

OBSERVATIONS OF THE SEASONAL CHANGES IN THE MARINE
ALGAE IN THE VICINITY OF HALIFAX, WITH
PARTICULAR REFERENCE TO
WINTER CONDITIONS.

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ABSTRACT.

Marine algae found in winter were studied at Halifax during the two seasons 1930-31 and 1931-32. In this study was included also an investigation of the succession of algal crops in the vicinity and especially at a lagoon outlet where it was possible to observe the sublittoral flora at all times. These winter studies were supplemented by the spring, summer, and autumn collecting of about seven years. No exclusively winter forms were found. The seasonal succession of crops in brief is as follows: a comparatively barren period in early autumn; dominance of an *Ilea-Scytosiphon*—*Dumontia*—*Polysiphonia* association until the middle of January; a *Monostroma*—*Spongomorpha*—*Bangia* association until the end of April; and from then on an association in which *Laminaria*, *Chorda*, *Polysiphonia*, etc., at first are dominant but are gradually replaced by *Chordaria* which becomes dominant by June. In late August and early September there is a general clearance of all annuals and a short return to the semi-barren period. Species found at Halifax are listed. For each species, the frequency, habitat, and season are given together with notes on other observations.

INTRODUCTION.

A survey of the marine algae of the Maritime Provinces has been conducted under the auspices of the Biological Board of Canada and the National Research Council of Canada. Up to the autumn of 1930, most of the work had been carried on in the summer. Apart from a few casual observations, no systematic study of winter forms had been made. Without a more definite knowledge of winter conditions, the completeness of a taxonomic list would have been very uncertain, and it was therefore necessary to make a more thorough examination of the winter flora. This was done at Halifax and forms the basis of the present report. The yearly succession of crops was observed in detail in the main outlet of the large lagoon near Thrumcap. Other places were less regularly examined to supply comparative information and these fur-

nished additional data concerning many species in Halifax Harbour. The appearance of the various algal seasons with their characteristic succession of crops as found in the outlet is given in outline, the information gained concerning the principal algae of the harbour is tabulated, and additional notes are given where necessary and possible.

A study of the sub-littoral algae is often difficult at any season and in winter even the littoral zone is not easy of access. In view of the obvious difficulties in winter collecting it is not surprising that up to the present few observations on marine algae have been made at this season. Professor B. M. Davis¹ has published an important detailed account of the marine algae of Woods Hole. In this he includes remarks on the seasonal distribution of each species but the content would imply that no exhaustive observations had been made in winter. In any event the Woods Hole region, though similar in many respects to Halifax Harbour, could not be regarded as an exact parallel. Dr. M. A. Howe² has published a short list of plants collected in Long Island Sound on February 7, and March 5, 1914. Mr. Roy M. Whelden³ in "The Maine Naturalist" treats of *Dumontia filiformis* growing in a pool from September to June. Apart from these there is very little information recorded concerning specific winter conditions on this coast. Other records contain casual references to winter conditions. Collins⁴ and Farlow⁵ each frequently give seasonal and ecological descriptions in their works. Hoyt⁶

¹Davis, B. M. A Biological Survey of the Waters of Woods Hole and Vicinity. Part I, Sec. II, Part II, Sec. IV. Bulletin of the Bureau of Fisheries Vol. XXXI. Washington, 1913.

²Howe, M. A. Some Midwinter Algae of Long Island Sound. Torreyia XIV. 6 June 1914.

³Whelden, Roy M. Observations on *Dumontia filiformis*. The Maine Naturalist. VIII. 4. 1923.

⁴Collins, F. S. The Green Algae of North America. Tufts College Studies. Vol. II, No. III. 1909.

⁵Farlow, W. G. The Marine Algae of New England and Adjacent Coast. Report of U. S. Fish Commission for 1879. 1881.

⁶Hoyt, W. D. Marine Algae of Beaufort, N. C. and Adjacent Regions, Bulletin of the Bureau of Fisheries XXXVI, Document No. 886. Washington, 1920.

