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### INVESTIGATIONS OF NEW ENGLAND MARINE ALGAE III COMPOSITION, SEASONAL OCCURRENCE AND REPRODUCTIVE PERIODICITY OF THE MARINE RHODOPHYCEAE IN NEW HAMPSHIRE

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## **Rhodora**

[Cambridge, Mass., etc.]New England Botanical Club [etc.]

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INVESTIGATIONS OF  
NEW ENGLAND MARINE ALGAE III  
COMPOSITION, SEASONAL OCCURRENCE AND  
REPRODUCTIVE PERIODICITY OF THE  
MARINE RHODOPHYCEAE IN NEW HAMPSHIRE<sup>1</sup>

EDWARD J. HEHRE<sup>2</sup> & ARTHUR C. MATHIESON

There are few published accounts of the marine algae in New Hampshire (Farlow, 1882; Collins, 1900, 1901, 1903, 1906; Croasdale, 1941; Wood and Straughan, 1953; Doty and Newhouse, 1954). Mathieson, Hehre and Reynolds (in press) have reviewed pertinent literature on the distribution and phenology of New England marine algae and have described the seasonal occurrence and vertical distribution of 99 species of marine algae at Jaffrey Point, New Hampshire. Mathieson, Reynolds and Hehre (in press) have recorded distributional patterns of marine algae in the Great Bay Estuary System.

The present paper is the culmination of a three year study of the Rhodophyceae in both coastal and estuarine environments. The purpose of the study is three-fold: (1) to describe the composition of the red algal flora of New Hampshire; (2) to record the seasonal occurrence of the Rhodophyceae of New Hampshire; (3) to determine the reproductive periodicities of as many taxa as possible.

Monthly collections were made from 1966-1968 at ten locations along the New Hampshire coast (Fig. 1). Prior to 1966, only irregular collections were made at each station. Sixty-two stations were established in the Estuary during the summer of 1966, eight of which were monitored approximately monthly from 1966-1968 (Fig. 1). Extreme winter conditions prohibited access during certain months.

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Although monthly collections were not made at the Isles of Shoals, and the collections are somewhat minimal, all but Duck, White and Seavey Islands are represented. The Isles of Shoals are within New Hampshire and Maine (Fig. 2), but are referred to as a single unit because of their close proximity.

The methods of collection and identification of specimens are similar to those of Parts I & II. The nomenclature of the second revised British Checklist (Parke and Dixon, 1968) has been applied whenever possible. The classification of the Acrochaetiaceae follows Papenfuss (1947). All collections not otherwise specified have been deposited in the Algal Herbarium at the University of New Hampshire (NHA). The principal individual collectors are designated as follows: E. J. Hehre (H) and A. C. Mathieson (M).

The general algal collections, *Algae Exsiccatae Americae-Borealis* (Farlow, Anderson, and Eaton), and the volume of *Phycotheca Boreali-Americana* (Collins, Holden and Setchell, 1895-1919) at the Farlow Herbarium (FH) at Harvard University were examined. All previously published records on the Rhodophyceae of New Hampshire were consulted.

#### Collecting Locations on New Hampshire Coast

The New Hampshire coastline (Fig. 1) is approximately 18 miles long. The southern boundary is Seabrook Beach ( $42^{\circ}52'30''$  N,  $70^{\circ}49'$  W); the boundary to the north is the mouth of the Piscataqua River at the entrance to Portsmouth Harbour ( $43^{\circ}04'20''$  N,  $70^{\circ}42'42''$  W). A brief description of each station is summarized below.

**Jaffrey Point** (Fig. 1, Station 1) a semi-exposed site consisting of massive rock outcrops and many large eulittoral tidepools. The eulittoral and sublittoral fringe zones are well developed. An artificial breakwater, composed of large granitic blocks, provides excellent substrate.

**Fort Constitution** (Fig. 1, Station 2) is a sheltered location within the entrance to Portsmouth Harbour. The substrate consists of small rock outcrops, mud and sand. The vegetation is sparse. *Zostera marina* L. var. *stenophylla*

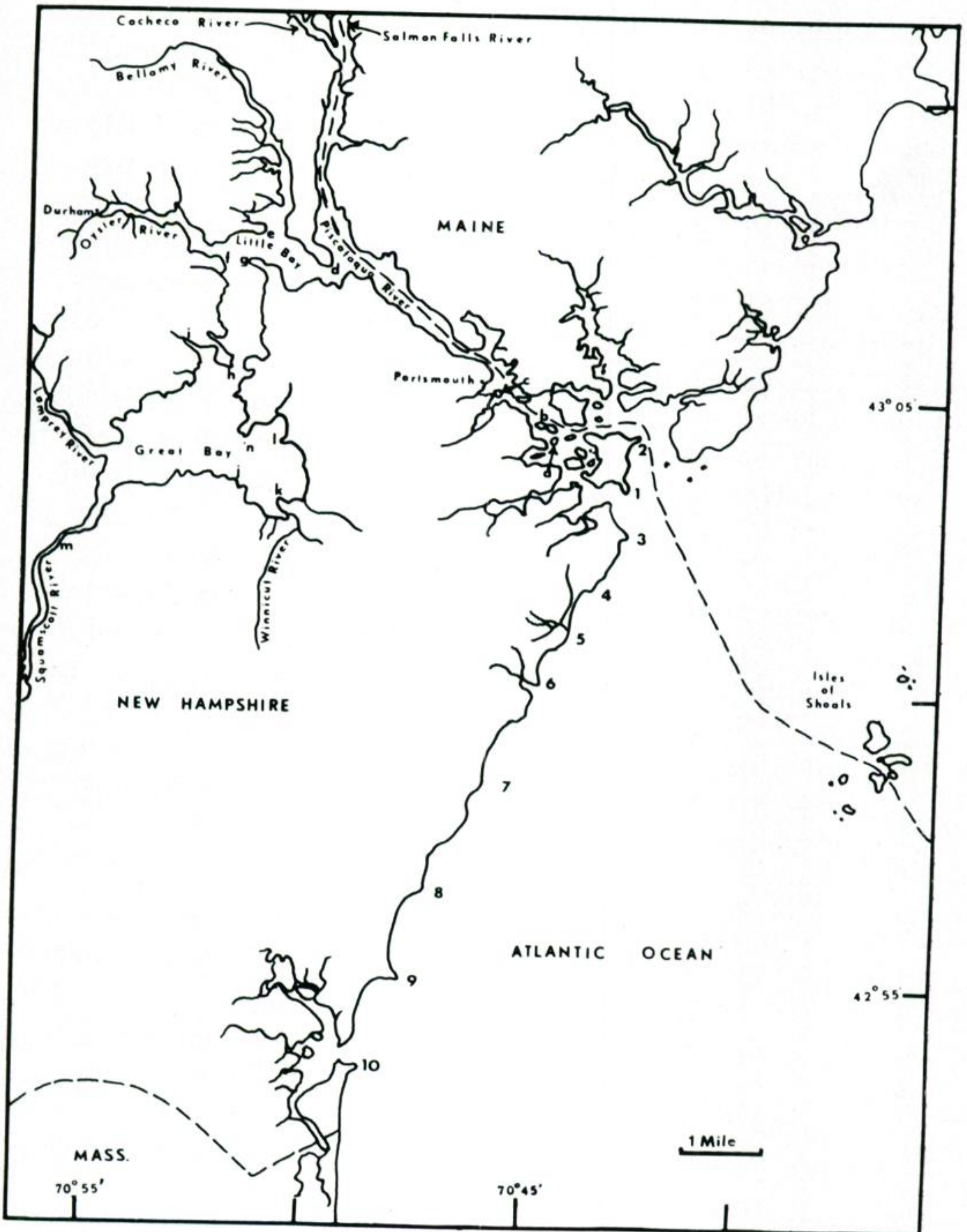


Figure 1  
The New Hampshire Coast and  
Great Bay Estuary System

COASTAL STATIONS:

1. Jaffrey Point, 2. Fort Constitution, 3. Odiorne's Point, 4. North Wallis Sands, 5. Concord Point, 6. Ragged Neck, 7. Rye Ledge, 8. Little Boar's Head, 9. Great Boar's Head, 10. Bound Rock.

*Aschers. et Graebn.* grows on the New Hampshire Coast only at Fort Constitution and Rye Ledge.

**Odiorne's Point** (Fig. 1, Station 3) is a semi-exposed beach with two distinct regions: a cobble area that supports little vegetation, and an area of rock outcrops which has a well developed flora.

**North Wallis Sands** (Fig. 1, Station 4) consists of massive rock outcrops on a sandy beach. Little vegetation is present.

**Concord Point** (Fig. 1, Station 5) is a semi-exposed site with two basic types of substrate: a cobble beach area, which is almost devoid of vegetation, and an area with massive rock outcrops. Except for the plants growing in occasional tidepools in the latter region, the vegetation is poor.

**Ragged Neck** (Fig. 1, Station 6) is a cobble beach at Rye Harbour. No tidepools are present and the vegetation is poor. A breakwater delimits the harbour entrance and supports a good flora.

**Rye Ledge** (Fig. 1, Station 7) is an exposed site consisting of massive rock outcrops and an area of large boulders and cobbles. Tidepools are common and a well developed sublittoral fringe is present. A rich algal flora is evident.

**Little Boar's Head** (Fig. 1, Station 8) is a semi-exposed cobble beach with scattered boulders and occasional rock outcrops. A few tidepools are present in the low eulittoral zone. The flora is poor.

**Great Boar's Head** (Fig. 1, Station 9) is a cobble beach with numerous large boulders. The flora in the eulittoral zone is poorly developed, but there is a good sublittoral fringe zone. Topographically Great Boar's Head is an exposed site, but its eulittoral vegetation, which is conspicuously dominated by fucoids, is indicative of a sheltered

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ESTUARY STATIONS:

a. Shapleigh Island, b. Pierce Island, c. Piscataqua River toll bridge, d. Hilton Park, e. Cedar Point, f. Durham Point, g. Fox Point, h. Adams Point, i. Crommet Creek, j. Weeks Point, k. Pierce Point, l. Fabyans Point, m. Squamscott River at Route 108, n. Nannie Island.

