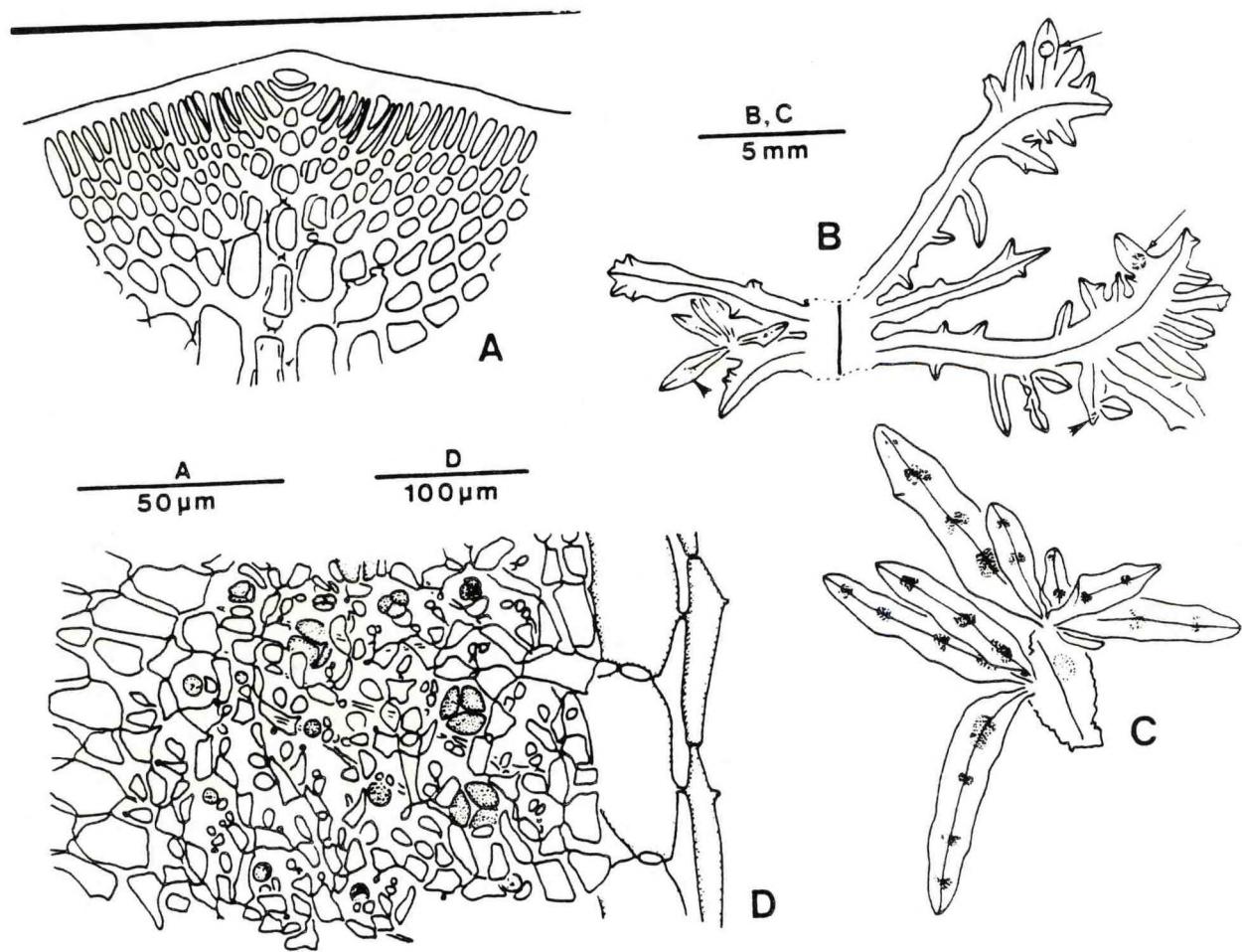


Figure 62. Branchioglossum minutum

branching sparse to profuse, irregular, alternate to opposite, of one, and occasionally 2-3 orders, mostly marginal with a rare branch from the midrib, especially in wounded areas; blades clustered, oblanceolate, 1(-2.2) cm tall, margins undulate; apices apiculate, occasionally obtuse, apical cell dividing transversely; main branches 1-3 mm broad, corticated at the base; midrib conspicuous, axial cells 18-40 μ m diam, 80-120 μ m long with rows of broad, short pericentral cells surrounding the axial cells; lamina monostromatic, all filaments making up the lamina extending to the margins. Dioecious; procarps forming sequentially on the midrib below the apex, 1-2 per blade developing into cystocarps; cystocarps hemispherical, 250-650 μ m diam, projecting on either side of blade; carpospores spherical to ovoid, 25-32 μ m diam; spermatangia in irregular, confluent sori midway between the midrib and the margin of the blade; tetrahedral tetrasporangia 20-40 μ m diam, in semicircular to circular, opposite sori contiguous with the midrib, elevated on both blade surfaces.

Distribution limited to the southeastern coast of the United States from mid-Florida to North Carolina. It is similar in size and macroscopic appearance to Hypoglossum hypoglossoides, but not as common as that species.

HYPOGLOSSUM Kuetzing

Hypoglossum hypoglossoides (Stackhouse) Collins & Hervey

Fig. 63 A-H

Plants epiphytic, epizoic, or on rocks, light pink to translucent, forming upright tufts to 20 cm tall, often much smaller, or prostrate spreading entwined mats; secondarily attached by marginal or terminal rhizoids; blades linear lanceolate, to 5 cm long, 1-4 mm wide, sparsely to greatly branched from the midrib, generally to 3 orders; apices acute to emarginate, rarely obtuse, the apical cell dividing transversely; blade lamina monostromatic, all filaments extending to the blade margins, which are entire to subcrenate and undulate; midribs 3-layered above, the axial cell flanked by 1-2 rows of elongate, hexagonal to cylindrical cells, corticated by rhizoids below. Dioecious; spermatangia in interrupted to confluent sori covering most or at least the upper parts of the blade, midway between the midrib and the margins; cystocarps globose, sessile on the midrib; tetrasporangia tetrahedral, 40-80 μ m diam, in half elliptical, heavily corticated sori along one or usually both sides of the midrib in the upper part of the blade.

Reported from the warm-temperate and tropical western Atlantic, Atlantic Europe, the Mediterranean and the Canary Islands. It is a common plant in the Sanctuary where it grows on rock and even emerges through overlying sand, but due to its delicate, translucent blades it is easily overlooked.

GRINNELLIA Harvey

Grinnellia americana (C. Agardh) Harvey

Fig. 64 A-D

Plants with simple blades, 1-50(-110) cm tall; branching restricted to the short stipe which is attached by a discoid holdfast; blades narrowly to broadly lanceolate or ovate-oblong to broadly ovate and cordate, translucent pink to rosy pink, rarely purplish; apical cell dividing transversely; midrib prominent, multilayered in older parts of blades, pericentral cells divided transversely; blades monostromatic, with intercalary divisions,