Johnson and York,⁷ and Johnson and Skutch⁸ make certain winter references. But none of these works has completely described the winter conditions of the northwestern Atlantic.

There are a number of articles describing winter conditions in parts of the north and northeastern Atlantic. A comparison between the conditions described in these works and the winter conditions observed in Halifax makes a very interesting study. A few of the publications that suggested comparisons, should be mentioned. Kjellman⁹ in "The Algae of the Arctic Sea" records seasonal observations in the ecological discussion of the plants of that region. For the British Isles, A. D. Cotton¹⁰ has described the seasons in Claire Island from February to October, and Knight and Parke¹¹ have recently published a very full account of the Manx algae, including information for all seasons. These comprehensive articles proved most interesting in comparison with conditions here, both in points of similarity and in points of dissimilarity. Many of the latter are mentioned in the notes referring to the various species.

The sub-littoral vegetation of an exposed coast is always difficult of exploration, and winter collecting even in the shelter of such a harbour as Halifax (See Figure I) is in most places not only difficult but dangerous. The ice and slipperiness of the rocks, together with the wind and cold turbulent water, make careful collecting impossible for most parts of the harbour. Usually it is necessary to depend on material washed up on the shore. But when these regular winter observations were started at Halifax, it was found that continuous collecting of deep water forms could be carried on at the main outlet of

⁷Johnson, D. S. and York, H. H. *The Relation of Plants to Tide-Levels.* Carnegie Institution of Washington, Publication No. 206, 1915.

⁸Johnson, D. S. and Skutch, A. F. *Littoral Vegetation of the Headland of Mt. Desert Island, Maine.* Parts I, II & III. *Ecology* IX, 188-215; 307-338; 429-448. 1928.

⁹Kjellman, F. R. *The Algae of the Arctic Sea.* Stockholm, 1885.

¹⁰Cotton, A. D. *Claire Island Survey, Marine Algae, Part 15.* *Proceeding of the Royal Irish Academy* XXXI, 1912.

¹¹Knight, Margery and Parke, Mary W. *Manx Algae.* L. M. B. C. *Memoirs, No. XXX.* Liverpool. 1931.