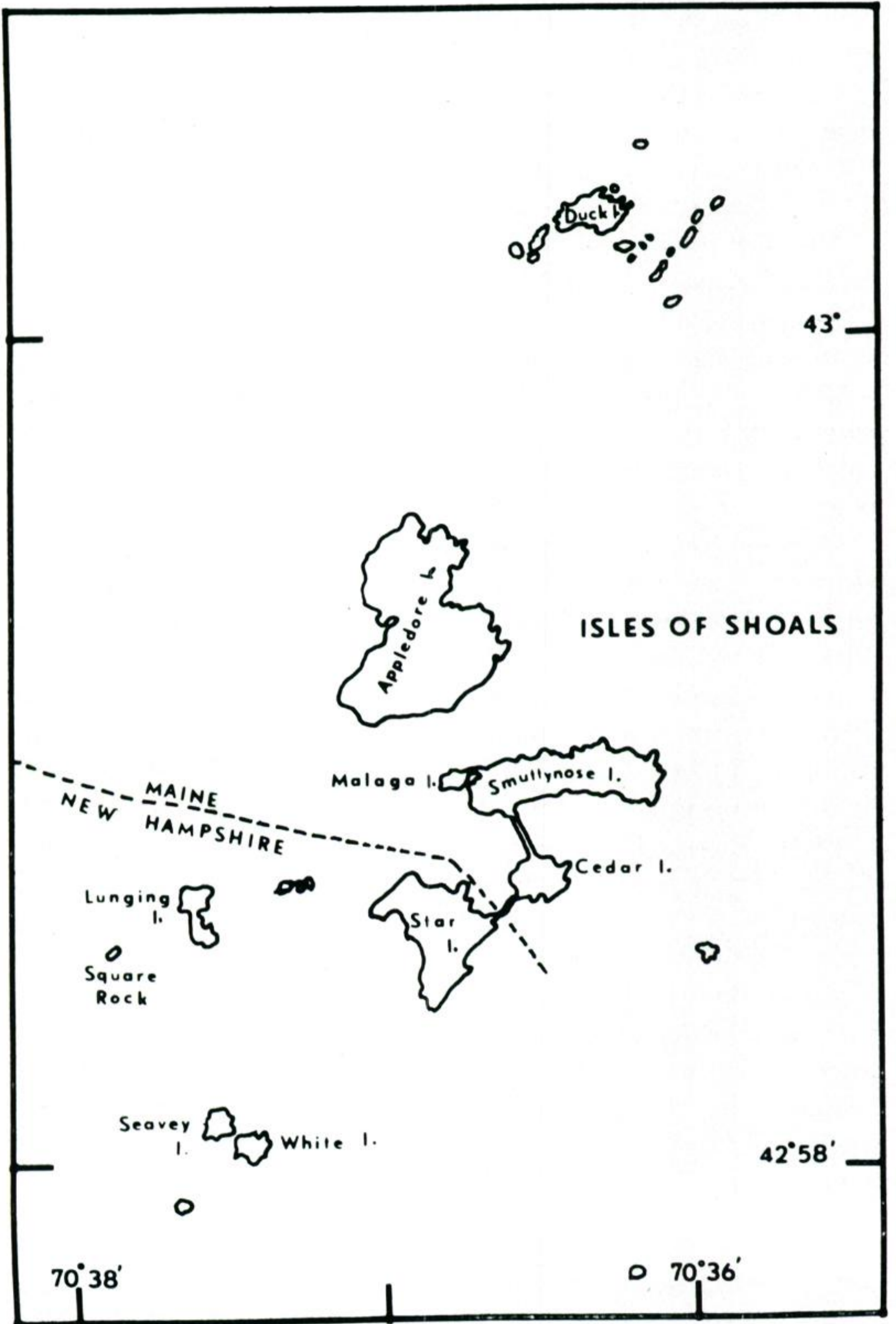


Figure 2  
The Isles of Shoals



location (Lewis, 1964). The cobble substrate is probably a major factor determining its vegetation.

**Bound Rock** (Fig. 1, Station 10) is a sandy beach with massive rock outcrops and breakwaters. Few species are present because of extreme sand fluctuation. Vast beds of *Mytilus* and *Fucus vesiculosus* occur on the rock surfaces. Only a few tidepools are present and they are exposed to constant fluctuations of sand. The breakwaters are dominated by annuals (*Porphyra umbilicalis* and *Bangia fuscopurpurea*).

#### Isles of Shoals

The Isles of Shoals (Fig. 2) are located approximately 9 miles SSE of the mouth of the Piscataqua River, and 6.5 miles due east of Straw Point, Rye. The Islands occupy an area three miles north-south by 1.5 miles east-west, and lie within the coordinates  $42^{\circ}58' N$ ,  $70^{\circ}37'20'' W$  and  $43^{\circ}00'30'' N$ ,  $70^{\circ}36' W$ .

There are nine major islands: five belong to the town of Kittery, Maine (Duck, Appledore, Malaga, Smuttynose, Cedar) and four to Rye, N.H. (Star, White, Seavey, Lunging). Nine other rocks and ledges are present in the Island group (Square Rock, Halfway Rocks, Eastern Rocks, Mingo Rock, Shag Rock, Anderson Ledge, Southwest Ledge, Cedar Island Ledge, White Island Ledge).

#### Great Bay Estuary System

The Great Bay Estuary System includes the Piscataqua River, Little Bay, Great Bay and seven major tributaries (Fig. 1). It is located approximately within the coordinates  $43^{\circ}03' N$  —  $43^{\circ}08' N$ ,  $70^{\circ}45' W$  —  $70^{\circ}55' W$ . Many tributaries, however, extend beyond these boundaries. A detailed description of the Great Bay Estuary Complex is given by Mathieson, Reynolds, and Hehre (in press).

Table 1 summarizes the seasonal occurrence and reproductive periodicity of the Rhodophyceae in New Hampshire. About 65% of the taxa found on the open coast are perennials (e.g., *Ahnfeltia plicata*, *Petrocelis middendorfi*,

*Plumaria elegans*, *Phycodrys rubens*, *Polysiphonia lanosa*, *Phyllophora brodiaei*, *P. membranifolia*, *Rhodochorton purpureum*, *Ptilota serrata*, *Cystoclonium purpureum* var. *cirrhosum*, *Ceramium rubrum*, *Corallina officinalis*, *Halosaccion ramentaceum*, *Clathromorphum circumscriptum*, *Hildenbrandia prototypus*, *Dermatolithon pustulatum*, *Membranoptera alata*, *Chondrus crispus*, *Gigartina stellata*, *Euthora cristata*, *Rhodymenia palmata*).

Three distinct types of annuals (winter, spring and summer) are distinguishable according to their season of maximum growth and development. No fall annuals have been found, although many summer plants persist into the fall and early winter. The fall season appears to be a transition period between summer and winter. Most annuals which occur on the open coast grow during the winter and spring (e.g., *Porphyra leucosticta*, *P. miniata*, *P. linearis*, *Bangia fuscopurpurea*). Summer annuals, which may persist into the fall, constitute a small part of the Rhodophycean flora of the Great Bay Estuary System (e.g., *Chondria baileyana*, *Dasya pedicellata*, *Lomentaria baileyana*, *Polysiphonia denudata*, *P. subtilissima*, *Ceramium strictum*). Only two summer annuals are restricted to the open coast (*Kylinia alariae* and *Nemalion helminthoides*).

Certain annuals (e.g., *Porphyra umbilicalis*) occur throughout the year and are precociously reproductive.<sup>3</sup> Others (e.g., *Dumontia incrassata*) occurred throughout the year, but reproductive organs were found only in the spring and summer. Many perennials are reproductive throughout the year (e.g., *Ceramium rubrum*, *Ahnfeltia plicata*, *Audouinella membranacea*, *Chondrus crispus*, *Euthora cristata*, *Phycodrys rubens*, *Phyllophora brodiaei*, *Polysiphonia lanosa*, *P. novae-angliae*, *Halosaccion ramentaceum*, *Rhodymenia palmata*, *Gigartina stellata*, *Hildenbrandia proto-*

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<sup>3</sup>Designates a plant that is reproductive throughout the year and that is usually found reproductive.

*typus*). Others have distinct periods of reproduction which may span one or more seasons (e.g., *Clathromorphum circumscriptum*, *Polyides rotundus*, *Melobesia lejolisii*, *Membranoptera alata*, *Phyllophora membranifolia*, *Cystoclonium purpureum* var. *cirrhosum*, *Plumaria elegans*, *Petrocelis middendorfi*, *Rhodomela confervoides*).

Several species have been collected only on one or two occasions e.g., *Bonnemaisonia hamifera*, *Trailliella intricata*, *Bangia ciliaris*, *Ceramium rubriforme*, *Erythrotrichia carnea*, *Pantoneura baerii*, *Peyssonelia rosenvingii*, *Lomentaria orcadensis*, *Antithamnion plumula*, and *Callithamnion corymbosum* while *Gloiosiphonia capillaris*, *Phyllophora traillii*, *Antithamnion boreale*, *A. pylaisaei*, and *Polysiphonia flexicaulis* were collected once or twice by Dr. Croasdale on the Isles of Shoals during the summer of 1938. Information regarding the seasonal occurrence and reproductive periodicity of these 15 taxa is incomplete.

#### ANNOTATED CHECKLIST

The following checklist includes 88 taxa of Rhodophyceae from the Great Bay Estuary System and coastal environments of New Hampshire (including the Isles of Shoals). It incorporates all known records of marine red algae from New Hampshire, as well as information on seasonality, reproduction and distribution (vertical and horizontal). Each taxon is cited at least once from every New Hampshire station at which it has been found, even though several collections may have been made. The numbers refer to the collector numbers on the specimens. Fifteen species are new records for the state of New Hampshire (*Porphyra leucosticta*, *P. linearis*, *Acrochaetium polyides*, *Kylinia virgatula*, *Bonnemaisonia hamifera*, *Rhodophysema georgii*, *Antithamnion americanum*, *A. plumula*, *A. pylaisaei*, *Callithamnion corymbosum*, *Pantoneura baerii*, *Chondria baileyana*, *Polysiphonia denudata*, *P. flexicaulis*, *P. subtilissima*), two of which represent extensions of range on the northeast coast of North America (*Acrochaetium polyides* and *Antithamnion plumula*).

## BANGIOIDEAE

## BANGIALES

## ERYTHROPELTIDACEAE

**Erythrotrichia carnea** (Dillwyn) J. Agardh

Found three times (February, September, November), vegetative. Epiphytic on *Ceramium deslongchampsii* var. *hooperi*, *Pylaiella littoralis* and *Polysiphonia lanosa* in the lower eulittoral zone. Found in coastal and estuarine environments; annual.

Recorded from the tropics to Nova Scotia, St. James Bay and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 23 February 1966 (M1637); Shaw's Hill, Piscataqua River, 21 September 1966 (H967); Cedar Point, 23 November 1966 (H968).

**Porphyropsis coccinea** (J. Agardh ex Areschoug) Rosen-  
vinge

Epiphytic on *Desmarestia aculeata*, and probably growing in the deep sublittoral zone. The only New England records for this species are the two specimens collected by F. S. Collins; annual (?).

Recorded from New York, New Hampshire, Nova Scotia and Baie des Chaleurs (as summarized in Taylor, 1957; Edelstein and McLachlan, 1968; Cardinal, 1967).

REPRESENTATIVE SPECIMEN: Hampton Beach, August 1884 (FH, J. S. Collins).

## BANGIACEAE

**Bangia ciliaris** Carmichael

Found once, vegetative, epiphytic on *Euthora cristata* in the sublittoral zone on the open coast; annual.

Recorded from South Carolina to Maine, Nova Scotia, and Newfoundland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 10 June 1967 (H225).

**Bangia fuscopurpurea** (Dillwyn) Lyngbye

Found from November to August in the mid to upper eulittoral zone. Common on the open coast, but with restricted distribution in Great Bay Estuary; annual; monospores found from December-April.

Recorded from Bermuda to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (H165); Fort Constitution, 29 May 1967 (H169); Odiorne's Point, 8 April 1967 (H170); North Wallis Sands, 20 March 1967 (H172); Concord Point, 5 March 1967 (H176); Ragged Neck, 9 March 1967 (H178); Rye Ledge, 25 May 1967 (H184); Little Boar's Head, 17 February 1967 (H185); Great Boar's Head, 24 January 1967 (H192); Bound Rock, 18 January 1967 (H194); Piscataqua River toll bridge, 29 May 1967 (H202); Hilton Park, 24 May 1967 (H204).

**\**Porphyra leucosticta* Thuret in Le Jolis<sup>4</sup>**

Found in January, March-July. Epiphytic on *Fucus* spp., *Chondrus crispus*, and *Polysiphonia elongata* in the low eulittoral and sublittoral fringe zones.

Occasional on the open coast and rare in the Estuary. Annual;  $\alpha$  spores found in March and April;  $\beta$  spores found March-May.

Recorded from Bermuda to Maine and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 23 July 1958 (FH I. M. Lamb A82); Jaffrey Point, 14 April 1968 (M5773); Odiorne's Point, 23 May 1968 (M2775); Hilton Park, 7 January 1967 (H2237).

**\**Porphyra linearis* Greville**

Found from December to May on rocks in the mid eulittoral zone on the open coast. Annual;  $\alpha$  spores found April and May;  $\beta$  spores found February and March.