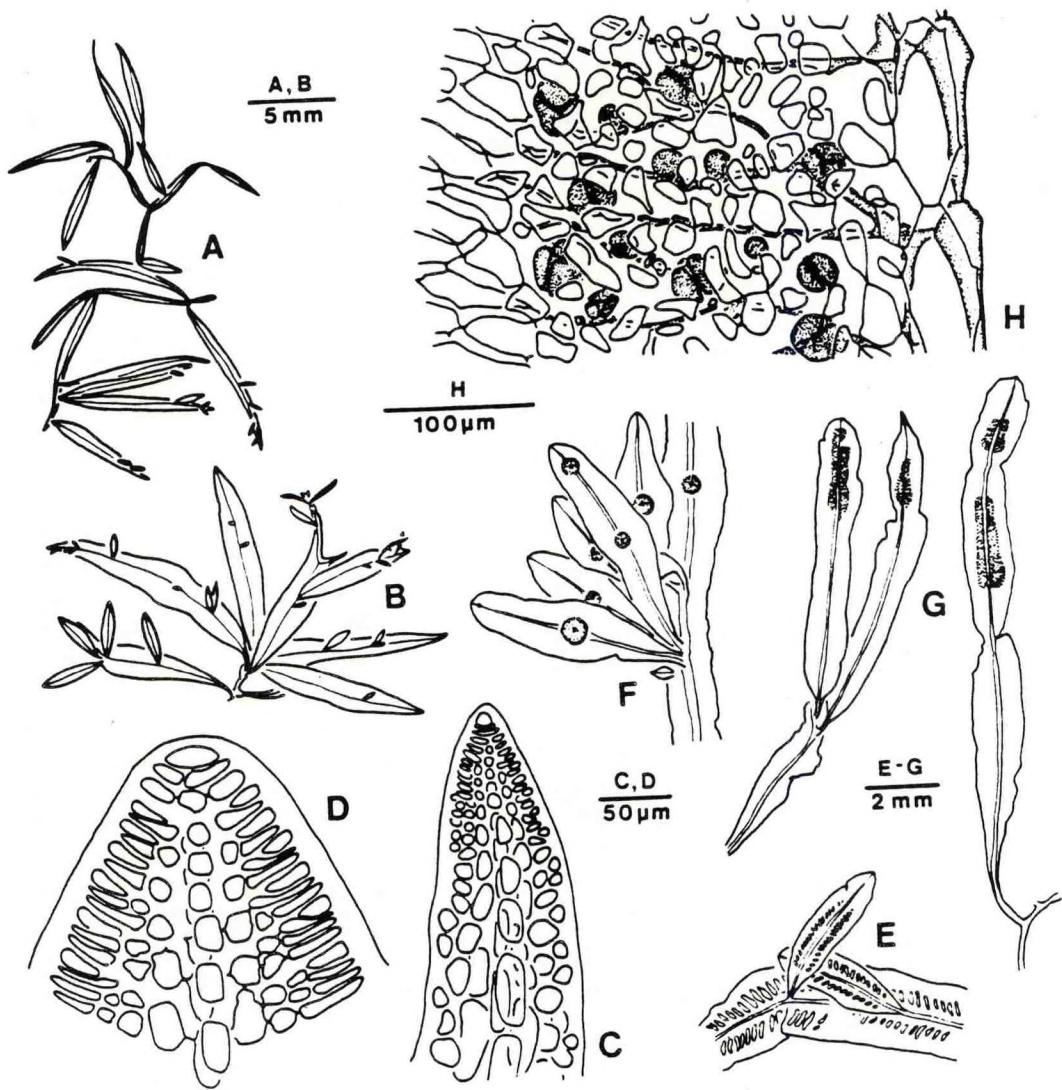


Figure 63. *Hypoglossum hypoglossoides*

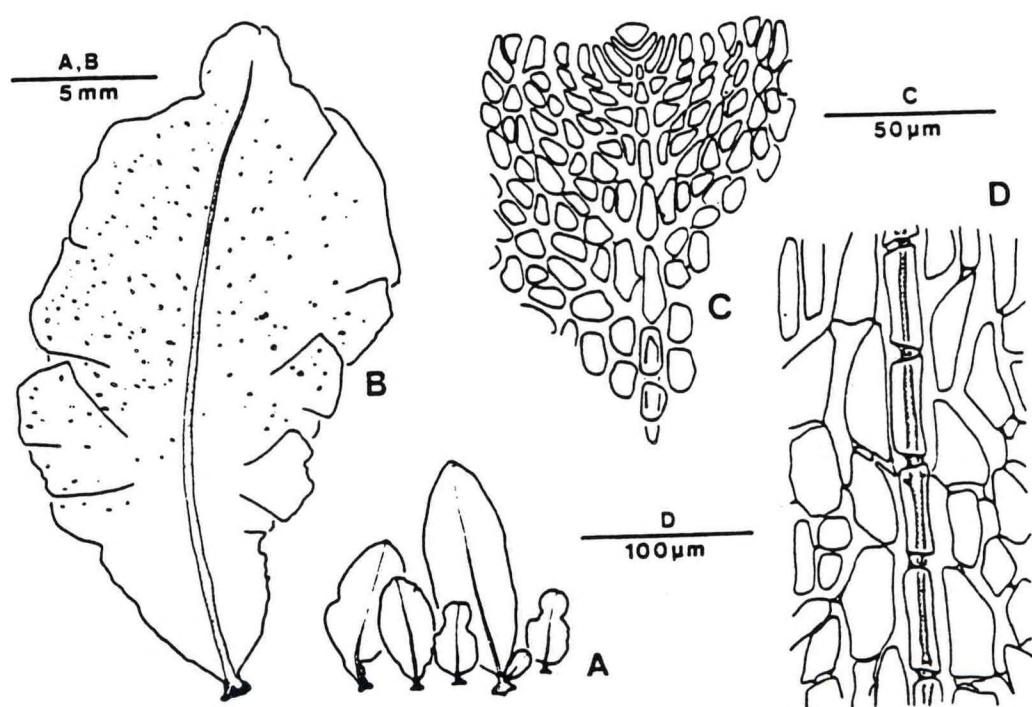


Figure 64. Griniella americana

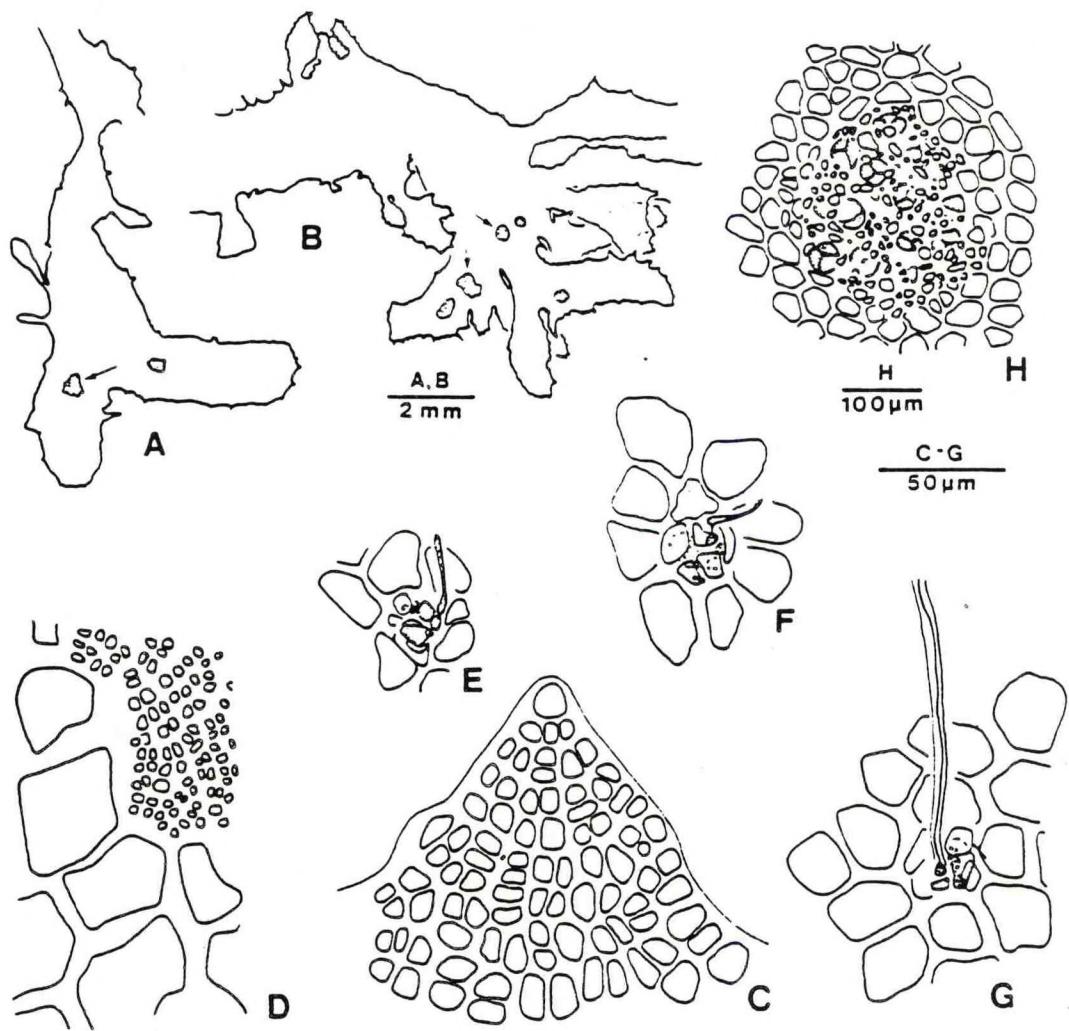


Figure 65. *Haraldia prorostrata*

not all filaments of the blade reaching the margins. Dioecious; spermatangia in small, scattered, elongate, irregular, separate or confluent sori, to 0.5 mm long; cystocarps scattered on the blade, stalked, hemispherical, to 1.5 mm diam, ostiolate; carposporangia 5-15 um diam, in chains; tetrasporangia tetrahedral, 50-80 um diam, in elevated, corticated, irregular, 1x2 mm sori scattered on both blade surfaces.

Distributed from Massachusetts to Venezuela in shallow and deep water. In the Sanctuary plants were a maximum of 3-4 cm tall. Plants on rock were rare, but tiny epiphytic and epizoic specimens were more frequently encountered, intermingled with Hypoglossum, Ceramium, Griffithsia and other common epiphytes. It was one of the few annual plants collected in March in the Sanctuary.

HARALDIA Feldmann

Haraldia prostrata Dawson, Neushul & Wildman

Fig. 65 A-H

Plants small, to 1.5 cm broad or long, primarily prostrate; branching irregularly pinnately or flabellately short-branched or lobed; blades membranous, overlapping, attached to themselves and the substrate by rhizoids formed from their tips, margins and undersides; blades broadly expanded and sometimes undulate, monostromatic throughout vegetative parts, without veins, the margins with teeth; apices acute; cells in central vegetative parts polygonal, mostly 50-60 um diam. Spermatangia in patches in the middle of the blades; procarps scattered on the dorsal blade surface; carposporophytes unknown; tetrasporangia borne in prominent, solitary, rounded sori.

The only samples of this plant came from the Snapper Bank collections. Dawson et al. 1960, suggest that plants from Barbados may refer to this species. The plants from the Georgia are fragmentary, but fit Dawson et al.'s description except for lacking undulate blades and having the tetrasporangia sori in places in addition to near the ends of the ultimate branches. In addition, the procarps and spermatangia observed in the Georgia specimens have not previously been reported for the species.

Dasyaceae

DASYA C. Agardh