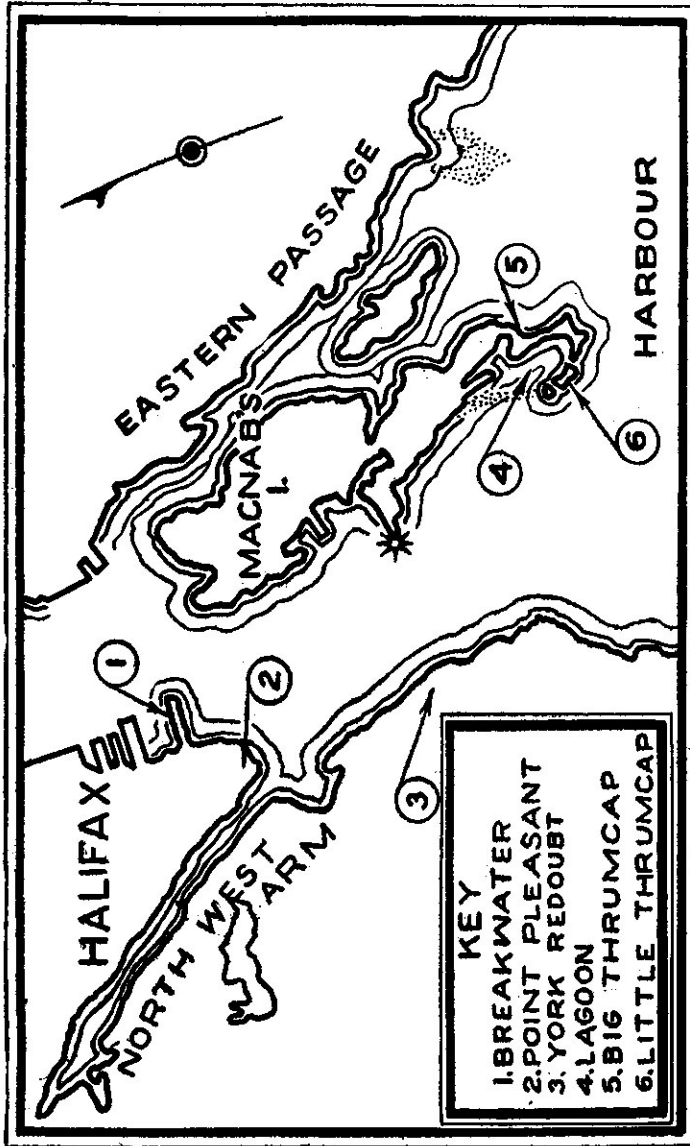


Fig. 1. Map of Halifax Harbour Indicating the Principal Collecting Stations.

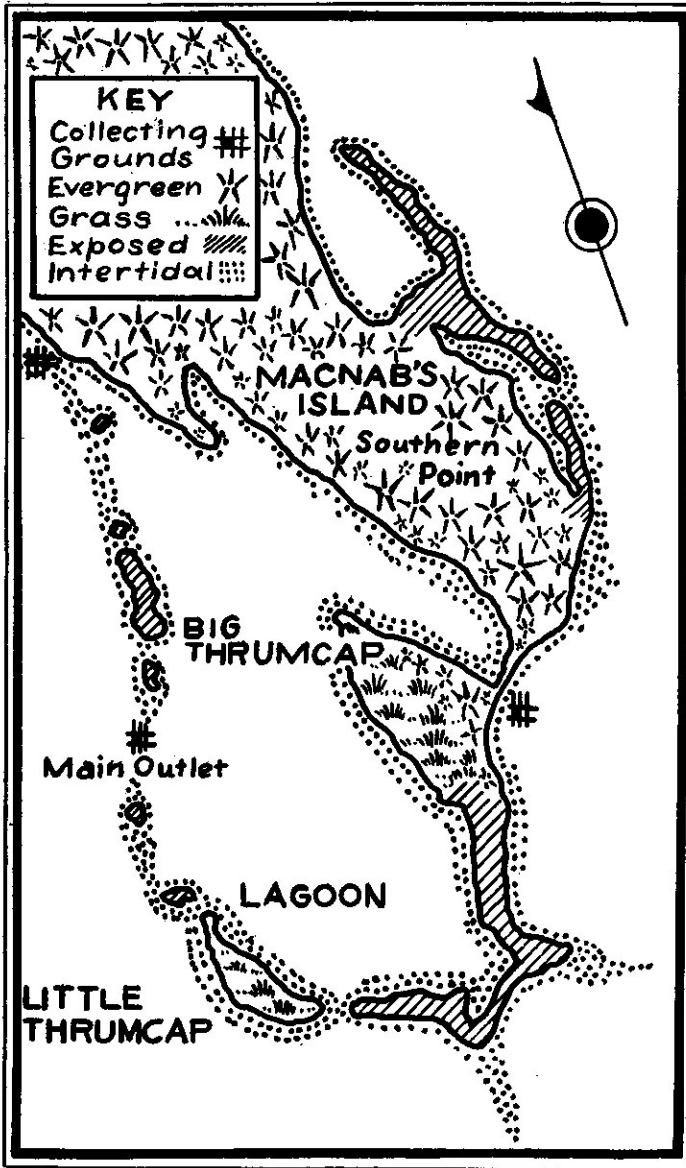


Fig. II. Map of Thrumcap Area.

the Thrumcap lagoon, (See Figure II) provided the collector was suitably equipped with waders and adequately protected against the cold. There are three of these exits, one of which becomes dry at low tide, one very nearly dry, but the third, the main outlet, is never completely dry even when the water is at its lowest. The depth at dead low tide varies from fifteen inches near the lagoon to ten inches in the shallower parts. The result is that semi-deep water conditions prevail. A current is always present, its direction depending on the ebb or flow of the tide and the relative level of the water in the lagoon. This current flows about 50 feet in 15 seconds. It exists throughout the entire length and breadth of the outlet which is about one hundred and fifty feet from the edge of the lagoon to the breakers at low water and about the same distance from side to side. The rocky bottom forms a good foothold for even the largest algae, and other conditions are evidently favourable, for, with the exception of forms to be obtained only by dredging or from the wash, practically all the deep water forms of the region occur here. The conditions that make continuous collecting possible are the lack of ice and the temporary freedom from surf during low tide. The water flows too rapidly for the formation of ice, assuring at all times a clear view of the bottom. For most of the day the outlet is covered by fairly deep water and a line of breakers. As the tide goes down the line of surf recedes sufficiently to allow the collector to wade out into the stream in perfect safety.