Recorded from Northern Massachusetts, Nova Scotia, Gaspé to Newfoundland (Lamb and Zimmermann, 1964; Edelstein and McLachlan, 1966b; as summarized in Taylor, 1957 as *Porphyra umbilicalis* f. *linearis*).

REPRESENTATIVE SPECIMENS: North Wallis Sands, 16 January 1967 (H2239); Concord Point, 19 February 1967 (H2240); Ragged Neck, 4 April 1967 (H2243); Rye Ledge, 10 January 1967 (H2245); Little Boar's Head, 2 April 1967 (H2247).

***Porphyra miniata* (C. Agardh) C. Agardh**

Found from March to August on rocks and epiphytic on *Chondrus crispus* in the upper sublittoral zone. Common on the open coast but with limited distribution in the Estu-

<sup>4</sup>\*New record for New Hampshire.

ary. Annual;  $\alpha$  spores found April to August;  $\beta$  spores found March to August.

Recorded from Northern Massachusetts to the arctic (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (M5813); Jaffrey Point, 19 May 1964 (H2248); Fort Constitution, 23 June 1967 (H2251); Odiorne's Point, 30 May 1967 (H2253); North Wallis Sands, 20 May 1967 (H2257); Concord Point, 27 June 1967 (H2260); Ragged Neck, 14 July 1967 (M5826); Rye Ledge, 25 May 1967 (H2261); Great Boar's Head, 18 April 1966 (M5828); Piscataqua River toll bridge, 29 May 1967 (H2263); Hilton Park, 23 June 1967 (H2264); Cedar Point, 24 June 1967 (H2265).

**Porphyra umbilicalis** (Linnaeus) J. Agardh

Found throughout the year on rocks in the mid to lower eulittoral zone. Common on the open coast and throughout the Estuary. Annual;  $\alpha$  and  $\beta$  spores found January-December.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M5861); Jaffrey Point, 7 January 1967 (H2268); Fort Constitution, 20 September 1966 (H2274); Odiorne's Point, 21 July 1966 (M5869); North Wallis Sands, 28 February 1967 (H2275); Concord Point, 27 June 1967 (H2278); Ragged Neck, 9 March 1967 (H2280); Rye Ledge, 25 May 1967 (H2288); Little Boar's Head, 24 May 1967 (H2292); Great Boar's Head, 24 January 1967 (H2294); Bound Rock, 20 February 1967 (H2302); Piscataqua River toll bridge, 20 January 1967 (H2337); Hilton Park, 9 December 1966 (H2326); Cedar Point, 7 August 1967 (H2318); Adams Point, 22 December 1966 (H2314); Weeks Point, 23 April 1966 (M5908).

**Porphyra umbilicalis** (Linnaeus) J. Agardh

forma **epiphytica** Collins

Epiphytic on various algae (e.g., *Fucus* spp. and *Poly-siphonia lanosa*) throughout the year in the lower eulittoral and upper sublittoral zones. Common on the open coast and throughout the Estuary. Annual;  $\alpha$  spores found January-November;  $\beta$  spores found January-December.

Recorded from Massachusetts to Maine (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5939); Jaffrey Point, 1 April 1967 (H2350); Fort Constitution, 22 June 1966 (M5944); Odiorne's Point, 30 May 1967 (H2355);

North Wallis Sands, 11 June 1967 (H2359); Concord Point, 10 August 1967 (H2363); Ragged Neck, 12 June 1967 (H2367); Rye Ledge, 25 May 1967 (H2371); Little Boar's Head, 2 April 1967 (H2372); Great Boar's Head, 25 June 1967 (H2377); Bound Rock, 18 January 1967 (H2383); Piscataqua River toll bridge, 12 August 1967 (H2395); Hilton Park, 27 April 1967 (H2391); Cedar Point, 23 November 1966 (H2398); Durham Point, 15 November 1966 (H2396); Adams Point, 27 June 1967 (H2400).

### FLORIDEAE

#### NEMALIONALES

##### ACROCHAETIACEAE

##### **Acrochaetium polyides** (Rosenvinge) Børgesen<sup>5</sup>

Found once as an endophyte in the peripheral cells of *Polyides rotundus* on the open coast. This is only the second time that the species has been recorded in North America. No reproductive structures seen; annual (?).

Previously recorded from Nova Scotia (Edelstein and McLachlan, 1966a).

REPRESENTATIVE SPECIMEN: North Wallis Sands, 10 September 1966 (H1).

##### **Audouinella membranacea** (Magnus) Papenfuss

Endozoic in the lorica of sertularians in the mid to lower eulittoral zone. Common on the open coast, but with limited distribution in the Estuary. Perennial (?); tetraspores found January-December.

Recorded from Connecticut to Maine, Nova Scotia and Greenland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Lund, 1959).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (H76); Fort Constitution, 20 January 1967 (H78); Odiorne's Point, 21 February 1967 (H83); North Wallis Sands, 20 March 1967 (H87); Concord Point, 8 January 1967 (H93); Ragged Neck, 26 December 1966 (H106); Rye Ledge, 25 April 1967 (H107); Little Boar's Head, 23 January 1967 (H113); Great Boar's Head, 24 January 1967 (H122); Bound Rock, 6 December 1966 (H129); Piscataqua River toll bridge, 22 June 1967 (H164); Hilton Park, 24 May 1967 (H153); Cedar Point, 3 March 1967 (H146); Durham Point, 26 June 1967 (H149); Adams Point, 17 April 1967 (H142); Weeks Point, 9 August 1967 (M3788).

##### **Kylinia alariae** (Jónsson) Kylin

Specific epiphyte on *Alaria esculenta* and restricted to ex-

<sup>5\*\*</sup>Range extension for the northeast coast of North America.

posed coastal stations where *A. esculenta* occurs. Found in the sublittoral fringe zone in July and August. Annual; monospores found in July.

Recorded from Northern Massachusetts to Maine and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M4963); Rye Ledge, 18 August 1966 (M4964).

***Kylinia secundata* (Lyngbye) Papenfuss**

Epiphytic on *Ruppia maritima*, various algae (e.g., *Porphyra umbilicalis*) and epizoic on sertularians. Common on the open coast and with limited distribution in the Estuary. Perennial (?); monospores found January-December; tetraspores rare, found once in March.

Recorded from Connecticut to Maine, Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 12 October 1966 (H1369); Fort Constitution, 29 May 1967 (H135); Odiorne's Point, 21 January 1967 (H137); North Wallis Sands, 21 December 1966 (H138); Concord Point, 10 December, 1966 (H139); Ragged Neck, 18 July 1966 (M4966); Rye Ledge, 29 March 1967 (M4967); Little Boar's Head, 25 November 1966 (H1372); Bound Rock, 7 January 1967 (H1373); Piscataqua River toll bridge, 12 August 1967 (H160); Hilton Park, 24 May 1967 (H153); Cedar Point, 21 December 1966 (H145); Durham Point, 19 September 1966 (H1374); Adams Point, 22 December 1966 (H141).

\****Kylinia virgatula* (Harvey) Papenfuss**

Epiphytic on specimens of *Rhodymenia palmata*. Found in September, October and December on the open coast. Annual; monospores found in September, October and December.

Previously recorded from North Carolina to Southern Massachusetts, Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Rye Ledge, 15 October 1966 (H1375); Little Boar's Head, 14 September 1966 (H1376); Great Boar's Head, 14 October 1966 (H1377).

***Kylinia virgatula* (Harvey) Papenfuss**

forma *luxurians* (J. Agardh) Collins



Found four times (in July and September). Epiphytic on the margins of *Zostera* leaves. Annual; monospores found in July and September.

Recorded from Connecticut to Maine and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Fort Constitution, 20 September 1966 (H1379); Shaw's Hill, Piscataqua River, 21 September 1966 (H1380); Shapleigh Island, Piscataqua River, 21 September 1966 (H1381); Fox Point, 21 July 1966 (M4977).

**Rhodochorton purpureum** (Lightfoot) Rosenvinge

Growing in the mid and lower eulittoral zone on rock faces covered by fucoids. Common throughout the year on the open coast, but with limited distribution in the Estuary. Perennial; tetraspores found in February.

Recorded from Rhode Island to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Smuttynose Island), 22 July 1966 (M6004); Jaffrey Point, 12 October 1966 (H2458); Fort Constitution, 28 April 1967 (M6008); Odiorne's Point, 21 January 1967 (H2469); North Wallis Sands, 20 March 1967 (H2479); Concord Point, 5 March 1967 (H2490); Ragged Neck, 4 April 1967 (H2491); Rye Ledge, 23 December 1966 (H2502); Little Boar's Head, 14 August 1967 (H2509); Great Boar's Head, 24 January 1967 (H2520); Bound Rock, 16 April 1967 (H2526); Hilton Park, 9 July 1967 (H2528).

BATRACHOSPERMACEAE

**Batrachospermum** sp.

Collected at the headtide of the Oyster River (Dr. Lewis Flint, personal communication).

**Lemanea fucina** Bory

Found in rapidly flowing waters at the headtide of the Oyster River (Wood and Straughan, 1953). No specimens were seen from this station. *L. fucina* is found on the University of New Hampshire campus, where the Oyster River is entirely fresh water. There are specimens in the University of New Hampshire Algal Herbarium collected by Dr. A. R. Hodgdon from an estuarine habitat in Maine.

REPRESENTATIVE SPECIMEN: Newcastle, Maine, 29 June 1964 (A. R. Hodgdon 14090).

HELMINTHOCLADIACEAE

**Nemalion helminthoides** (Vellely in Withering) Batters

Found in July and August growing on rocks and mussels (*Mytilus edulis*) in the extreme lower eulittoral zone. Restricted to the open coast. Annual; cystocarpic plants found in August.

Recorded from Long Island to Nova Scotia (as summarized in Taylor, 1957 as *Nemalion multifidum*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5120); Ragged Neck, 10 August 1967 (H1598); Rye Ledge, 12 August 1967 (M5121); Bound Rock, 18 July 1966 (H1599).

#### BONNEMAISONIACEAE

##### \**Bonnemaisonia hamifera* Hariot

Collected three times (April, June and July) in drift. Vegetative; probably growing in the deep sublittoral zone. Annual (Chihara, 1961).

Previously recorded from Long Island to Southern Massachusetts and Nova Scotia (as summarized in Taylor, 1957 as *Asparagopsis hamifera*; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (Kingsbury, 1965); Isles of Shoals (Cedar Island), 22 July 1966 (H75); Isles of Shoals (Smuttynose Island), 16 June 1966 (M3765).

##### *Trailliella intricata* (J. Agardh) Batters

Found once, vegetative, in the low eulittoral zone on the open coast. It is believed to be the tetrasporophyte of *Bonnemaisonia hamifera* (Chihara, 1961, 1962).

Recorded from Long Island to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Star Island), 22 July 1966 (M6076).

### CRYPTONEMIALES

#### SQUAMARIACEAE

##### *Peyssonelia rosenvingii* Schmitz in Rosenvinge

Found twice (January and April), vegetative, growing on rocks in the lower eulittoral and sublittoral zones on the open coast. Perennial.

Recorded from Northern Massachusetts to Maine, Nova Scotia, Baie des Chaleurs, Baie de Gaspé and Greenland (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967; Cardinal, 1967; Lund, 1959).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 22 January 1966 (M5130); Jaffrey Point, 20 April 1967 (M5129).

**\*Rhodophysema georgii** Batters

Found throughout most of the year as an epiphyte on *Zostera marina*. Perennial; tetraspores found in February and November.

Recorded from Long Island to Maine, Nova Scotia and Newfoundland (as summarized in Taylor, 1957, as *Rhododermis georgii*; Edelstein and McLachlan, 1966b; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Fort Constitution, 29 May 1967 (H2530); Rye Ledge, 11 November 1966 (H1056); Cedar Point, 29 May 1967 (H2534); Adams Point, 17 April 1967 (H2532).