Dasya baillouviana (Gmelin) Montagne in Barker-Webb & Berthelot

Fig. 66 A-C

Plants on rock, shell, epizoic or, rarely epiphytic, to 90 cm tall, virgate to bushy, pinkish-, brownish-, rosy-, to deep purplish-red, arising from a small discoid holdfast; indeterminate axes cylindrical, polysiphonous, with 5 pericentral cells and rhizoidal cortication, 2-3(-6) mm diam, sparsely to abundantly, radially and alternately branched; determinate pseudolateral branches monosiphonous, pigmented, initially abundant on indeterminate axes, later deciduous on lower axes, spirally arranged, 2-8(-14) mm long, basal cells 10-40 um diam, 20-50 um long, median cells to 60 um diam, 200 um long, then tapering to 5-12 um diam with acute or obtuse tips. Dioecious; spermatangia in pedicellate stichidia; stichidia lanceolate to acute linear lanceolate, 80-160 um diam, 0.6-1.0(-1.2) mm long; cystocarps single, rarely in groups of 2-3, near tips of short determinate branches, urceolate, to 1.1 mm diam, with an obvious neck 100-200 um diam;

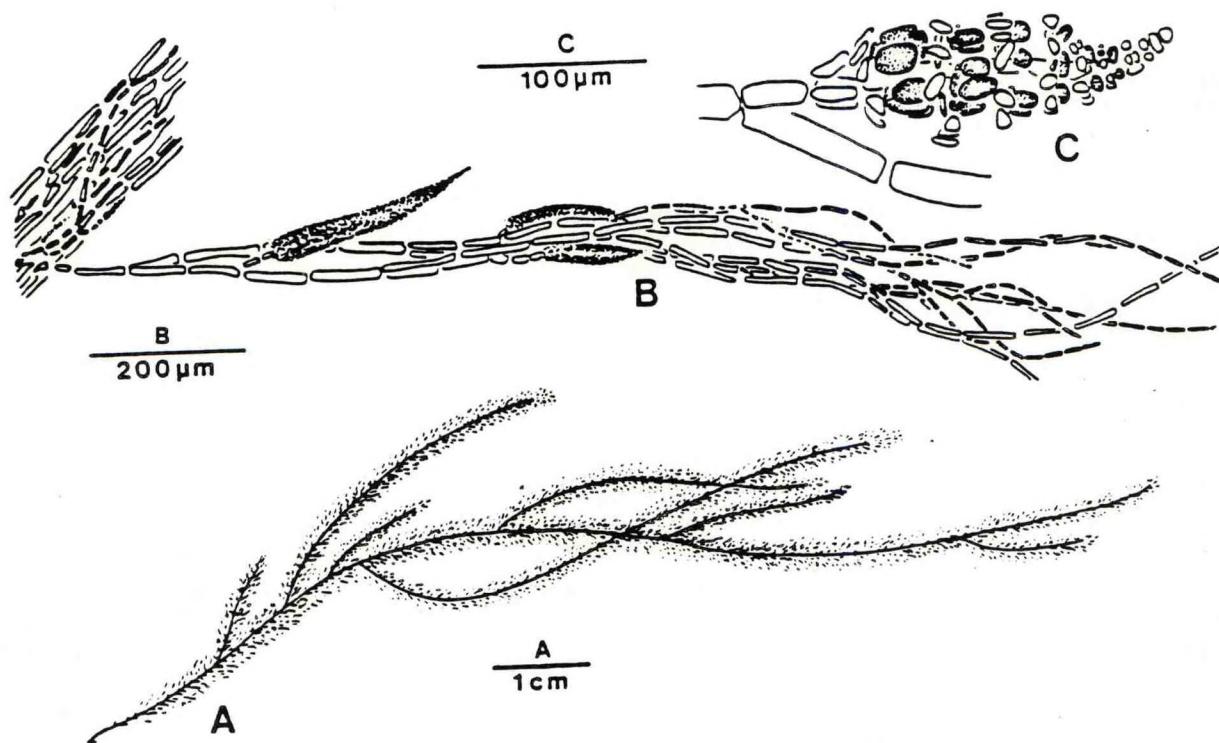


Figure 66. *Dasva baillouviana*

tetrasporangia in stichidia with dimensions of spermatangial stichidia, sporangia divided tetrahedrally, globose, 40-80 μm diam, in whorls partially covered by sterile cover cells.

Distributed from Massachusetts to Brazil and elsewhere in tropical seas. Plants growing attached in the Sanctuary are small, at most 15 cm tall. They are found as epizoic specimens as often as on rock. In spite of their small size, the attached plants are fertile; male, cystocarpic and tetrasporangial plants were collected in July. Larger, fertile plants were noted in June as bottom drift. This species is a common winter-spring annual along the southeastern coast of the United States. The small size of the plants and their development in the summer following their appearance in shallow water suggests that plants do not overwinter in the offshore, Sanctuary waters, but are "seeded in" by drifting plants. Richardson (1981), however, reported that in North Carolina's shallow waters germlings overwinter as small, filamentous mats which mature as erect plants in the spring. The suggested direct and rapid development to small, but fertile summer plants in one season may be an alternative type of life history.