As compared with other situations the habitat of this outlet is typically marine and sub-littoral. The only important respects in which it differs from the sea are in the matter of light and temperature. The shallow unshaded water permits more light to reach the bottom than ever penetrates to the ocean floor, and as the water flows out from the lagoon it has a temperature slightly colder in winter and warmer in summer than the water at the mouth of the harbour. The place does not in any way resemble a tidepool. Stagnation never occurs, for the water is always moving; nor is the outlet subject to extremes of temperature, for water from the open

sea flows in and out twice each day keeping the conditions about the same as those of the ocean. From the standpoint of the algologist this main outlet of the lagoon is an ideal winter collecting ground for sub-littoral marine forms and during the course of this present work it has been of unusual interest.

Along with the lagoon outlet and on the same dates, three other places at Thrumcap were examined, namely the southern barrier beach, the tide pool north of the lagoon, and the lagoon itself.

The barrier beach runs across the southeast end of the lagoon, from Little Thrumcap to MacNab's Island. It separates the lagoon from the ocean and includes the shore on the south side of Big Thrumcap. It was already familiar, having been visited many times every summer during the progress of the survey. This barrier includes a small crescent-shaped beach in which is trapped the wash from the long Thrumcap reef and from the shoals off Devil's Island. Great numbers of deep water forms are cast up here especially after storms.

The tide pool north of the lagoon also received minute inspection. It is about eighty-five yards long and twenty-seven yards wide and is a shallow pool typical of the upper littoral zone. The bottom is of small stones, pebbles and sand. Shortly after the tide starts to fall it becomes a completely isolated body of shallow water. It has no currents and remains undisturbed and unchanged for about nine hours until the tide comes into its level again. Hence this pool provides conditions that contrast sharply with those found in the outlet.

The lagoon is one mile long by half a mile wide. Its greatest depth is fifteen feet, and the bottom is of mud and stones. It is well protected on all sides, being enclosed by MacNab's Island on the east and north, Big and Little Thrumcaps and the barrier reef on the south, and the barrier reef with its outlets on the west. The surface is always comparatively calm and during the summer its water becomes warmer than

that of the surrounding ocean. Although so well protected this lagoon cannot be looked upon as a big tidepool, for it is too deep and covers too large an area, and in addition the diurnal exchange of water between it and the ocean maintains a continuous and fairly rapid current at certain places. The presence of these currents is well demonstrated during the winter, for there are certain spots that never freeze even in the coldest weather. In this lagoon the turbulent water from an exposed part of the coast is taken in direct and given temporary shelter. In its flora the lagoon provides a very interesting combination of forms. It includes those that cannot live in bays but demand the unpolluted water fresh from the ocean itself as well as those that usually inhabit any sheltered body of water.

Between November 1930 and July 1932, twenty-one consecutive monthly visits were made to these collecting grounds in the Thrumcap area. Each visit included inspection of the outlet, beach, tidepool, and lagoon. In this manner four representative places were examined during two winters.

To obtain a comprehensive picture of the seasonal change for an area, it is necessary to make observations in all kinds of habitat. The other stations chosen for this investigation at Halifax include every type of shore from steep rugged rocks to sand or mud, and every type of exposure from the bleak shores of Devil's Island to the sheltered coves at the head of Bedford Basin. Visits were made to these places at all seasons though at less regular intervals than to Thrumcap. These stations showed certain differences from the cycle of growth seen at the lagoon outlet and gave much valuable comparative information. The more important of these collecting grounds are listed below.

POINTS VISITED AT ALL SEASONS.