HILDENBRANDIACEAE

**Hildenbrandia prototypus** Nardo

Growing on rocks throughout the year in the eulittoral and upper sublittoral zones. Common on the open coast and throughout the Estuary. Perennial; tetraspores found January-December.

Recorded from Florida to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M4882); Jaffrey Point, 8 November 1966 (H1223); Fort Constitution, 23 June 1967 (H1239); Odiorne's Point, 17 October 1966 (H1240); North Wallis Sands, 11 June 1967 (H1256); Concord Point, 13 September 1966 (H1260); Ragged Neck, 9 March 1967 (H1271); Rye Ledge, 25 May 1967 (H1287); Little Boar's Head, 23 January 1967 (H1297); Great Boar's Head, 24 April 1967 (H1306); Bound Rock, 6 December 1966 (H1314); Piscataqua River toll bridge, 27 February 1967 (H1361); Hilton Park, 24 May 1967 (H1353); Cedar Point, 17 April 1967 (H1325); Durham Point, 31 May 1967 (H1336); Adams Point, 17 April 1967 (H1319); Fabyan's Point, 15 October 1966 (H1339); Pierce Point, 23 June 1967 (H1362).

CORALLINACEAE

**Clathromorphum circumscriptum** (Strømfelt) Foslie

Found throughout the year in tidepools in the mid and lower eulittoral zone, and extending into the sublittoral zone. Common on the open coast and rare in the Estuary. Perennial; bispores found from December-May.

Recorded from Northern Massachusetts to Ellesmere Island

(as summarized in Taylor, 1957, as *Phymatolithon compactum*; Adey, 1965).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M4312); Jaffrey Point, 8 November 1966 (H586); Fort Constitution, 21 March 1967 (H594); Odiorne's Point, 26 November 1966 (H604); North Wallis Sands, 11 October 1966 (H619); Concord Point, 13 September 1966 (H629); Ragged Neck, 19 February 1967 (H641); Rye Ledge, 11 November 1966 (H667); Little Boar's Head, 2 April 1967 (H649); Great Boar's Head, 24 January 1967 (H658); Hilton Park, 24 May 1967 (H617).

**Corallina officinalis** Linnaeus

Growing from the sublittoral zone to the mid eulittoral zone on the open coast. Perennial.

Recorded from Bermuda to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M4363); Jaffrey Point, 7 January 1967 (H679); Fort Constitution, 4 December 1966 (H684); Odiorne's Point, 26 June 1967 (H692); North Wallis Sands, 11 October 1966 (H705); Concord Point, 10 August 1967 (H713); Ragged Neck, 12 June 1967 (H725); Rye Ledge, 11 November 1966 (H741); Little Boar's Head, 13 October 1966 (H751); Great Boar's Head, 25 June 1967 (H759); Bound Rock, 3 September 1967 (H757).

**Dermatolithon pustulatum** (Lamouroux) Foslie

Found throughout the year as an epiphyte on various algae (e.g., *Chondrus crispus*, *Gigartina stellata*, *Fucus* spp.) in the lower eulittoral and sublittoral fringe zones of the open coast. Perennial; bispores found in all months except April. Recorded from Rhode Island to Massachusetts, New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Mathieson, Hehre and Reynolds, in press; Edelstein, McLachlan and Craigie, 1967, all as *Lithophyllum macrocarpum*; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M5006); Jaffrey Point, 1 April 1967 (H1438); Fort Constitution, 27 February 1967 (H1442); Odiorne's Point, 10 March 1967 (H1453); North Wallis Sands, 16 January 1967 (H1463); Concord Point, 22 November 1966 (H1474); Ragged Neck, 12 June 1967 (H1483); Rye Ledge, 25 April 1967 (H1494); Little Boar's Head, 13 October 1966 (H1497); Great Boar's Head, 24 April 1967 (H1504); Bound Rock, 6 December 1966 (H1518); Hilton Park, 17 February 1968 (M5039).

**Lithophyllum corallinae** (Crouan frat.) Heydrich

Specific epiphyte on *Corallina officinalis* on the open coast.

Perennial; bispores found in March, June and July.

Recorded from Rhode Island to Maine (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Cedar Island), 22 July 1966 (H1379); Jaffrey Point, 7 January 1967 (H1384); Fort Constitution, 22 June 1966 (M4993); Odiorne's Point, 10 March 1967 (H1393); North Wallis Sands, 20 May 1967 (H1397); Concord Point, 5 March 1967 (H1404); Ragged Neck, 9 March 1967 (H1410); Rye Ledge, 11 November 1966 (H1417); Little Boar's Head, 8 March 1967 (H1426); Great Boar's Head, 20 March 1967 (H1432).

**Lithothamnium glaciale** Kjellman

Growing in the lower eulittoral and sublittoral zones on the open coast. Perennial; bispores found in February and April.

Recorded from Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 1 April 1967 (H1550); Fort Constitution, 21 March 1967 (H1536); Odiorne's Point, 10 March 1967 (H1542); North Wallis Sands, 20 March 1967 (H1538); Concord Point, 27 June 1967 (H1524); Rye Ledge, 22 June 1967 (H1519); Little Boar's Head, 27 July 1967 (H1528); Great Boar's Head, 24 April 1967 (H1522); Bound Rock, 18 November 1966 (H1523).

**Melobesia lejolisii** Rosanoff

Found throughout the year as an epiphyte on *Zostera* and *Phyllophora* spp. in the sublittoral zone. Common in drift on the open coast and throughout the Estuary. Perennial; tetraspores found October-July.

Recorded from Florida to the arctic (as summarized in Taylor, 1957, as *Fosliella lejolisii*).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 23 February 1966 (M4710); Fort Constitution, 21 March 1967 (H1040); Odiorne's Point, 8 April 1967 (H1044); North Wallis Sands, 17 April 1967 (H1051); Concord Point, 27 June 1967 (H1052); Ragged Neck, 9 March 1967 (H1054); Rye Ledge, 15 October 1966 (H1057); Little Boar's Head, 25 November 1966 (H1058); Hilton Park, 3 May 1968 (M4712); Durham Point, 16 October 1966 (H1059); Pierce Point, 8 November 1966 (H1060).

**Phymatolithon lenormandi** (Areschoug) Adey

Growing on rocks and shells throughout most of the year

in the sublittoral zone on the open coast, but with restricted distribution in the Estuary. No reproductive structures found; perennial.

Recorded from New Jersey to the arctic (as summarized in Taylor, 1957, as *Lithothamnium lenormandi*; Adey, 1966).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Smuttynose Island), 22 July 1966 (M5312); Jaffrey Point, 6 May 1967 (M5311); Fort Constitution, 28 April 1968 (M5313); Odiorne's Point, 17 October 1966 (H1890); North Wallis Sands, 16 February 1967 (M5315); Concord Point, 9 October 1966 (H1891); Ragged Neck, 8 October 1966 (H1892); Rye Ledge, 15 October 1966 (H1895); Little Boar's Head, 13 October 1966 (H1896); Great Boar's Head, 14 October 1966 (H1898); Hilton Park, 14 October 1966 (H1899).

#### DUMONTIACEAE

##### **Dumontia incrassata** (O. F. Müller) Lamouroux

Common in the mid to lower eulittoral zone throughout the year on the open coast, and with limited distribution in the Estuary. Often found in tidepools; annual, tetraspores found March-August.

Recorded from Long Island to Nova Scotia and James Bay (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M4604); Jaffrey Point, 7 January 1967 (H939); Fort Constitution, 20 January 1967 (H948); Odiorne's Point, 8 April 1967 (H954); North Wallis Sands, 20 March 1967 (H960); Concord Point, 5 March 1967 (H904); Ragged Neck, 22 May 1967 (H910); Rye Ledge, 25 May 1967 (H913); Little Boar's Head, 23 January 1967 (H920); Great Boar's Head, 24 April 1967 (H935); Bound Rock, 6 December 1966 (H938); Piscataqua River toll bridge, 4 December 1966 (H881); Hilton Park, 14 October 1966 (H870); Cedar Point, 3 March 1967 (H892); Fox Point, 17 November 1966 (H896); Nannie Island, 7 July 1966 (M4578).

#### POLYIDEACEAE

##### **Polyides rotundus** (Hudson) Greville

Growing in the sublittoral zone throughout the year on the open coast and with limited distribution in the Estuary. Perennial; tetraspores found from October to January; cystocarpic nemathecia found from October to February. Recorded from Long Island to the Hudson Strait (as summarized in Taylor, 1957, as *Polyides caprinus*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (M5363); Jaffrey Point, 7 January 1967 (H1915); Fort Constitution, 24 July 1967 (M5378); Odiorne's Point, 26 July 1967 (H1917); North Wallis Sands, 11 October 1966 (H1920); Concord Point, 8 January 1967 (H1925); Ragged Neck, 9 March 1967 (H1927); Rye Ledge, 15 October 1966 (H1928); Little Boar's Head, 24 May 1967 (H1931); Great Boar's Head, 13 November 1966 (H1938); Bound Rock, 18 January 1967 (M1945); Piscataqua River toll bridge, 27 February 1967 (H1948); Hilton Park, 27 April 1967 (H1947).

#### GLOIOSIPHONACEAE

**Gloiosiphonia capillaris** (Hudson) Carmichael *ex* Berkeley  
Found once by Croasdale (July) growing on the open coast.  
Annual; cystocarpic in July.

Recorded from Connecticut to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 25 July 1938 (Croasdale 4794).

#### KALLYMENIACEAE

**Euthora cristata** (C. Agardh) J. Agardh

Growing in the sublittoral zone on the open coast throughout the year. Perennial; tetrasporic and cystocarpic plants found from January to December.

Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M4660); Jaffrey Point, 1 April 1967 (H969); Fort Constitution, 27 February 1967 (H974); Odiorne's Point, 30 May 1967 (H977); North Wallis Sands, 20 May 1967 (H985); Concord Point, 10 December 1966 (H992); Ragged Neck, 9 March 1967 (H1004); Rye Ledge, 10 January 1967 (H1016); Little Boar's Head, 24 May 1967 (H1023); Great Boar's Head, 25 June 1967 (H1028); Bound Rock, 6 December 1966 (H1029).

#### CHOREOCOLACACEAE

**Choreocolax polysiphoniae** Reinsch

Parasitic on the fronds of *Polysiphonia lanosa*. Restricted to the open coast. Present throughout the year and perennial; tetraspores found from January to December; cystocarpic plants found in July, August and November.

Recorded from Connecticut to Nova Scotia and Newfound-

land (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 10 June 1967 (H551); Fort Constitution, 23 June 1967 (H554); Odiorne's Point, 11 August 1967 (H561); North Wallis Sands, 17 April 1967 (H562); Concord Point, 21 May 1967 (H567); Ragged Neck, 22 May 1967 (H571); Rye Ledge, 25 May 1967 (H575); Little Boar's Head, 14 August 1967 (H580); Great Boar's Head, 24 April 1967 (H584).

#### GIGARTINALES

##### CRUORACEAE

##### **Petrocelis middendorffii** (Ruprecht) Kjellman

Found throughout the year on rocks in the lower eulittoral zone. Common on the open coast and with restricted distribution in the Estuary. Perennial; tetraspores found from October to June.

Recorded from Long Island to Maine, Nova Scotia and the Arctic (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5135); Jaffrey Point, 5 December 1966 (H1604); Fort Constitution, 21 March 1967 (H1607); Odiorne's Point, 30 May 1967 (H1617); North Wallis Sands, 11 June 1967 (H1626); Concord Point, 3 April 1967 (H1634); Ragged Neck, 20 July 1967 (H1640); Rye Ledge, 24 July 1967 (H1649); Little Boar's Head, 24 May 1967 (H1663); Great Boar's Head, 25 June 1967 (H1670); Hilton Park, 24 May 1967 (H1665).