Taylor (1960) reports this species under the name Dasya pedicellata.

Rhodomelaceae

DIPTEROSIPHONIA Schmitz & Falkenberg

Dipterosiphonia reversa Schneider

Fig. 67 A-C

Plants prostrate, dorsiventrally organized, to 2 cm long, attached by unicellular rhizoids to 1 mm long. Axes cylindrical, 80-105 μm diam, uncorticated, having 5 pericentral cells; pericentral cells 3-4 times as long as broad in the main axes, to as long as broad near the apices, the first cut off on the same side as the branch primordia. Lateral branch primordia formed near the apex, first 2 on one side of the shoot, then 2 on the other side, the distal primordium of a pair usually not developing, aborting after forming a few cells, or more rarely forming a simple unbranched, polysiphonous lateral; the proximal lateral primordium developing into a branched, polysiphonous determinate or indeterminate branch, extending dorsally from the main axis; secondary branches on these proximal laterals alternate on every other segment, occasionally forming secondary determinate branchlets to 1 mm in length, 50-75 μm diam at the base, tapering to 20-40 μm below the apex. Gametangia and terasporangia unknown.

Originally described from the offshore waters of North Carolina (Schneider, 1975). The Georgia collections are the second record of this species. Plants grow intermingled with other small filamentous algae and sessile invertebrates.

POLYSIPHONIA Gréville

Plants radially organized, with erect and sometimes prostrate, polysiphonous branches, all branches of similar appearance. Attached generally by unicellular rhizoids. Axes cylindrical, laterally or pseudodichotomously branched, each axial cell surrounded by 4 or more pericentral cells, with or without a rhizoidal or pseudoparenchymatous layer of cortication. Colorless, branched trichoblasts often formed in spirals near the apex, one per segment. Spermatangia clustered on rudimentary, lanceolate or oblong trichoblasts; cystocarps stalked or sessile, oval or urn-shaped, thin-walled and ostiolate; tetrasporangia tetrahedrally divided, one per segment, in the ultimate polysiphonous

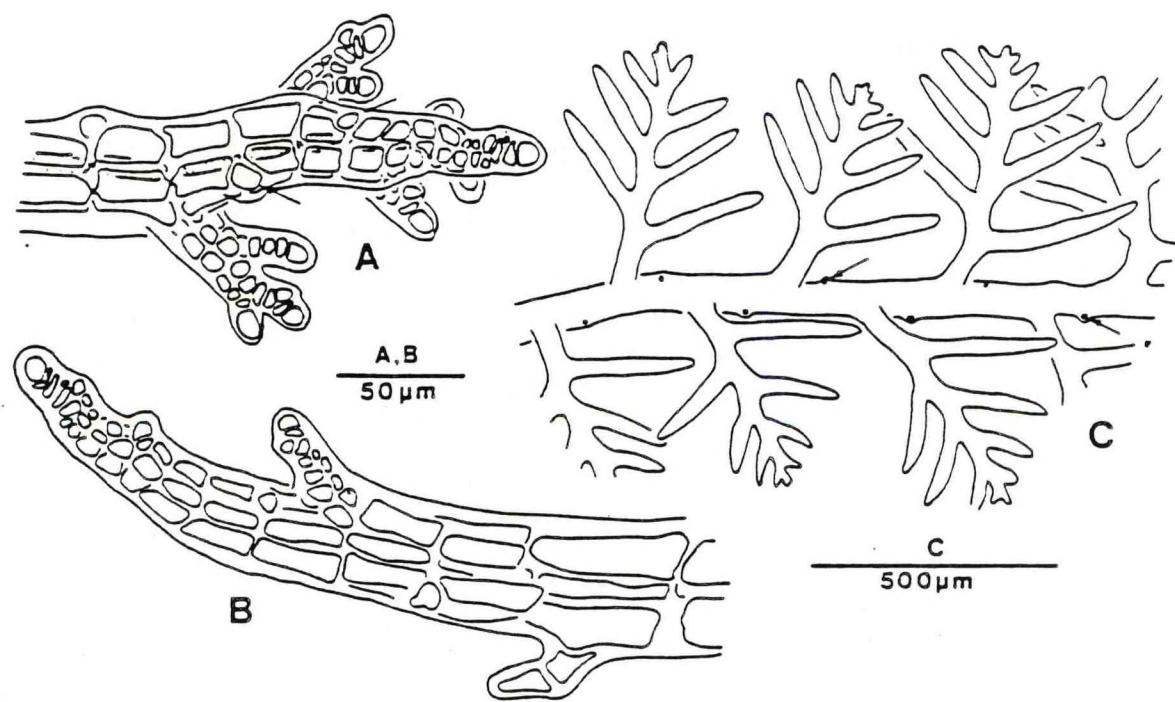


Figure 67. *Dipterosiphonia reversa*

branchlets. Two species are reported from the Sanctuary.

Polysiphonia denudata (Dillwyn) Greville ex Harvey in Hooker

Fig. 68 A-C

Plants dark reddish-purple or purplish-brown, in loose tufts 15(-25) cm tall, initially attached by a small discoid holdfast, secondarily attached by unicellular rhizoids from proximal ends of pericentral cells and pit-connected to them; trichoblasts generally lacking, except occasionally in rapidly growing branches; lower axes 100-750 μ m diam, sparingly branched; upper axes soft and flexuous, 100-170 μ m diam, much branched, alternate to pseudodichotomous, widely angled, 90-120 degrees, tapering in the ultimate branchlets to 33-45 μ m; branches arising in axils of trichoblasts; segments 1(-3) diam long, with 5-6 pericentral cells, ecorporate except some slight cortication near the base; branchlets formed laterally at the base of trichoblasts, to 45 μ m diam; apical cells prominent, not obscured by trichoblasts. Spermatangial filaments long-conical to cylindrical and fusiform, 30-80 μ m diam, 100-300 μ m long, with or without 1-3 sterile tip cells; cystocarps short-stalked, globose to broadly ovoid, 200-450 μ m diam, with narrow to broad ostioles; tetrasporangia subglobose to wide ellipsoidal, 50-85 μ m diam, in long straight series in upper half of erect axes, the segments slightly swollen at maturity.

Widespread in the Atlantic from tropical to boreal and antarctic waters, the Mediterranean and Black Seas. The species was rare in the Sanctuary, but did also occur on the Snapper Banks.

Polysiphonia atlantica Kapraun & J. Norris

Fig. 69 A,B

Plants epiphytic, or on rocks or wood, brownish- and purplish-red to blackish; prostrate indeterminate axes spreading and forming mats, attached by numerous unicellular rhizoids formed from the center of pericentral cells and in open communication with them, with or without digitate tips; apical cells obvious, pericentral cells 4; segments ecorporate, 2-3 diam long; scar cells from trichoblasts conspicuous; prostrate axes tips curved upward, 60-100 μ m diam, erect axes from every 4th-5th segment; erect indeterminate axes 1-2 cm tall, slightly narrower than prostrate axes, pseudodichotomously branched below, sparsely branched above, branches replacing trichoblasts in developmental sequences at the apices, trichoblasts usually lacking, occasionally persistent, simple to twice branched; adventitious branching rare. Spermatangial sori on 1-few-celled stalks, cylindrical, to 40 μ m diam, 180 μ m long, formed from entire trichoblast primordia on tips of erect axes, without sterile tip cells; cystocarps short-stalked to sessile, formed centrally on erect axes, urceolate, to 200 μ m diam, 250 μ m long with obvious necks and ostioles.