1. *York Redoubt.*

This station is on the west side of the harbour opposite to Thrumcap. It is an exposed situation barely inside the harbour mouth. The coast here is rugged and the rocks steep. The

observations made at this point provided an excellent comparison for the deep water forms.

2. *Point Pleasant.*

This is a semi-exposed situation. The shore is of boulders. Extending out under the water is a long gently sloping shelf of rock and a long reef of rocks and mud. Many species of the *Laminaria* association form extensive beds on this reef, and at a very low tide it is possible to walk out among these plants.

3. *The breakwater of the ocean terminals.*

The breakwater is built of artificially placed blocks of stone laid down in the middle of the harbour. The sides are steep and rugged with many crevices. They provide much the same type of habitat as is found at York Redoubt, but in a semi-sheltered locality. In regard to exposure there is a wide range on the breakwater itself, for the south side is much more exposed than the north. The sides are so steep that on a clear calm day it is possible to stand on the lower rocks and observe the algal growth to its lower limits. A good foothold is provided by the blocks of rock, so that collecting can be done here during any kind of weather and at all seasons.

4. *Maugher's Beach.*

This is a barrier of rock and sand extending from the lighthouse to MacNab's Island. On the exposed south side it receives the wash from the reef known as Lighthouse Bank, and on the north side the wash from Horseshoe Shoal. The barrier provides two beaches suitable for collecting, each of which includes both sand and boulders.

COLLECTING POINTS NOT VISITED IN WINTER.

In addition to these four collecting stations which were examined both winter and summer there were other parts of the harbour where collections were made in all but the severest months of the winter. Chief among these were: the Northwest Arm, slightly warmer than the harbour in summer and possessing many wharves and other woodwork to which algae become attached; Bedford Basin, from which there are several

coves and inlets; Devil's Island, just outside the mouth of the harbour, an exposed bleak island with steep rocky cliffs washed by spray, and possessing a small artificial anchorage with woodwork; Barrie's Reef, a long spit of sand running out from the shore opposite Devil's Island; and the Hen and Chickens, a reef of large boulders outside the mouth of the Northwest Arm. Dredging was carried on in the Northwest Arm, in the harbour off Lighthouse Bank, Middleground Shoal, Point Pleasant Shoal, Bedford Basin, and other places.

METHODS OF EXAMINATION OF MATERIAL.

Due to the proximity of the collecting grounds to Dalhousie University, it was possible to bring the material collected to the botanical laboratories for examination on the same day. Many specimens were killed and fixed or otherwise preserved in the field. Some were later imbedded in paraffin and sectioned for detailed study. Still others were brought living to the laboratory and either mounted or examined microscopically for fruiting stages, etc. In this way it was possible to mount and examine fresh living specimens.

INFORMATION GATHERED AND CONCLUSIONS REACHED AS A RESULT OF THIS INVESTIGATION.

Species List.

The following is a list of the species found at Halifax. Those that were included in the marine flora at the main outlet of the lagoon are marked by an asterisk.

CHLOROPHYCEAE.

- Bryopsis plumosa*, Ag.
- **Chaetomorpha aerea*, (Dillw.) Kuetz., forma *Linum*, (Muell.) Collins.
- Chaetomorpha melagonium*, (Web. & Mohr.) Kuetz., forma *typica*, Kjellm.
- **Cladophora crystallina*, Kuetz.
- **Cladophora flexuosa*, (Griff.) Harv.
- Cladophora flexuosa*, (Griff.) Harv., forma *densa*, Collins.
- Cladophora gracilis*, (Griff.) Kuetz.
- Cladophora hirta*, Kuetz.
- Codiolum pusillum*, (Lyngb.) Kjellm.
- Enteromorpha compressa*, (L.) Grev.