##### SOLIERIACEAE

##### **Agardhiella tenera** (J. Agardh) Schmitz

Reported by Taylor (1957) from N.H. However, none of the herbarium specimens nor references cited by Taylor indicate that it is found north of Gloucester, Massachusetts.

Recorded from the tropics to North Carolina, north to Massachusetts and New Hampshire (as summarized in Taylor, 1957).

##### RHODOPHYLLIDACEAE

##### **Cystoclonium purpureum** (Hudson) Batters

var. **cirrhosum** Harvey

Found throughout the year growing on rocks and occasionally on other algae in the lower eulittoral and sublittoral



zones. Common on the open coast, and with restricted distribution in the Estuary. Perennial; tetraspores found from April to November.

Recorded from New Jersey to New Hampshire, Baie des Chaleurs and Baie de Gaspé (as summarized in Taylor, 1957; Lamb and Zimmermann, 1964; Mathieson, Hehre and Reynolds, in press; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M4441); Jaffrey Point, 7 January 1967 (H772); Fort Constitution, 20 September 1966 (H780); Odiorne's Point, 11 August 1967 (H781); North Wallis Sands, 20 May 1967 (H784); Concord Point, 13 September 1966 (H792); Ragged Neck, 22 May 1967 (H799); Rye Ledge, 15 October 1966 (H809); Little Boar's Head, 24 May 1967 (H820); Great Boar's Head, 15 September 1966 (H822); Bound Rock, 18 November 1966 (H829); Piscataqua River toll bridge, 27 February 1967 (H858); Hilton Park, 27 April 1967 (H847); Durham Point, 15 November 1966 (H842); Adams Point, 22 December 1966 (H840).

**Rhodophyllis dichotoma** (Lepeschkin) Gobi

Found January-February and May-July on the open coast. The plant has been found only 4 times in drift. It was collected once by SCUBA in the deep sublittoral-epiphytic on *Ptilota serrata*. Perennial; tetraspores found in January and July; cystocarpic plants found in February, May and June.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 28 May 1968 (M6138); Hampton Beach, 27 February 1966 (H2559); Bound Rock, 24 June 1967 (H2560).

GRACILARIACEAE

**Gracilaria foliifera** (Forsskål) Børgesen

Found from March to December either free-floating or attached to small stones in the lower eulittoral and upper sublittoral zones throughout the Estuary. Perennial; tetraspores found from June-October; cystocarpic plants found in April and from June to November.

Recorded from the tropics to New Hampshire (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Hilton Park, 24 May 1967 (H1205); Cedar Point, 7 August 1967 (H1193); Durham Point, 5 July 1966

(M4813); Adams Point, 10 September 1966 (H1192); Fabyan's 4813); 23 June 1967 (H1200); Pierce Point, 23 June 1967 (H1207).

#### PHYLLOPHORACEAE

##### **Ahnfeltia plicata** (Hudson) Fries

Growing throughout the year in the lower eulittoral and sublittoral zones on the open coast. Restricted distribution in the Estuary. Perennial; monospores found January-December.

Recorded from New Jersey to Devon Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M3669); Jaffrey Point, 27 May 1967 (H2); Fort Constitution, 24 July 1967 (M3683); Odiorne's Point, 21 February 1967 (H6); North Wallis Sands, 28 February 1967 (H14); Concord Point, 8 January 1967 (H23); Ragged Neck, 9 March 1967 (H25); Rye Ledge, 11 November 1966 (H29); Little Boar's Head, 17 February 1967 (H38); Great Boar's Head, 24 April 1967 (H45); Bound Rock, 17 March 1968 (H48); Hilton Park, 9 July 1967 (H60); Durham Point, 5 July 1966 (M3705); Adams Point, 19 July 1966 (M3704); Weeks Point, 14 September 1966 (H63).

##### **Ceratocolax hartzii** Rosenvinge

Specific parasite on *Phyllophora brodiaei* in the sublittoral zone on the open coast. Perennial; tetraspores found in January, February, April and May.

Recorded from Rhode Island to the Arctic (Newroth, 1968).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Cedar Island), 22 July 1966 (H369); Jaffrey Point, 8 November 1966 (H370); Odiorne's Point, 10 March 1967 (H371); North Wallis Sands, 21 December 1966 (H372); Ragged Neck, 4 April 1967 (H374); Little Boar's Head, 19 February 1966 (M4112); Bound Rock, 18 January 1967 (H375).

##### **Phyllophora brodiaei** (Turner) Endlich

Found throughout the year growing in the sublittoral zone on the open coast. Common in drift. Perennial; carpotetrasporangial nemathecium found from January to December. Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M5253); Jaffrey Point, 8 February 1967 (H1780); Fort Constitution, 24 July 1967 (M5265); Odiorne's Point, 10 September 1966 (H1789); North Wallis Sands, 16 January 1967 (H1795); Concord Point, 3 April 1967 (H1804); Ragged Neck, 23 November

1966 (H1805); Rye Ledge, 25 November 1966 (H1814); Little Boar's Head, 8 March 1967 (H1818); Great Boar's Head, 13 November 1966 (H1819); Bound Rock, 6 December 1966 (H1824).

**Phyllophora membranifolia** (Goodenough *et* Woodward)

J. Agardh

Growing throughout the year in the lower eulittoral and sublittoral zones on the open coast, and with limited distribution in the Estuary. Perennial; tetraspores found from September to March; cystocarpic plants found in January, March, April and November.

Recorded from New Jersey to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5278); Jaffrey Point, 11 July 1967 (H1827); Fort Constitution, 20 September 1966 (H1832); Odiorne's Point, 26 June 1967 (H1836); North Wallis Sands, 20 May 1967 (H1844); Concord Point, 9 October 1966 (H1854); Ragged Neck, 10 August 1967 (H1861); Rye Ledge, 11 November 1966 (H1864); Little Boar's Head, 14 August 1967 (H1875); Great Boar's Head, 24 January 1967 (H1881); Bound Rock, 18 November 1966 (H1886); Hilton Park, 2 October 1968 (N. B. Reynolds 286).

**Phyllophora traillii** Holmes *ex* Batters

Found once by Croasdale in July growing on rocks in the low eulittoral zone on the open coast. Vegetative; perennial. Recorded from Connecticut to Maine and Nova Scotia (as summarized in Taylor, 1957; Edelstein and McLachlan, 1968).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 28 July 1938 (Croasdale 5297).

GIGARTINACEAE

**Chondrus crispus** Stackhouse

Common throughout the year on rocks and in tidepools in the mid to lower eulittoral zone, and extending into the sublittoral zone. Found on the open coast and throughout most of the Estuary. Perennial; tetraspores found January-December; carpospores found January-May, July, September-November.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M4180); Jaffrey Point, 5 December 1966 (H392); Fort Consti-

tution, 20 January 1967 (H397); Odiorne's Point, 30 May 1967 (H412); North Wallis Sands, (16 January 1967 (H418); Concord Point, 9 October 1966 (H436); Ragged Neck, 12 June 1967 (H445); Rye Ledge, 11 November 1966 (H451); Little Boar's Head, 8 March 1967 (H463); Great Boar's Head, 24 April 1967 (H474); Bound Rock, 6 December 1966 (H491); Piscataqua River toll bridge, 27 February 1967 (H535); Hilton Park, 14 October 1966 (H519); Cedar Point, 15 January 1967 (H499); Durham Point, 31 May 1967 (H509); Adams Point, 30 May 1967 (H493); Weeks Point, 14 September 1966 (H539).

**Gigartina stellata** (Stackhouse) Batters

Found throughout the year in the lower eulittoral and sublittoral fringe zones on the open coast, and with limited distribution in the Estuary. Perennial; cystocarpic plants found January-December.

Recorded from Rhode Island to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M4741); Jaffrey Point, 5 December 1966 (H1062); Fort Constitution, 8 November 1966 (H1077); Odiorne's Point, 26 June 1967 (H1089); North Wallis Sands, 11 June 1967 (H1099); Concord Point, 19 February 1967 (H1108); Ragged Neck, 26 December 1966 (H1119); Rye Ledge, 22 June 1967 (H1129); Little Boar's Head, 14 September 1966 (H1141); Great Boar's Head, 14 October 1966 (H1152); Bound Rock, 8 August 1967 (M4774); Piscataqua River toll bridge, 27 February 1967 (H1184); Hilton Park, 24 May 1967 (H1162); Cedar Point, 3 March 1967 (H1170); Durham Point, 19 September 1966 (H1171).

RHODYMENIALES

RHODYMENIACEAE

**Halosaccion ramentaceum** (Linnaeus) J. Agardh

Growing throughout the year in the sublittoral fringe region. Only found at three coastal stations. Perennial; tetraspores found December-October.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 25 July 1938 (Croasdale 4867); Jaffrey Point, 12 October 1966 (H1218); Rye Ledge, 26 February 1967 (H1221).

**Rhodymenia palmata** (Linnaeus) Greville

Growing throughout the year in the lower eulittoral and sublittoral zones. Common on the open coast and the Estuary. Perennial; tetraspores found from January to December.

Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 May 1968 (M6176); Jaffrey Point, 7 January 1967 (H2565); Fort Constitution, 20 September 1966 (H2566); Odiorne's Point, 21 February 1967 (H2575); North Wallis Sands, 20 March 1967 (H2584); Concord Point, 8 January 1967 (H2595); Ragged Neck, 10 August 1967 (H2600); Rye Ledge, 25 April 1967 (H2615); Little Boar's Head, 14 August 1967 (H2627); Great Boar's Head, 11 December 1966 (H2631); Bound Rock, 18 November 1966 (H2641); Piscataqua River toll bridge, 18 October 1966 (H2685); Hilton Park, 9 July 1967 (H2650); Cedar Point, 24 June 1967 (H2671); Durham Point, 14 August 1967 (H2672); Adams Point, 22 December 1966 (H2666); Pierce Point, 8 November 1966 (H2679).

## CHAMPIACEAE

**Lomentaria baileyana** (Harvey) Farlow

Growing on shells, pebbles, epiphytic on other algae or on *Zostera*, or free-floating. Found from July to November; common throughout the Estuary. Annual; tetraspores found in July and August.

Recorded from the tropics to New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Doty and Newhouse, 1954; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Cedar Point, 12 September 1966 (H1557); Durham Point, 19 September 1966 (H1558); Adams Point, 13 September 1966 (H1563); Fabyan's Point, 17 September 1966 (H1565); Pierce Point, 13 September 1966 (H1566).

**Lomentaria orcadensis** (Harvey) Collins *ex* Taylor

Collected in the sublittoral zone (August and October) at two coastal and one estuarine location. Perennial; tetraspores found in August.

Recorded from Rhode Island to Maine (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 August 1967 (M5085); Odiorne's Point, 7 August 1967 (M5086); Hilton Park, 2 October 1968 (N. B. Reynolds 287).

## CERAMIALES

## CERAMIACEAE

**\*Antithamnion americanum** (Harvey) Farlow

Two specimens seen from the open coast; vegetative; annual(?).

Recorded from New Jersey to Labrador (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals, before 1870; (*FH L. L. Thaxter* 7782). Isles of Shoals (*FH Cole*).

**Antithamnion boreale** (Gobi) Kjellman

Found once by Croasdale (July) growing in the sublittoral zone on the open coast. Annual(?); tetraspores found in July.

Recorded from Northern Massachusetts to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Appledore Island), 26 July 1938 (*Croasdale* 3728).