Distributed from North Carolina south to Brasil and in the eastern Atlantic from Britain and Denmark south to West Africa, through the Mediterranean to the Indian Ocean. Plants of this species on the southeastern coast of the United States were reported as Polysiphonia macrocarpa prior to Kapraun and Norris' description of P. atlantica in 1982. It is a common species in the Sanctuary where it grows on rock, but all collections are sterile.

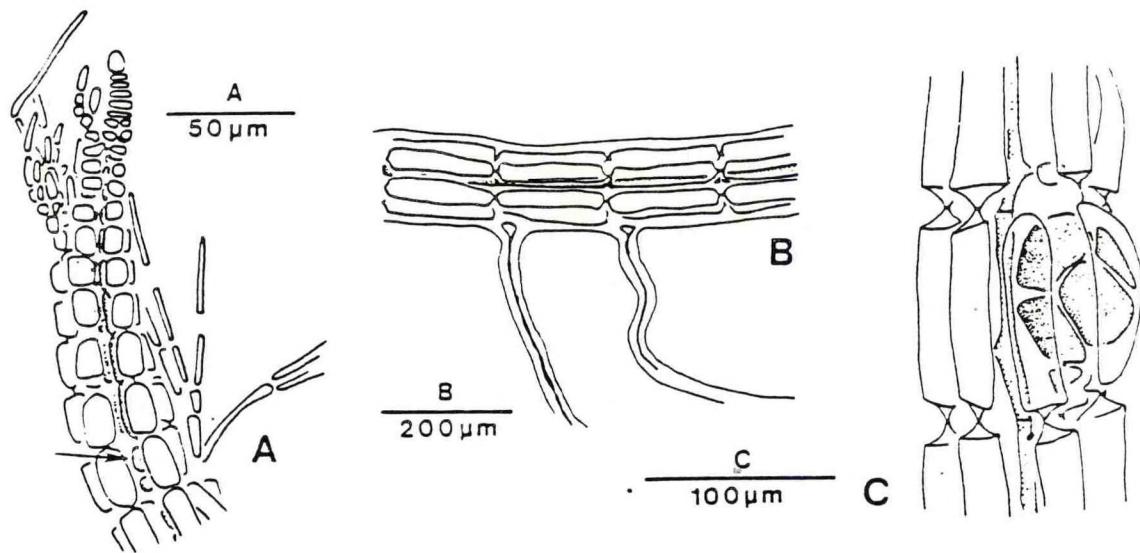


Figure 68. Polysiphonia denudata

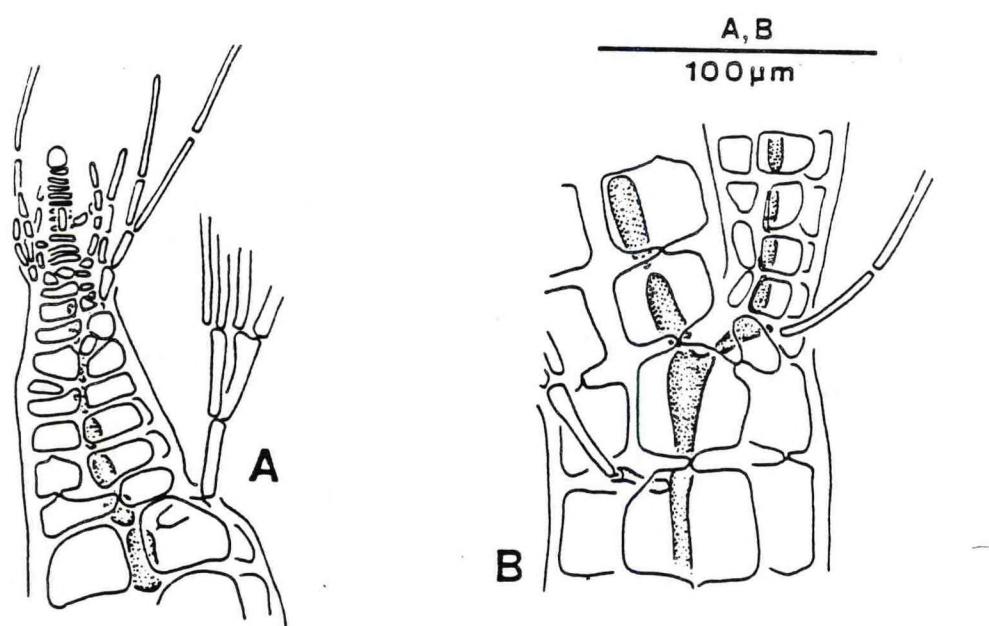


Figure 69. Polysiphonia atlantica

CHONDRIA C. Agardh

Chondria polyrhiza Collins & Hervey

Fig. 70 A-C

Plants spreading laterally, erect branches 5-8 mm tall, axes slender, to 0.5 mm diam, firm, the central axial filament surrounded by 5 pericentral cells and a cortex of pseudoparenchymatous tissue. Attached by multicellular clusters of unicellular rhizoids. Branching alternate, ultimate branches more slender, more or less constricted at the base; apices acute, apical cells exposed or covered by tufts of short trichoblasts; segments of pericentral cells visible through the cortex in only the youngest branches if at all; outer cortical cells linear, 5-15 μ m diam, 25-60 μ m long. Tetrasporangia in the ultimate branchlets which are swollen and subdeterminate; gametangia unknown.

Distributed from North Carolina south to Brasil. This species is rare in the Sanctuary.

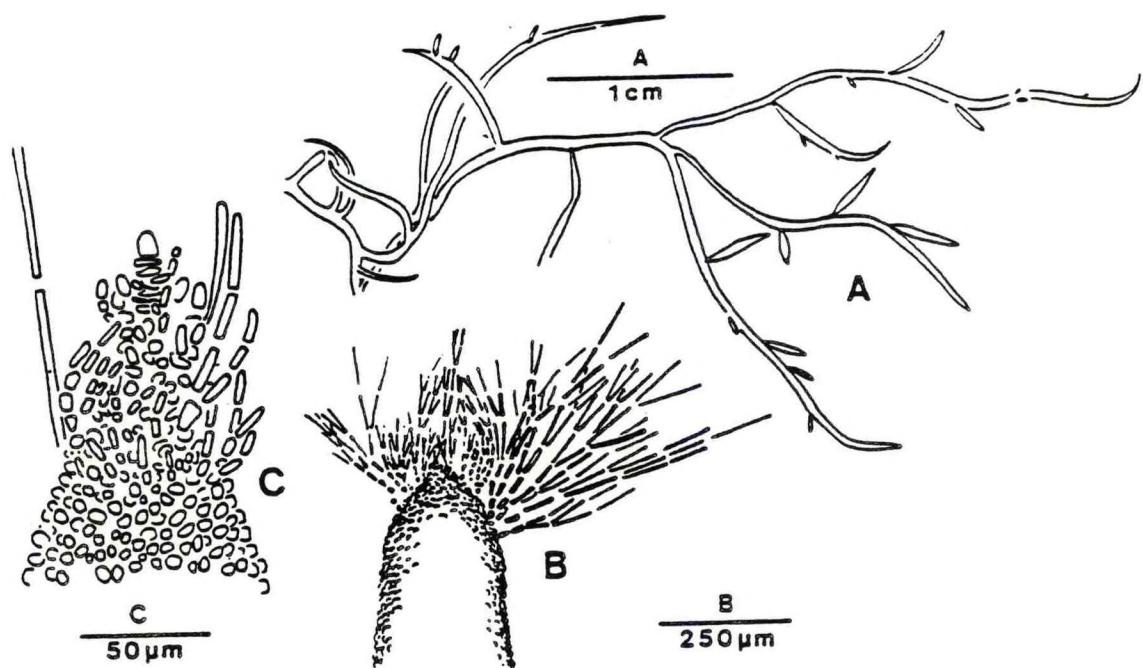


Figure 70. *Chondria polyrhiza*

ADDITIONAL READINGS ON SEAWEEDS AND THE PLANTS OF THIS REGION

Additional collecting in the sanctuary and the adjacent waters is certain to produce some plants of species which are not included in this guide. The author's experience in similar waters off of North Carolina showed that new regional records of species and even undescribed species were found in sites where collecting had gone on for over 15 years. So it may be useful to refer to reports of seaweeds from adjacent regions.