- **Enteromorpha intestinalis*, (L.) Link, forma *clavata*, J. Ag.
- Enteromorpha intestinalis*, (L.) Link, forma *cylindracea*, J. Ag.
- **Enteromorpha Linza*, (L.) J. Ag.
- Enteromorpha minima*, Naeg., forma *glacialis*, Kjellm.
- Enteromorpha prolifera*, (Muell.) J. Ag.
- **Hormiscia penicilliiformis*, (Roth) Fries.
- **Monostroma fuscum*, (Post. & Rupr.) Wittr.
- **Rhizoclonium tortuosum*, Kuetz.
- Rhizoclonium tortuosum*, Kuetz., forma *polyrhizum*, Holden.
- **Spongormorpha arcta*, (Dillw.) Kuetz.

PHAEOPHYCEAE.

- Agarum Turneri*, Post. & Rupr.
- **Alaria esculenta*, (L.) Grev.
- Ascophyllum Mackaii*, (Turn.) Holmes & Batters.
- **Ascophyllum nodosum*, (L.) Le Jolis.
- Asperococcus echinatus*, (Mert.) Grev.
- Castagnea virescens*, (Carm.) Thuret.
- Castagnea Zosteræ*, (Mohr.) Thuret.
- **Chorda Filum*, (L.) Stackh.
- **Chordaria flagelliformis*, (Muell.) J. Ag.
- Desmarestia aculeata*, (L.) Lamour.
- **Desmarestia viridis*, (Muell.) Lamour.
- Desmotrichum undulatum*, (J. Ag.) Reinke.
- **Dictyosiphon foeniculaceus*, (Huds.) Grev.
- **Ectocarpus confervoides*, (Roth) Le Jolis.
- **Elachistea fucicola*, (Vell.) Fries.
- **Fucus evanescens*, Ag.
- Fucus platycarpus*, Thuret.
- **Fucus vesiculosus*, L.
- Fucus vesiculosus*, L., variety *sphaerocarpus*, Farlow.
- **Ilea fascia*, (Muell.) Fries.
- **Ilea zosterifolia*, (Reinke) S. & G.
- **Laminaria Agardhii*, Kjellm.
- **Laminaria digitata*, Lamour.
- Laminaria longicuris*, De la Pyl.
- Mesogloia divaricata*, (Ag.) Kuetz.
- Punctaria latifolia*, Grev.
- **Punctaria plantaginea*, (Roth) Grev.
- **Pylaiella littoralis*, (L.) Kjellm.
- **Ralfsia verrucosa*, Aresch.
- **Saccorhiza dermatodea*, (De la Pyl.) J. Ag.
- **Scytosiphon lomentarius*, (Lyngb.) J. Ag.

RHODOPHYCEAE.

- Ahnfeltia plicata*, (Huds.) Fries.
- Antithamnion cruciatum*, (Ag.) Naeg.
- Antithamnion floccosum*, (Muell.) Kleen.
- **Bangia fusco-purpurea*, (Dillw.) Lyngb.
- Callithamnion Baileyi*, Harv.
- Callithamnion corymbosum*, (Sm.) Lyngb.
- **Ceramium rubrum*, (Huds.) Ag.
- **Chondrus crispus*, (L.) Stackh.
- **Corallina officinalis*, L.

- Cystoclonium purpurascens*, (Huds.) Kuetz.
Delesseria alata, Lamour.
Delesseria sinuosa, (Good. & Woodw.) Lamour.
 • *Dumontia filiformis*, (Muell.) Grev.
Gigartina mamillosa, (Good. & Woodw.) J. Ag.
 • *Gloiosiphonia capillaris*, (Huds.) Carm.
Halosaccion ramentaceum, (L.) J. Ag.
 • *Hildenbrandtia rosea*, Kuetz.
 • *Lithothamnion* spp.
Melobesia LeJolisii, Rosan.
Nemalion multifidum, (W. & M.) J. Ag.
 • *Petrocelis cruenta*, J. Ag.
Polyides rotundus, (Gmel.) Grev.
 • *Polysiphonia fastigiata*, (Roth) Grev.
 • *Polysiphonia nigrescens*, (Dillw.) Grev.
Polysiphonia Olneyi, Harv.
 • *Polysiphonia urceolata*, (Lightf.) Grev.
 • *Polysiphonia violacea*, (Roth) Grev.
 • *Porphyra laciniata*, (Lightf.) Ag.
Phlota pectinata, (Gunn.) Kjellm.
Rhodochorton Rothii, (Turt.) Naeg.
 • *Rhodomela subsusca*, Ag.
 • *Rhodymenia palmata*, (L.) Grev.