**Antithamnion cruciatum** (C. Agardh) Nägeli

Growing in mud or epiphytic on other algae in the lower eulittoral and sublittoral zones from May to November. Found on the open coast and throughout most of the Estuary. Annual; tetraspores found from June to September. Recorded from Bermuda to New Hampshire and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 26 July 1938 (*Croasdale* 3729); Odiorne's Point, 7 August 1967 (*M3731*); Hilton Park, 9 July 1967 (*H70*); Cedar Point, 12 September 1966 (*H69*); Adams Point, 13 October 1966 (*H68*).

**Antithamnion floccosum** (O. F. Müller) Kleen

Growing in the sublittoral zone. Found on the open coast, and with restricted distribution in the Estuary. Collected from January to May, and August. Annual; tetraspores found in April and August.

Recorded from Northern Massachusetts to Ile St. Pierre (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 7 January 1967 (*H73*); Odiorne's Point, 7 August 1967 (*M3752*); Rye Ledge, 20 April 1952 (*M3753*); Adams Point, 4 May 1968 (*M3754*).

**\*\**Antithamnion plumula* (Ellis) Thuret in Le Jolis**

Found once (July) growing on mud in the low eulittoral zone in the Estuary. No reproductive structures seen; annual.

Previously recorded from New Jersey to Southern Massachusetts (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Cedar Point, 27 July 1966 (H74).

**\**Antithamnion pylaisaei* (Montagne) Kjellman**

Growing in the sublittoral zone on the open coast. Two specimens seen (May); vegetative; annual(?).

Recorded from Long Island to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 25 May 1938 (Croasdale 3762); Rye Beach, (FH Cole).

***Callithamnion baileyi* Harvey**

Found throughout most of the year on mud, stones and epiphytic on other algae in the lower eulittoral zone. Present on the open coast and throughout the Estuary. Perennial(?); tetraspores found in March and July; carpospores found from July to October; spermatia found in July, September and October.

Recorded from New Jersey to Prince Edward Island and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 26 July 1938 (Croasdale 3825); Jaffrey Point, 3 May 1968 (M3826); Concord Point, 22 November 1966 (H210); Piscataqua River toll bridge, 12 August 1967 (H214); Hilton Park, 7 January 1967 (H218); Cedar Point, 3 March 1967 (H213); Durham Point, 16 October 1966 (H216); Adams Point, 19 July 1966 (M3827); Pierce Point, 25 July 1967 (H215).

**\**Callithamnion corymbosum* (J. E. Smith) Lyngbye**

Found in July in the lower eulittoral zone in the Estuary. Annual(?); tetraspores found in July.

Recorded from Bermuda to Nova Scotia (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMEN: Adams Point, 23 July 1967 (H219).

***Callithamnion roseum* (Roth) Lyngbye**

Growing on the open coast. One specimen seen; vegetative; annual(?).

Recorded from New Jersey to Southern Massachusetts and New Hampshire (as summarized in Taylor, 1957; Doty and Newhouse, 1954).

REPRESENTATIVE SPECIMEN: Isles of Shoals, before 1870 (FH L. L. Thaxter 7788).

**Callithamnion tetragonum** (Withering) S. F. Gray

Reported by Croasdale (1941) from the Isles of Shoals. No specimens seen; annual(?).

Recorded from New Jersey to Maine (as summarized in Taylor, 1957).

**Ceramium deslongchampsii** Chauvin in Duby

var. **hooperi** (Harvey) Taylor

Found from April to November growing on rocks and pilings under over-hanging furoids in the mid to lower eulittoral zone on the open coast and in the Estuary. Perennial(?); tetraspores found in August.

Recorded from Connecticut to the Lower St. Lawrence (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 9 September 1967 (H220); North Wallis Sands, 16 July 1967 (H221); Piscataqua River toll bridge, 12 August 1967 (H222); Cedar Point, 23 November 1966 (H223); Squamscott River, 13 September 1966 (H224).

**Ceramium diaphanum** (Lightfoot) Roth

Reported by Collins (1900) and Doty and Newhouse (1954). No specimens seen. The abundance and distribution of this plant given in the latter paper suggests possible confusion with *Ceramium strictum*.

Recorded from Virginia to Prince Edward Island (as summarized in Taylor, 1957).

**Ceramium rubriforme** Kylin prox.

Found once (July) in the lower eulittoral zone on the open coast. Vegetative; perennial.

Recorded from Southern Massachusetts to New Hampshire and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMEN: Isles of Shoals (Star Island), 22 July 1966 (M3905).

**Ceramium rubrum** (Hudson) C. Agardh

Found throughout the year growing on rocks and epiphytic



on various algae in the lower eulittoral and sublittoral zones. Common on the open coast and throughout the Estuary. Perennial; tetraspores found January-December; cystocarpic plants found all months except May.

Recorded from the tropics to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M3940); Jaffrey Point, 7 January 1967 (H226); Fort Constitution, 20 September 1966 (H234); Odiorne's Point, 21 February 1967 (H236); North Wallis Sands, 16 January 1967 (H243); Concord Point, 8 January 1967 (H253); Ragged Neck, 26 December 1966 (H264); Rye Ledge, 11 November 1966 (H271); Little Boar's Head, 24 May 1967 (H285); Great Boar's Head, 24 January 1967 (H288); Bound Rock, 18 January 1967 (H299); Piscataqua River toll bridge, 27 February 1967 (H349); Hilton Park, 27 April 1967 (H339); Cedar Point, 3 March 1967 (H317); Durham Point, 26 June 1967 (H324); Adams Point, 13 September 1966 (H309); Fabyans Point, 8 July 1967 (H330); Pierce Point, 23 June 1967 (H346); Squamscott River, 4 March 1967 (H356).

#### **Ceramium strictum** Harvey

Found from June to October growing on rocks and epiphytic on *Zostera* and certain algae. Common throughout the Estuary in the lower eulittoral and sublittoral zones. Rare on the coast. Annual; tetraspores and carpospores found from June to October.

Recorded from Florida to Prince Edward Island and Baie des Chaleurs (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Concord Point, 13 September 1966 (H357); Bound Rock, 19 July 1966 (M4079); Hilton Park, 9 July 1967 (H358); Cedar Point, 7 August 1967 (H362); Durham Point, 14 August 1967 (H363); Adams Point, 23 July 1967 (H360); Fabyans Point, 2 August 1966 (M4100); Squamscott River, 20 July 1966 (H366).

#### **Plumaria elegans** (Bonnemaison) Schmitz

Found throughout the year growing on vertical rock faces under over-hanging furoids in the lower eulittoral zone on the open coast. Perennial; paraspores found from September to January.

Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 28 July 1938 (*Croasdale* 5338); Jaffrey Point, 8 November 1966 (H1900); North Wallis Sands, 11 October 1966 (H1910); Rye Ledge, 11 November 1966 (H1911); Great Boar's Head, 12 August 1967 (H1913); Bound Rock, 15 March 1968 (M5343).

**Ptilota serrata** Kützing

Found throughout the year growing in the sublittoral zone on the open coast. Common in drift. Perennial; tetraspores found from November to June; spermatia found in February and March; only one cystocarpic plant found (May). Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island); 28 May 1968 (M5984); Jaffrey Point, 6 May, 1967 (M5987); Odiorne's Point, 21 February 1967 (H2401); North Wallis Sands, 16 January 1967 (H2406); Concord Point, 10 December 1966 (H2420); Ragged Neck, 9 March 1967 (H2422); Rye Ledge, 25 April 1967 (H2430); Little Boar's Head, 14 September 1966 (H2443); Great Boar's Head, 24 January 1967 (H2448); Bound Rock, 18 November 1966 (H2453).

**Spermothamnion repens** (Dillwyn) Rosenvinge

Growing on mud and pebbles in the lower eulittoral zone in March and July-September. Rare on the open coast, and with limited distribution in the Estuary. Perennial; tetraspores found in July.

Recorded from Florida to Nova Scotia (as summarized in Taylor, 1957, as *Spermothamnion turneri*).

REPRESENTATIVE SPECIMENS: North Wallis Sands, 20 March 1967 (H245); Cedar Point, 27 July 1966 (H2556); Durham Point, 19 September 1966 (H2557); Adams Point, 19 July 1966 (M6043).

DELESSERIACEAE

**Membranoptera alata** (Hudson) Stackhouse

Found throughout the year epiphytic on various algae in the sublittoral zone. Frequent in drift on the open coast. Perennial; tetraspores found from November to July.

Recorded from Northern Massachusetts to Baffin Island (as summarized in Taylor, 1957; including *Membranoptera denticulata*. See Mathieson, Hehre and Reynolds, in press).

REPRESENTATIVE SPECIMENS: Isles of Shoals, before 1870 (FH L. L. *Thaxter* 7792); Jaffrey Point, 8 November 1966 (H1567); Fort Constitution, 22 June 1966 (M5103); Odiorne's Point, 26 July 1967 (H1570); North Wallis Sands, 11 June 1967 (H1575); Concord Point,

13 September 1966 (H1578); Ragged Neck, 18 September 1966 (H1580); Rye Ledge, 15 October 1966 (H1587); Little Boar's Head, 2 April 1967 (H1592); Great Boar's Head, 13 November 1966 (H1593); Bound Rock, 18 January 1967 (H1596).

\***Pantoneura baerii** (Postels *et* Ruprecht) Kylin

Collected twice (May and June) in the sublittoral zone on the open coast. Perennial; tetraspores found in May.

Previously recorded from Northern Massachusetts, Labrador, Hudson Straits and Ellesmere Island (as summarized in Taylor, 1957; Lamb and Zimmermann, 1964).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (Kingsbury, 1965); Isles of Shoals (Appledore Island), 28 May 1968 (M5118).

**Phycodrys rubens** (Linnaeus) Batters

Growing throughout the year in the sublittoral zone of the open coast. Young plants occasionally found in deep tide-pools in the lower eulittoral zone. Perennial; tetraspores found October-July; cystocarpic plants found November-August; spermatia found once in July.

Recorded from New Jersey to Ellesmere Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M5174); Jaffrey Point, 7 January 1967 (H1676); Fort Constitution, 23 June 1967 (H1685); Odiorne's Point, 21 February 1967 (H1689); North Wallis Sands, 11 October 1966 (H1696); Concord Point, 13 September 1966 (H1713); Ragged Neck, 12 June 1967 (H1727); Rye Ledge, 23 December 1966 (H1728); Little Boar's Head, 24 May 1967 (H1742); Great Boar's Head, 15 September 1966 (H1752); Bound Rock, 31 May 1967 (H1761).

DASYACEAE

**Dasya pedicellata** (C. Agardh) C. Agardh

Young plants grow epiphytically on various algae, while older plants occur free-floating or entangled amongst other plants. Common throughout the Estuary from July to December. Annual; tetraspores found from July-October; spermatia and carpospores found from July to November.

Recorded from the tropics to New Hampshire and Nova Scotia (as summarized in Taylor, 1957; Doty and Newhouse, 1954; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Hilton Park, 19 July 1966 (M4539); Cedar Point, 7 August 1967 (H864); Durham Point, 19 September

1966 (H865); Adams Point, 13 October 1966 (H862); Fabyans Point, 2 August 1966 (M4535); Pierce Point, 18 October 1966 (H868).

RHODOMELACEAE

**Bostrychia rivularis** Harvey

Reported by Farlow (1882). Supposedly found in the vicinity of the Isles of Shoals by Captain Pike. No specimens have been found to verify this species and it remains a doubtful record.

Recorded from the tropics to New Hampshire (as summarized in Taylor, 1957).

\***Chondria baileyana** (Montagne) Harvey

Found from June-November, growing on shells, pebbles and epiphytic on other algae and on *Zostera*. It occurs in the lower eulittoral and sublittoral zones throughout the Estuary. Annual; tetraspores found from June to September; cystocarpic plants found in June and September.

Previously recorded from New Jersey to Northern Massachusetts and Nova Scotia (as summarized in Taylor, 1957; Edelstein, McLachlan and Craigie, 1967).