William Randolph Taylor's *Marine Algae of the Eastern Tropical and Subtropical Coasts of the Americas* published in 1960 remains the single best book on the flora from North Carolina to Brasil. However only 31 species in this guide appear in that book under the names used here, seven others appear under other names, and 30 cannot be identified with that book. D.F. Kapraun's *An Illustrated Guide to the Benthic Marine Algae of Coastal North Carolina I and II* and C.J. Dawes' *Marine Algae of the West Coast of Florida* are more recent, but geographically more limited references, each covering about half of the species listed in this guide. Boergesen's three volume work on *The marine algae of the Danish West Indies* is an older and less easily available reference, but is still very useful. Humm and Wick's *Introduction and Guide to the Marine Bluegreen Algae* gives a good coverage of a group of plants often neglected in coverage of the seaweeds.

For more general knowledge of the seaweeds there are a number of modern, useful texts (Bold & Wynne, 1985; Dawes, 1981; Lee, 1980; Sze, 1986). An introduction to the recent primary literature on algae is available in Rosowski and Parker's *Selected Papers in Phycology* and *Selected Papers in Phycology II* which contain reprints of important papers and introductions to the recent literature in a variety of fields of phycology.

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TABLE 1**COLLECTION SITES****Gray's Reef National Marine Sanctuary**

| Latitude | Longitude | Depth |
|--------------------------|-----------------------|---------------------|
| 1. $31^{\circ} 23.82' N$ | $80^{\circ} 53.15' W$ | 62-68 ft, 19-21 m |
| 2. $31^{\circ} 23.60' N$ | $80^{\circ} 53.00' W$ | 58-62 ft, 18-19 m |
| 3. $31^{\circ} 24.09' N$ | $80^{\circ} 52.32' W$ | 57-70 ft, 17-21 m |
| 4. $31^{\circ} 24.30' N$ | $80^{\circ} 51.70' W$ | 56-63 ft, 17-19 m |
| Snapper Banks | | |
| 5. $31^{\circ} 35.0' N$ | $80^{\circ} 23.0' W$ | 100 ft, 30 m |
| 6. $31^{\circ} 35.5' N$ | $80^{\circ} 19.0' W$ | 101-105 ft, 31-32 m |
| 7. $31^{\circ} 34.0' N$ | $80^{\circ} 19.0' W$ | 112-115 ft, 34-35 m |
| 8. $31^{\circ} 34.7' N$ | $80^{\circ} 17.9' W$ | 114 ft, 35 m |

TABLE 2. MONTHS OF COLLECTION FOR EACH SPECIES

| Species | Month of collection |
|----------------------------------|----------------------|
| <u>Schizothrix mexicana</u> | Jul Aug |
| <u>Cladophora</u> sp. | Jul* Aug |
| <u>Cladophora dalmatica</u> | Aug |
| <u>Cladophora laetevirens</u> | Aug |
| <u>Cladophora pellucidoidea</u> | Jun Jul Aug |
| <u>Bryopsis pennata</u> | Jul# Aug |
| <u>Derbesia marina</u> | Aug |
| <u>Derbesia turbinata</u> | Jul* Aug |
| <u>Derbesia</u> sp. | Jul* |
| <u>Boodleopsis pusilla</u> | Jun Jul# Aug# |
| <u>Codium isthmocladum</u> | Mar Jun Jul# Aug Sep |
| <u>Caulerpa mexicana</u> | Jul Aug |
| <u>Giffordia mitchellae</u> | Jul |
| <u>Giffordia onslowensis</u> | Jul |
| <u>Onslowia endophytica</u> | Jul Aug |
| <u>Dictyota dichotoma</u> | Jul Aug |
| <u>Spatoglossum schroederi</u> | Jul Aug Sep |
| <u>Dictyopteris hoytii</u> | Jul Aug |
| <u>Rosenvingia intricata</u> | Jul |
| <u>Colpomenia sinuosa</u> | Jul |
| <u>Sargassum filipendula</u> | Mar Jun Jul Aug Sep |
| <u>Stylonema alsidii</u> | Jul Aug |
| <u>Erythrocladia irregularis</u> | Jul Aug |
| <u>Erythrotrichia carnea</u> | Jul Aug |
| <u>Audouinella bispora</u> | Jul Aug |

| | |
|--|---------------------|
| <u>Audouinella hoytii</u> | Jul |
| <u>Audouinella ophioglossa</u> | Jul Aug |
| <u>Scinaia complanata</u> | Jun Jul Aug Sep |
| <u>Falkenbergia hillebrandii</u> | Jul# Aug* |
| <u>Dudresnaya crassa</u> | Jul Aug |
| <u>Dudresnaya georgiana</u> | Jun Jul Aug |
| <u>Dudresnaya puertoricensis</u> | Jul Aug |
| <u>Halymenia agardhii</u> | Jun Jul Aug Sep |
| <u>Halymenia floridana</u> | Jun Jul Aug |
| <u>Halymenia hancockii</u> | Aug |
| <u>Predaea feldmanii</u> | Jul Aug |
| <u>Soliera filiformis</u> | Jul Aug |
| <u>Sebdenia polydactyla</u> | Jun Jul Aug |
| <u>Gracilaria blodgettii</u> | Jul Aug |
| <u>Gracilaria mammillaris</u> | Jul |
| <u>Leptophytum</u> sp. | Aug |
| <u>Pneophyllum</u> sp. | Jul Aug |
| <u>Fosliella farinosa</u> | Aug |
| <u>Botryocladia occidentalis</u> | Mar Jun Jul Aug Sep |
| <u>Botryocladia wynnei</u> | Jun Jul Aug |
| <u>Rhodymenia pseudopalmata</u> | Mar Jun Jul Aug |
| <u>Champia parvula</u> | Jun Jul Aug |
| <u>Lomentaria baileviana</u> | Jun Jul# Aug |
| <u>Callithamnion</u> | Jun Jul# Aug# Sep |
| <u>Antithamnionella breviramosa</u> | Jul* |
| <u>Antithamnionella spirographidis</u> | Jul Aug |
| <u>Ceramium fastigiatum</u> | Jun Jul# Aug Sep |
| <u>Spyridia hypnoides</u> | Jul Aug |

| | |
|-----------------------------------|----------------------|
| <u>Callithamniella</u> sp. | Jul |
| <u>Plenosporium boergesonii</u> | Aug Sep |
| <u>Anotrichium tenue</u> | Jul Aug |
| <u>Griffithsia gobulifera</u> | Jun Jul# Aug# |
| <u>Ptilothamnion</u> sp. | Jul Aug* |
| <u>Lejolesia</u> sp. | Mar Jun Jul |
| <u>Branchioglossum minutum</u> | Jun Jul# Aug# |
| <u>Hypoglossum hypoglossoides</u> | Mar Jun Jul# Aug Sep |
| <u>Grinnellia americana</u> | Mar Jun Jul# Aug |
| <u>Haraldia prostrata</u> | Jul* Aug* |
| <u>Dasya baillouviana</u> | Jul# Aug |
| <u>Dipterosiphonia reversa</u> | Jul# Aug# |
| <u>Polysiphonia denudata</u> | Jul* Aug |
| <u>Polysiphonia atlantica</u> | Jun Jul# Aug |
| <u>Chondria polyrhiza</u> | Jun Jul* Aug |

* Collected only in the Snapper Banks area.