Forms Peculiar to Winter Alone.

As regards the search for forms that occur in winter alone, no exclusively winter forms were found. Even those algae which have their most abundant crops in the winter months can be found at some time between May and October. If this feature, common to all the forms of marine algae in Halifax Harbour, is characteristic for other parts of the Maritime Provinces as well, it is unlikely that the difficulties of winter collecting caused any serious omissions from the list of algae for these provinces.

Succession of Algal Crops.

The sea is never wholly without active vegetation. The dormant period common to land plants is entirely lacking, and during the winter some of the marine algae are at the height of their season. From another standpoint, that of crop succession, marine and land flora are very similar, for in each environment the crop of one season is regularly replaced by that of the next. But even in this there is a difference. In the ocean the succession of crops goes on for twelve months of the year. There is a general sweeping away of large forms in the

autumn, but even while this is going on the perennials continue their growth, and other forms are beginning their development. There is no intervening period of inactivity so common to the land flora of this climate. In describing this circle of development perhaps the most logical starting point is the time when the growth of marine forms is at its lowest. At Halifax this is in the early autumn. The sequence of species is described as it occurs in the main outlet of the Thrumcap lagoon. Instances in which other places at Halifax differ from this sequence are cited elsewhere.

September and October Season.

September and October are the poorest months of the year for algal growth and mark the end of the summer "season". The annuals have been gradually washing in during the late summer and the remaining ones now submit to the wholesale destruction caused by the early autumn storms. Even the ever present perennials look old and worn. *Chondrus* is covered with shellfish and many species have grown so large during the comparatively calm months of the summer that, when the autumn storms come on, they are torn from the rocks. Certain forms are always left, including *Ascophyllum nodosum*, species of *Fucus*, *Enteromorpha*, *Polysiphonia*, a few scattered clumps of the nomadic *Ilea fasciata*, etc. Beds of *Chondrus crispus* cover a large part of the bottom and grow around the base of nearly every rock. But many of these algae are comparatively small whereas most of the conspicuous species become washed away about the end of August. The final stage in the disappearance of the plentiful summer growth takes place during a very few weeks with the result that the shore has a more barren appearance at this time than at any other season.

November to the Middle of January Season.

November sees the beginning of a new crop which consists chiefly of filamentous Reds. These establish themselves so vigorously and in so many places over the bottom that the

bright red tufts of these young Rhodophyceae make beautiful patches of colour in the otherwise almost barren area. Certain of these plants are destined to remain and continue growth for nearly twelve months. These are *Polysiphonia urceolata*, *P. violaceae*, *Rhodomela subfusca* and *Ceramium rubrum*. There are other Reds which start their growth at this time but which do not continue to flourish for such a long period. Such a plant is *Dumontia filiformis* which usually appears about the end of December or the first of January. Starting at the same time as these filamentous Reds are two Browns, *Ilea fascia* and *Scytosiphon lomentarius*. In among these forms, young plants of *Laminaria Agardhii* may be seen as early as the middle of November. All these forms of both Reds and Browns grow very rapidly during November, until by the middle of December the bottom and all the projecting rocks are covered with large plants of these species. By January certain of these plants show signs of age. The long and large *Scytosiphon* plants become reddish brown and many are washed away. The *Ilea* becomes white on the edges or dark brown all over. In either case it begins to disintegrate and break off. Some of the filamentous Reds become brown with diatom epiphytes. Even until the middle of January, however, the dominant forms are filamentous Reds and large beds of *Scytosiphon* and *Ilea*.

Middle of January to April Season.