REPRESENTATIVE SPECIMENS: Durham Point, 14 August 1967 (H377); Adams Point, 23 July 1967 (H376); Fabyans Point, 17 September 1966 (H386); Pierce Point, 13 September 1966 (H381).

**Chondria tenuissima** (Goodenough *et* Woodward) C. Agardh  
Reported by Doty and Newhouse (1954). No specimens were available, but from their data, it would appear to be *Chondria baileyana*.

\***Polysiphonia denudata** (Dillwyn) Greville *ex* Harvey  
in Hooker

Found from July to December in the lower eulittoral and sublittoral zones throughout the Estuary. Annual; tetraspores found from July to October; cystocarpic plants found from July to September.

Recorded from the tropics to Prince Edward Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Hilton Park, 28 August 1968 (N. B. Reynolds 281); Cedar Point, 12 September 1966 (H1952); Durham Point, 19 September 1966 (H1953); Adams Point, 13 October 1966 (H1950); Fabyans Point, 17 September 1966 (H1955); Pierce Point,

8 November 1966 (H1958); Squamscott River, 13 September 1966 (H1960).

**Polysiphonia elongata** (Hudson) Sprengel

Found throughout the year growing in tidepools in the lower eulittoral and sublittoral zones throughout the Estuary. Perennial; tetraspores found from June to September; carpospores and spermatia found in July.

Recorded from New York to Prince Edward Island and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Pierce Island, Piscataqua River, 18 July 1966 (M5436); Hilton Park, 9 December 1966 (H1977); Cedar Point, 23 November 1966 (H1983); Durham Point, 15 November 1966 (H1988); Adams Point, 13 September 1966 (H1968); Fabyans Point, 15 October 1966 (H1991); Pierce Point, 8 November 1966 (H1999).

\***Polysiphonia flexicaulis** (Harvey) Collins

One record (July) on the open coast (Croasdale) and one (July) in the Estuary. Annual; cystocarpic plants found in July.

Recorded from Long Island to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 28 July 1938 (Croasdale 5471); Cedar Point, 10 July 1941 (E. Flagg 5473).

**Polysiphonia harveyi** Bailey

Reported by Collins (1900) and Doty and Newhouse (1954). No data or specimens available.

Recorded from South Carolina to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

**Polysiphonia lanosa** (Linnaeus) Tandy

Hemiparasitic on *Ascophyllum nodosum*. Common on the open coast, and with limited distribution in the Estuary. Present throughout the year. Perennial; tetraspores found from June to November; cystocarpic plants found from June to December; spermatia found from January to May. Recorded from New Jersey to Newfoundland (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5511); Jaffrey Point, 7 January 1967 (H2003); Fort Consti-

tution, 8 November 1966 (*H2018*); Odiorne's Point, 17 October 1966 (*H2028*); North Wallis Sands, 11 June 1967 (*H2038*); Concord Point, 10 August 1967 (*H2051*); Ragged Neck, 22 May 1967 (*H2061*); Rye Ledge, 15 October 1966 (*H2062*); Little Boar's Head, 24 May 1967 (*H2083*); Great Boar's Head, 25 July 1967 (*H2095*); Bound Rock, 18 January 1967 (*H2096*); Piscataqua River toll bridge, 24 June 1966 (*H2098*); Hilton Park, 28 August 1968 (*N. B. Reynolds 273*).

***Polysiphonia nigra* (Hudson) Batters**

Found in the lower eulittoral (in tidepools) and the sublittoral zones. Occasional on the open coast, and with restricted distribution in the Estuary. Annual(?); tetraspores found in March and July; cystocarpic plants found from October to December.

Recorded from New Jersey to Nova Scotia and Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Jaffrey Point, 8 November 1966 (*H2102*); Odiorne's Point, 7 August 1967 (*M5562*); North Wallis Sands, 7 August 1967 (*M5564*); Rye Ledge, 27 February 1968 (*M5565*); Bound Rock, 6 December 1966 (*H2103*); Hilton Park, 7 January 1967 (*H2108*); Cedar Point, 27 July 1966 (*H2105*); Durham Point, 16 October 1966 (*H2113*); Adams Point, 13 October 1966 (*H2111*).

***Polysiphonia nigrescens* (Hudson) Greville**

Found throughout the year on rocks in the lower eulittoral and sublittoral zones on the open coast and throughout the Estuary. Frequent in drift. Perennial; tetraspores found from May to December; cystocarpic plants found in March and from June to September; spermatia found in February. Recorded from South Carolina to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Appledore Island), 26 July 1938 (*Croasdale 5586*); Jaffrey Point, 8 November 1966 (*H2129*); Odiorne's Point, 10 March 1967 (*H2119*); North Wallis Sands, 10 September 1966 (*H2122*); Concord Point, 10 August 1967 (*H2124*); Ragged Neck, 23 November 1966 (*H2126*); Rye Ledge, 12 September 1966 (*H2127*); Bound Rock, 7 March 1966 (*M5601*); Hilton Park, 7 January 1967 (*H2131*); Cedar Point, 24 May 1967 (*H2146*); Durham Point, 3 March 1967 (*M5632*); Adams Point,

13 October 1966 (H2144); Fabyans Point, 16 November 1966 (H2150); Pierce Point, 18 October 1966 (H2154).

**Polysiphonia novae-angliae** Taylor

Found throughout the year on rocks and epiphytic on other algae in the lower eulittoral and sublittoral zones. Common on the open coast, and with restricted distribution in the Estuary. Perennial; tetraspores found January-December; cystocarpic plants found from June to November; spermatia found in February, March and May.

Recorded from Rhode Island to Newfoundland (as summarized in Taylor, 1957; Mathieson, Dawes and Humm, 1969).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), 22 July 1966 (M5656); Jaffrey Point, 6 May 1967 (M5658); Fort Constitution, 24 July 1967 (M5659); North Wallis Sands, 20 March 1967 (H2156); Concord Point, 8 January 1967 (H2157); Ragged Neck, 10 August 1967 (H2159); Rye Ledge, 12 September 1966 (H2160); Great Boar's Head, 11 December 1966 (H2162); Bound Rock, 18 January 1967 (H2163); Piscataqua River toll bridge, 12 August 1967 (H2186); Hilton Park, 13 February 1967 (H2193); Cedar Point, 17 April 1967 (H2177); Durham Point, 15 December 1966 (H2181); Adams Point, 13 October 1966 (H2171).

\***Polysiphonia subtilissima** Montagne

Found from June to October growing on rocks and mud in the lower eulittoral and sublittoral zones. Restricted to parts of the Estuary where salinities are very low. Annual; only one tetrasporic specimen was observed (July). Previously recorded from the tropics to Northern Massachusetts and with some doubt to the Baie de Gaspé (as summarized in Taylor, 1957; Cardinal, 1967).

REPRESENTATIVE SPECIMENS: Cedar Point, 27 June 1966 (H2118); Crommet Creek, 20 June 1966 (M5573); Squamscott River, 21 June 1966 (H2115).

**Polysiphonia urceolata** (Lightfoot *ex* Dillwyn) Greville

Growing on rocks in the lower eulittoral and sublittoral zones throughout the year. Common on the open coast and with restricted distribution in the Estuary. The seasonal varieties (*roseola* and *patens*) as designated by Taylor (1957) were not distinguishable. Perennial; tetraspores found from May to August; cystocarpic plants found in July and August; spermatia found from January to May.

Recorded from North Carolina to the arctic (as summarized in Taylor, 1957, including varieties *roseola* and *patens*).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Lunging Island), 22 July 1966 (M5727); Jaffrey Point, 9 August 1967 (H2204); Fort Constitution, 24 July 1967 (M5738); Odiorne's Point, 30 May 1967 (H2209); North Wallis Sands, 20 May 1967 (H2213); Concord Point, 27 June 1967 (H2215); Ragged Neck, 12 June 1967 (H2216); Rye Ledge, 24 July 1967 (H2217); Little Boar's Head, 24 May 1967 (H2222); Great Boar's Head, 24 January 1967 (H2225); Bound Rock, 20 February 1967 (H2228); Hilton Park, 14 October 1966 (H2235); Fox Point, 5 December 1966 (H2200).

**Rhodomela confervoides** (Hudson) Silva

Found throughout the year on the open coast in the low eulittoral and sublittoral zones. Perennial; tetraspores found in March and from May to August; cystocarpic plants found in June and July; spermatia found in March and April.

Recorded from New Jersey to Baffin Island (as summarized in Taylor, 1957).

REPRESENTATIVE SPECIMENS: Isles of Shoals (Star Island), June 1965 (Kingsbury, 1965); Jaffrey Point, 1 April 1967 (H2535); Fort Constitution, 22 June 1966 (M6031); Odiorne's Point, 7 August 1967 (M6032); North Wallis Sands, 28 February 1967 (H2536); Concord Point, 5 March 1967 (H2541); Ragged Neck, 12 December 1966 (H2544); Rye Ledge, 11 November 1966 (H2550); Little Boar's Head, 22 December 1966 (H2551); Great Boar's Head, 14 October 1966 (H2552); Bound Rock, 7 March 1966 (H2554).

DISCUSSION

Eighty-eight taxa of red algae are listed from the coastal and estuarine environments of New Hampshire; fifteen taxa represent additions to the flora of the state. Six taxa are doubtful records (*Polysiphonia harveyi*, *Bostrychia rivularis*, *Chondria tenuissima*, *Agardhiella tenera*, *Ceramium diaphanum*, *Batrachospermum* sp.).

Many of the plants are boreal and subarctic species (e.g., *Porphyra miniata*, *Euthora cristata*, *Rhodophyllis dichotoma*, *Gigartina stellata*, *Halosaccion ramentaceum*, *Ptilota serrata*, *Phyllophora* spp., *Polyides rotundus*, *Rhodochorton purpureum*). Certain components of the Estuary flora have



affinities towards warm temperate regions — in particular, the summer annuals whose center of distribution is south of New England (e.g., *Lomentaria baileyana*, *Dasya pedicellata*, *Spermothamnion repens*, *Polysiphonia denudata*, *Chondria baileyana*, *Gracilaria foliifera* and *Polysiphonia subtilissima*).

The paucity of information regarding seasonality and reproductive periodicity of marine algae of northern New England is due to a lack of seasonal collections. Winter observations are essentially nonexistent and little phenological data are available. In particular, those algae which have their growth or reproduction during late fall to early spring are apt to be missed (e.g., *Bangia fuscopurpurea*, *Plumaria elegans*, *Polysiphonia nigra*, *Porphyra linearis*, *Rhodochorton purpureum*). Edelstein and McLachlan (1966b) studied the occurrence and reproduction of marine algae during the winter months in Nova Scotia. Data from their study and the present investigation show many similarities.

The reproductive periodicities recorded for several species differ markedly from those listed in Taylor (1957). Several species reproduce throughout the year (e.g., *Porphyra umbilicalis*, *Audouinella membranacea*, *Hildenbrandia prototypus*, *Euthora cristata*, *Choreocolax polysiphoniae*, *Ahnfeltia plicata*, *Phyllophora brodiaei*, *Chondrus crispus*, *Gigartina stellata*, *Rhodymenia palmata*, *Ptilota serrata*, *Ceramium rubrum*, *Polysiphonia lanosa*, *P. nigrescens*, *P. novae-angliae*, *P. urceolata*), although they were reported to reproduce during only one or two seasons. Other species had more prolonged periods of reproduction than previously reported (e.g., *Petrocelis middendorffi*, *Antithamnion cruciatum*, *Membranoptera alata*, *Dasya pedicellata*). Reproductive specimens of *Plumaria elegans* were found in the fall and winter while Taylor reports reproduction from the summer and earlier. He describes *Porphyra miniata* as being reproductive during any season, giving the impression that it occurs throughout the year. According to our observations, *P. miniata* is an annual (spring and summer). It

was found to be reproductive every month in which it was found (March-August). Our observations on *P. miniata* are similar to those of Lamb and Zimmermann (1964).