Collected in both the Sanctuary and the Snapper Banks area.

GLOSSARY

abaxial. Located on the side away from the axis of the plant, toward the base. See **adaxial**.

acropetal. Produced in succession from the base upward so that the youngest are nearer the apex.

aculeate. Bearing prickles or spines.

acuminate. Tapering gradually to a point.

acute. Sharp, ending abruptly in a point.

adaxial. Located on the side toward the axis; turned toward the apex. See **abaxial**.

adventitious. Developing in an unusual position and out of the usual sequence; said of branches.

alternate. Formed singly at regular intervals along an axis.

annual. Living for only a single year during which the life history is completed.

annulate. Ringed; made up of ringed segments.

antheridium, pl. antheridia. A male reproductive structure producing motile, flagellated gametes.

anticlinal. Perpendicular to the surface.

apiculate. Terminating in a short, sharp point.

arcuate. Curved, bent in a bow.

assimilatory filaments. Pigmented, photosynthetic parts of a plant; contrasted to filaments which are structural and nonphotosynthetic.

auxiliary cell. In the Rhodophyta a cell which either produces a carposporophyte after receiving a diploid nucleus from the fertilized carpogonium, or to which a connecting filament attaches. In the latter case the carposporophyte is produced from the connecting filament.

axial filament. A series of cells extending longitudinally down the center of a branch or blade.

axillary. Situated in the angle between the upper surface of a branch or leaf and the main axis.

benthic. Growing or living on the seafloor.

biseriate. In two rows.

bisporangium, pl. bisporangia. A reproductive structure producing two spores.

carpogonium, pl. carpogonia. The female gametangium in the Rhodophyta. It includes the egg and the trichogyne, which is a receptive structure to which the male spermatia attach.

carposporangium, pl. carposporangia. The reproductive cell of the carposporophyte. It produces diploid carpospores by mitosis.

carpospore. The diploid spores produced by the carposporophyte.

carposporophyte. The diploid, partially parasitic generation in the life history of the Rhodophyta. It is produced by mitotic division of the zygote nucleus and usually forms a filamentous structure attached to the gametophyte. Some or all of the cells form carposporangia and release diploid carpospores.

clavate. Club-shaped, tapering from a greater diameter toward the end of the cell or branch to a narrower base.

coaxial. Similtaneous division of apical cells of parallel filaments to produce tranverse bands of cells.

coenocytic. Multinucleate; cells having more than one nucleus either as a result of nuclear division without cell division, or because cells have fused.

conceptacle. A cavity in the surface tissue of a plant; they contain gametangia in the Fucales and gametangia, sporangia or carposporophytes in the Rhodophyta.

confluent. Growing together to form a fused mass.

connecting filament. In the Rhodophyta a long, slender outgrowth from the carpogonium or an auxiliary cell which links those cells and is a conduit for transfer of the diploid nuclei formed from the zygote nucleus.

conspecific. Belonging to the same species.

coralline. Calcified and thus resembling coral animals. More narrowly used in reference to the members of the family Corallinaceae of the Rhodophyta.

cordate. Heart-shaped, with the point upward or outward.

cortex. Tissue external to the medulla or external to the axial cell or pericentral cells where there is no medulla. It is usually parenchymatous or pseudoparenchymatous.

corticated. Having a cortex.

cover cell. A special cell in the Rhodophyta cut off by a pericentral cell in the Ceramiales, or in the Corallinaceae it refers to the surface cells.

cruciate. Division of tetrasporangia in the Rhodophyta by planes of division perpendicular to each other.

cryptostomata. A sterile cavity opening to the surface and containing a tuft of hairs; characteristic of some members of the Fucales in the Phaeophyta.

cuneate. Wedge-shaped.

cystocarp. The carposporophyte and, if present, surrounding pericarp tissue in members of the Rhodophyta.

deciduous. Falling off, not persistent.

dentate. Toothed.

determinate. Having a genetically fixed limit to growth.

dichotomous. Forked, bifurcate; a pair of branches produced by an equal splitting of the apical cell or apical meristem.

digitate. Diverging from a single point as in the fingers of the hand.

dioecious. Having male and female gametangia on separate plants.

distal. Farther from the point of attachment or origin. See proximal.

distichous. Arranged in two rows on opposite sides of an axis.

dorsal. Located on the upper surface.

dorsiventral. Having distinct top and bottom surfaces.

dredge. A device for scraping or scooping material from the seafloor when dragged behind a vessel.

ecorticate. Lacking a cortex.

emarginate. Having a slight notch at the tip.

endemic. Native, its range restricted to a specific region.

endophytic. Living within the tissue of another plant.

entire. Having a continuous, simple margin without lobes, indentations, teeth, spines etc.

epilithic. Living attached to rock.

epidermal cells. The outer layer of cells.

epiphytic. Growing on a plant.

epithallium. Uppermost cells of crustose coralline algae; in very simple crusts they are formed on the hypothallus; in more complex crusts a meristem of intercallary cell forms the epithallium above and a perithallus below.

epizoic. Growing on an animal.

exserted. Protruding.

falcate. Sickle-shaped.

fasicle. A cluster or tuft of branches all arising at about the same place on an axis.

fastigate. Having many branches which are erect and appressed or parallel.

flabellate. Fan-shaped.

forcipate. Forked and incurved, pincer-like.

fusiform. Elongate and tapering toward each end.

gametangium, pl. gametangia. A cell or multicellular structure which produces gametes.

gametophyte. Gamete producing generation in a life history, generally haploid.

gonimoblast. Filaments forming the diploid, carposporophyte generation in the Rhodophyta.

gonimolobe. Branch of a carposporophyte in which the carposporangia mature synchronously.

haptera. Root-like, multicellular parts of a holdfast.

holdfast. Basal attachment structure, may be a single modified cell or multicellular.

hyaline. Transparent, colorless, nonpigmented.

hypogynous cell. The cell directly below the cell bearing the female reproductive structures.

hypothallium. Basal layer(s) of cells of crustose coralline algae; it grows by marginal apical cells to increase the diameter of a crust.

indeterminate. Having unlimited growth potential; in branches it indicates ability to resemble the primary axis in structure and function.

intercalary. Lying somewhere along the length of a branch or filament, but not at the apex or base.

internode. Part of a branch or filament between lateral branch points or nodes.

involute. A group of sterile cells or filaments subtending a carposporophyte and usually arching around it.

isomorphic. A life history in which the gametophyte and sporophyte look alike.

lamina. The flat, thin part of a leaf or blade.

lanceolate. Lance-shaped; flattened, narrow, two or three times as long as broad, widest in the middle or toward the base and tapering toward each end.

linear. Long and narrow with parallel sides, but more than thread-like.

lobate. Divided into lobes.

locule. A compartment or space within a structure.

medulla. A central core of tissue. It is surrounded by the cortex.

meiosporangium. The reproductive structure in which spores are produced by meiosis (sometimes followed by mitosis).

meristem. The region of a multicellular plant in which cell division is localized. Adjective: *meristematic*.

microtome. A mechanical device for cutting tissue into thin sections.

midrib. The thickened longitudinal axis of a blade.

mitosporangium. The reproductive structure in which spores are produced by mitosis.

moniliform. Resembling a string of spherical beads.

monoecious. Having male and female gametangia on the same plant.

monosporangium. A sporangium which forms a single spore.

monostromatic. Composed of a single layer of cells.

mucronate. Terminated by a short, sharp point.

multiaxial. Structure resulting from growth by several apical cells each of which produces a filament, the filaments making up the central, medullary core of the plant.

multinucleate. Having several to many nuclei per cell, coenocytic.

node. The point along an axis where branches originate.

ob-. A prefix meaning reversed, upside-down.

oblanceolate. Lanceolate, but broader toward the apex.

obovate. Having the two dimensional shape of a longitudinal section through an egg and attached at the narrow end.

obvoid. Having the three dimensional shape of an egg and attached at the narrow end.

obtuse. Blunt or rounded on the end.

oogonium, pl. oogonia. The egg forming, female gametangium.

opposite. Paired branches inserted at the same level on the axis and with the axis between them.

ostiole. An opening or pore in the tissue around a conceptacle or cystocarp through which spores or gametes are released.

palmate. Having several lobes or segments spreading from the same point. See *digitate*.

papillate. Having short, nipple-like outgrowths from the surface or margin, or having a nipple-like shape.

parenchymatous. Composed of thin-walled, isodiametric cells produced by cell divisions

in three dimensions. Compare with **pseudoparenchymatous**.

parietal. Occurring in the periphery of a cell; near the cell wall.

pedicel. A small stalk, sometimes a single cell, which supports a reproductive structure.

pedicellate. Borne on or having a pedicel.

penicillate. Brush-like; having a terminal cluster or tuft of filaments.

perennial. A plant living for three or more years and usually becoming reproductive in the second and subsequent years.

pericarp. Sterile tissue united around and enclosing a carposporophyte.

pericentral cell. A cell cut off from the axial cell by a longitudinal division; it is initially as long as the axial cell and may or may not remain so and may or may not divide.

perithallium. Erect filaments of crustose coralline algae; they are borne on the hypothallus and form the bulk of the tissue in thick crusts.

pinnate. Arrangement of branchlets in two rows along opposite sides of an axis; feather-like. The branchlets may be in opposite pairs or may alternate.

pinnules. The ultimate branchlets in a pinnately branched plant. In Bryopsis they are tubular, coenocytic branches. In the Rhodophyta they are multicellular.

plastid. A cell organelle; often photosynthetic and containing pigment.

plurilocular. Having more than several to many compartments within a sporangium or gametangium.

polychotomous. Having the axis divided into several equal branches at a node.

polyphyletic. Referring to a taxonomic group whose members have separate evolutionary histories so that they are less closely related to each other than they are to other organisms.

polysiphonous. Having longitudinal files of pericentral cells in columns around an axial cell row, with a tier of pericentral cells forming a ring around the axial cell and each cell being secondarily connected to the cells above and below it in the axis.

polysporangium, pl. polysporagia. A sporangium containing more than four spores.

polyspore. The spores formed in a polysporangium.

primordium. The first recognizable beginning of a structure.

procarp. Association of specific carpogonia with specific auxiliary cells in the Rhodophyta.

proliferous. Producing supernumerary outgrowths similar to, but generally smaller than the structure bearing them.

propagulum, pl. propagula. A modified, deciduous, vegetative branch, which functions as a means of vegetative reproduction.

prostrate. Procumbent; growing along the substrate.

proximal. Nearer the point of origin or attachment.

pseudodichotomous. Appearing dichotomous, but formed when a lateral branch partially displaces the apex, becoming equal in appearance and position to the apex.

pseudofilament. An arrangement of cells in a loose thread, frequently held together by mucilage, but the cells not united at their walls or by plamodesmata.

pseudolateral. The displaced apex in a sympodially branched axis; the apex is replaced by a true lateral, which continues the production of the main axis; the pseudolateral generally has determinate growth.

pseudoparenchymatous. Tissue which has the appearance of parenchyma, but is composed of closely packed, uniseriate filaments. It is a type of tagmatic structure.

pyrenoid. A proteinaceous structure within a plastid and associated with food reserves.

pyriform. Pear-shaped, broader at the bottom than at the top.

raceme. A reproductive structure with sporangia or gametangia borne along a main axis in acropetal sequence.

racemose. In the form of a raceme.

radial branching. Having lateral branches formed singly and along different radii around the axis.

receptacle. The terminal branchlet or part of a branch in which conceptacles are embedded in the Fucales.

rhizoid. A unicellular or single stranded, filamentous, attachment structure.

SCUBA. Self Contained Underwater Breathing Apparatus; used for free swimming, underwater breathing, usually using compressed air.

secund. Unilateral; arranged along one side of an axis.

seriate. Arranged in a row.

serrate. Toothed on the margin, the teeth pointing toward the apex.

sessile. Lacking a stalk.

simple. Unbranched, undivided.

snout. An acellular tube of wall material formed around the ostiole of a coralline algal conceptacle.

sorus, pl. sori. A cluster of reproductive structures which are not raised above the surface of the plant.

spatulate. Spoon-shaped; having a broad, rounded distal end and attached by a slender end.

spermatangium, pl. spermatangia. The gametangium containing a single male spermatium.

spermatium, pl. spermatia. A nonflagellate male gamete.

sporangium, pl. sporangia. The reproductive structure producing spores. These spores may be products of mitosis (mitosporangia) or may be formed by meiosis (meiosporangia) and they are often named for the number of spores formed (monosporangia, bisporangia, tetrasporangia, polysporangia).

sporophyte. The stage in the life history in which spores are produced by meiosis; it is typically diploid.

stellate. Star-shaped; with lobes of arms radiating in three dimensions from a central point.

stephanokont. Having many flagella borne in a ring around the distal end of a cell.

stichidium, pl. stichidia. A specialized reproductive branch, generally somewhat swollen, which produces spermatia or tetraspores in some Rhodophyta.

stipe. A stem or stalk.

stipitate. Having a stalk.

stolon. A horizontal axis growing from the base of the parent plant and capable of producing new plants or shoots.

sub-. A prefix indicating less than, almost, approaching.

subacute. Almost acute, but broader.

subcrenate. With a suggestion of rounded, forward pointing teeth.

subdentate. With a suggestion of a toothed edge, but not consistently so.

subflabellate. Tending to be branched in a fan, but not consistently so.

subquadrate. Often, but not always with four sides.

subsecund. Tending to have branches in a unilateral series, but not in all cases.

sympodial. Branching in which the apex is displaced by a subtending lateral branch; the apex forms a pseudolateral, the lateral continues the direction of growth of the main axis.

tagmatic. Growth in which filaments are laterally united to form a larger structure; in cases where the filaments are very closely appressed and their filamentous origin is obscured they can form a pseudoparenchyma.

tetrahedral. Referring to the division of a tetrasporangium by oblique walls so that the four spores all touch at the center of the sporangium and only three spores are visible

from any direction. The walls of the spores form a "Y" beneath the surface of the sporangium.

tetrasporangium. A sporangium containing four spores; the spores are usually the products of meiosis.

tetraspore. One of the four spores formed in a tetrasporangium.

transverse. At right angles to the long axis.

trawl. A device used in fishing; it is a conical net which is dragged behind a vessel.

trichoblast. A colorless, branched or unbranched, hair-like filament in the Rhodophyta.

trichocyst. Atypical cells formed in the crustose coralline hypothallus.

trichogyne. Receptive extension of the carpogonium to which spermatia attach.

trichothallic. Used to describe an intercalary meristem in a uniserial filament.

turbinate. Shaped like a top (a cone with a rounded base) and attached at the point.

um. Symbol for a micrometer; one millionth of a meter, one thousandth of a millimeter.

unicellular. Consisting of a single cell.

unilateral. Formed on one side of an axis.

unilocular. A structure with a single compartment, undivided by walls.

uniserial. Formed in a single row or chain.

urceolate. Urn-shaped.

vegetative. Not reproductive.

vesicle. A thin-walled, hollow, swollen branch; in the Fucales they are gas-filled floats; in the Rhodophyta they are filled with mucilaginous material.

villose. Covered with long, soft hairs.

virgate. Long, slender, stiff and much branched.

whorled. Branching with several branches at the same level around the axis.

zonate. Divided by parallel walls to form a short row of cells; in the zonate tetrasporangia of the red algae four spores are formed in a row.

zoospore. A motile, flagellated spore.

zygote. The cell, or nucleus formed by the union of two gametes.

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