The seasonal occurrence of most species generally agrees with those of Taylor (1957), except for *Bangia fuscopurpurea* and *Antithamnion floccosum* which differed slightly. *Bangia fuscopurpurea* occurred from late fall to late summer. Taylor records it from early spring and summer. *Antithamnion floccosum* was found from winter to late summer while Taylor records it only in the spring.

Both asexual and sexual structures were found. Monospores, bispores, paraspores and tetraspores were encountered. Tetraspores were the most common type. Monospores were found only in *Bangia fuscopurpurea*, *Kylinia* spp. and *Ahnfeltia plicata*. Bispores were found only in the crustose corallines, while paraspores were found exclusively in *Plumaria elegans*. Tetraspores were found in most other species. One conspicuous exception is *Gigartina stellata*, where the tetrasporophyte generation is unknown.

Certain plants were found only as tetrasporophytes (e.g., *Antithamnion cruciatum*, *A. floccosum*, *Audouinella membranacea*, *Ceratocolax hartzii*, *Cystoclonium purpureum* var. *cirrhosum*, *Dumontia incrassata*, *Melobesia lejolisii*, *Halosaccion ramentaceum*, *Hildenbrandia prototypus*, *Lomentaria baileyana*, *L. orcadensis*, *Membranoptera alata*, *Petrocelis middendorfi*, *Rhodochorton purpureum*, *Rhodymenia palmata*). Sexual generations have been described for most of these plants except *Halosaccion ramentaceum*, *Hildenbrandia prototypus* and *Rhodymenia palmata*.

Sexual structures were found on most species except those which produced monospores, bispores and paraspores. Female plants were more frequent than male plants. Some species produced cystocarps and spermatia at different times of the year (e.g., *Polysiphonia lanosa*, *P. nigrescens*, *P. novae-angliae*, *P. urceolata*, *Ptilota serrata*, *Rhodomela confervoides*). Others produced both structures at the same time (e.g., *Callithamnion baileyi*, *Dasya pedicellata*, *Rhycodrys rubens*, *Polysiphonia denudata*).

A distinct overlap in the occurrence of tetraspores and carpospores was noted for several species. *Callithamnion baileyi* and *Polysiphonia nigra* showed no distinct overlapping.

Three trends were evident:

(1) Tetraspores and carpospores were found throughout the year (e.g., *Ceramium rubrum*, *Chondrus crispus*, *Euthora cristata*, *Phycodrys rubens*).

(2) Tetraspores were found throughout the year while carpospores were found during only one or two seasons (e.g., *Polysiphonia urceolata*, *Choreocolax polysiphoniae*).

(3) Tetraspores and carpospores were present during one or more seasons. Both summer annuals (e.g., *Ceramium strictum*, *Dasya pedicellata*, *Chondria baileyana*, *Polysiphonia denudata*) and perennials (e.g., *Phyllophora membranifolia*, *Polyides rotundus*, *Polysiphonia elongata*, *P. lanosa*, *P. nigrescens*) were discernable.

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Table 1

## Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, o = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
<i>Acrochaetium polyides</i>	—	—	—	—	—	—	—	—	O	—	—	—
<i>Ahnfeltia plicata</i>	M	M	M	M	M	M	M	M	M	M	M	M
<i>Antithamnion boreale</i>	—	—	—	—	—	—	T	—	—	—	—	—
<i>A. cruciatum</i>	—	—	—	—	O	T	T	T	T	O	—	—
<i>A. floccosum</i>	O	O	O	T	O	—	—	T	—	—	—	—
<i>A. plumula</i>	—	—	—	—	—	—	O	—	—	—	—	—
<i>A. pylaisaei</i>	—	—	—	—	O	—	—	—	—	—	—	—
<i>Audouinella membranacea</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Bangia ciliaris</i>	T	T	T	T	T	T	T	T	T	T	T	T
<i>B. fuscopurpurea</i>	—	—	—	—	—	O	—	—	—	—	—	—
<i>Bonnemaisonia hamifera</i>	M	M	M	M	O	O	O	O	—	—	O	M
<i>Callithamnion baileyi</i>	—	—	—	—	O	O	O	—	—	—	—	—
<i>C. corymbosum</i>	O	—	T	—	—	—	T,C,S	C	C,S	C,S	—	—
<i>Ceramium deslongchampsii</i>	—	—	—	—	—	—	T	—	—	—	—	—
var. <i>hooperi</i>	—	—	—	O	O	O	O	T	O	O	O	—
<i>C. rubrifforme</i>	—	—	—	—	—	—	O	—	—	—	—	—
<i>C. rubrum</i>	C,T	C,T	C,T	C,T	T	C,T	C,T	C,T	C,T	C,T	C,T	C,T
<i>C. strictum</i>	—	—	—	—	—	C,T	C,T	C,T	C,T	C,T	—	—
<i>Ceratocolax hartzii</i>	T	T	O	T	T	O	O	O	—	—	—	O
<i>Chondria baileyana</i>	—	—	—	—	—	T	C,T	C,T	C,T	O	O	—

Table 1 (continued)

## Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores,  $\alpha$  = large spores,  $\beta$  = small spores, o = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
<i>Chondrus crispus</i>	C,T	C,T	C,T	C,T	C,T	T	C,T	T	C,T	C,T	C,T	T
<i>Choreocolax polysiphoniae</i>	T	T	T	T	T	T	C,T	C,T	T	T	C,T	T
<i>Clathromorphum circumscriptum</i>	B	B	B	B	B	O	O	O	O	O	O	B
<i>Corallina officinalis</i>	O	O	O	O	O	O	O	O	O	O	O	O
<i>Cystoclonium purpureum</i> var. <i>cirrhosum</i>	O	O	O	T	T	T	T	T	T	T	T	O
<i>Dasya pedicellata</i>	—	—	—	—	—	—	T,C,S	T,C,S	T,C,S	T,C,S	C,S	O
<i>Dermatolithon pustulatum</i>	B	B	B	O	B	B	B	B	B	B	B	B
<i>Dumontia incrassata</i>	O	O	T	T	T	T	T	O	O	O	O	O
<i>Erythrotrichia carnea</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Euthora cristata</i>	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T	C,T
<i>Gigartina stellata</i>	C	C	C	C	C	C	C	C	C	C	C	C
<i>Gloiosiphonia capillaris</i>	—	—	—	—	—	—	C	—	—	—	—	—
<i>Gracilaria foliifera</i>	—	—	O	C	O	C,T	C,T	C,T	C,T	C,T	C	O
<i>Halosaccion ramentaceum</i>	T	T	T	T	T	T	T	T	T	T	O	T
<i>Hildenbrandia prototypus</i>	T	T	T	T	T	T	T	T	T	T	T	T
<i>Kylinia alariae</i>	—	—	—	—	—	—	M	O	—	—	—	—
<i>K. secundata</i>	M	M	M,T	M	M	M	M	M	M	M	M	M
<i>K. virgatula</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>K. virgatula</i> f. <i>luxurians</i>	—	—	—	—	—	—	M	—	M	—	—	—

Table 1 (continued)

Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carpospores, M = monospores, N = carpotetraspores, P = paraspores, S = spermatia, T = tetraspores, α = large spores, β = small spores, o = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
<i>Lithophyllum corallinae</i>	O	O	B	O	O	B	O	O	O	O	O	O
<i>Lithothamnium glaciale</i>	—	B	O	B	O	O	O	O	O	O	O	—
<i>Lomentaria baileyana</i>	—	—	—	—	—	—	T	T	O	O	—	—
<i>L. orcadensis</i>	—	—	—	—	—	—	—	T	—	O	—	—
<i>Melobesia lejolisii</i>	T	T	T	T	T	O	O	O	O	T	T	T
<i>Membranoptera alata</i>	T	T	T	T	T	T	O	O	O	O	T	T
<i>Nemalion helminthoides</i>	—	—	—	—	—	—	O	C	—	—	—	—
<i>Pantoneura baerii</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Petrocelis middendorfi</i>	T	T	T	T	T	O	O	—	O	T	T	T
<i>Peyssonelia rosenvingii</i>	O	—	—	—	—	—	—	—	—	—	—	—
<i>Phycodrydrys rubens</i>	C,T	C,T	C,T	C,T	C,T	C,T	T,C,S	—	O	T	C,T	C,T
<i>Phyllophora brodiaei</i>	N	N	N	N	N	N	N	N	N	N	N	N
<i>P. membranifolia</i>	C,T	T	C,T	C	O	O	O	O	T	T	C,T	T
<i>P. traillii</i>	—	—	—	—	—	—	O	—	—	—	—	—
<i>Phymatolithon lenormandi</i>	C,T	O	—	—	O	O	O	—	O	O	O	O
<i>Plumaria elegans</i>	—	O	O	O	O	O	O	O	P	P	P	P
<i>Polyides rotundus</i>	P	C	O	O	O	O	O	O	O	C,T	C,T	C,T
<i>Polysiphonia denudata</i>	—	—	—	—	—	—	C,T	C,T	C,T	T	O	O
<i>P. elongata</i>	O	O	O	O	O	T	T,C,S	T	T	O	O	O
<i>P. flexicaulis</i>	—	—	—	—	—	C	—	—	—	—	—	—



Table 1 (continued)

## Seasonality and Reproductive Periodicity of the Rhodophyceae in New Hampshire

B = bispores, C = carpospores, M = monospores, N = carpotetraspores, P = paraspores, s = spermatia, T = tetraspores,  $\alpha$  = large spores,  $\beta$  = small spores, o = vegetative, — = plants not found.

TAXA	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
<i>P. lanosa</i>	S	S	S	S	S	C,T	C,T	C,T	C,T	C,T	C,T	C
<i>P. nigra</i>	O	O	T	—	—	—	T	O	O	C	C	C
<i>P. nigrescens</i>	O	S	C	O	T	C,T	C,T	C,T	C,T	T	C,T	C,T
<i>P. novae-angliae</i>	T	T,S	T,S	T	T,S	C,T	C,T	C,T	C,T	C,T	C,T	T
<i>P. subtilissima</i>	—	—	—	—	—	O	T	O	O	O	—	—
<i>P. urceolata</i>	S	S	S	S	T,S	T	C,T	C,T	O	T	T	O
<i>Porphyra leucosticta</i>	O	—	$\alpha,\beta$	$\alpha,\beta$	B	O	O	—	—	—	—	—
<i>P. linearis</i>	O	B	B	$\alpha$	$\alpha$	—	—	—	—	—	—	O
<i>P. miniata</i>	—	—	B	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	—	—	—	—
<i>P. umbilicalis</i>	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$
<i>P. umbilicalis f. epiphytica</i>	B	B	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha,\beta$	$\alpha$
<i>Porphyropsis coccinea</i>	—	—	—	—	—	—	—	O	—	—	—	—
<i>Ptilota serrata</i>	T	T,S	T,S	T	C,T	T	O	O	S	S	T,S	T,S
<i>Rhodochorton purpureum</i>	O	T	O	O	O	O	O	O	O	O	O	O
<i>Rhodomela confervoides</i>	O	O	T,S	S	T	C,T	C,T	T	O	O	O	O
<i>Rhodophyllis dichotoma</i>	T	C	—	—	C	C	T	—	—	—	—	—
<i>Rhodophysema georgii</i>	—	T	O	O	O	—	O	—	O	O	T	—
<i>Rhodymenia palmata</i>	T	T	T	T	T	T	T	T	T	T	T	T
<i>Spermothamnion repens</i>	—	—	O	—	—	—	T	O	O	—	—	—
<i>Trailiella intricata</i>	—	—	—	—	—	—	O	—	—	—	—	—