During December and early in January, small plants of certain Greens can be observed. These are chiefly *Monostroma fuscum*, *Hormiscia penicilliiformis*, *Spongomorpha arcta*, and *Enteromorpha Linza*. By the middle of January they are conspicuous and by February they have grown to such an extent that the whole aspect of the flora changes suddenly to a bright green. The only exceptions to this green colour are extensive beds of *Dumontia* and the tops of certain larger rocks that have during the same period become covered with a dense growth of *Bangia fuscopurpurea*. But in spite of the *Bangia* and the *Dumontia* the whole growth has a green appearance.

The species that contributes the greatest surface of green is *Monostroma fuscum*. It grows epiphytically on *Chondrus crispus*, and is so plentiful that it is almost impossible to find a *Chondrus* plant uninfected. In among these green plants may be found two newcomers, small plants of *Alaria esculenta* and *Chorda Filum*. The latter appears first about the middle of March. *Laminaria Agardhii* continues to lengthen and assumes its typical frilled appearance. *Scytosiphon* to a considerable extent and *Ilea* to a less extent are still present though in a disintegrating condition. *Dumontia* becomes long and twisted and is a dark purple-red in colour. But the Greens are so numerous and extensive that their colour continues to dominate the region all through February and most of March. This green phase ends abruptly. By about the end of March, the *Monostroma* plants disintegrate and are completely washed away as a fine green scum. The *Enteromorpha Linza* turns white and breaks off. The *Hormiscia* disappears from the rocks where it was first found. The only Green that remains in any quantity is *Spongomorpha arcta* which becomes stringy and much less conspicuous. The *Bangia* dies, remaining on the tops of the rocks as a greyish brown covering of decaying filaments. The conspicuous growth of the green period is at an end.

April to the End of August Season.

As a result of the disintegration of the Greens, the general colour of the flora suddenly becomes brown. This colour is not due to the *Phaeophyceae* so abundant in early winter. The *Ilea* has almost disappeared. *Scytosiphon* is present but not conspicuous. The *Dumontia* is still plentiful but not conspicuous. The conspicuous plants are large, including *Chorda Filum*, *Laminaria Agardhii*, *Alaria esculenta*, and *Saccorhiza rjatodea*. Under cover of the growth of the previous months these plants have grown extensively and with the disappearance of the Greens they can be seen everywhere. *Polysiphonia* and *Rhodomela* are also much longer and most of them are also brown due to epiphytic diatoms. For a few weeks these

species have undisputed possession of the area, but on all the rocks there may be found small plants that at first look like a fine species of *Dictyosiphon*, but which on examination prove to be young plants of *Chordaria flagelliformis*. From then on, that is from about the first of May until the middle of July, *Chordaria* gradually becomes more and more prevalent providing an excellent example of one species replacing nearly all others. *Laminaria Agardhii* and *Alaria esculenta* become broken off in the current. The dark brown hairs on the *Chorda Filum* become bleached and finally whole plants are washed away. The *Scytosiphon* that remains becomes infected with *Dictyosiphon foeniculaceus*, and later both host and epiphyte are washed away. The *Dumontia* plants disintegrate and gradually disappear. The filamentous Reds remain, but are now very brown with diatoms. But the *Chordaria* continues to flourish and by the middle of July everything is covered with the long heavy dark plants. The end of this phase starts about the end of July with the ageing of the *Chordaria*. This species remains the dominant form all through August and up to the time when all the remaining annuals are swept away by the autumn storms. This brings the account of the cycle of growth back to the starting point.

The sequence of crops throughout the year in the lagoon is well illustrated by the following table:

September & October.		Barren season, perennials only.
November to middle of January.	early late	Development of filamentous Reds, <i>Dumontia</i> , <i>Ilea</i> , <i>Scytosiphon</i> and young <i>Laminarias</i> . <i>Ilea</i> mature. <i>Scytosiphon</i> large.
Middle of January to April.	early middle late	Start of Greens. Young <i>Alaria</i> . Predominance of Greens. Continued growth of <i>Laminarias</i> and <i>Dumontia</i> . Start of <i>Chorda</i> . Start of <i>Chordaria</i> . Disintegration of Greens.
April to end of August.	early	Predominance of <i>Chorda</i> , <i>Laminaria</i> , etc. and predominance of browned filamentous Reds.

	Increase of <i>Chordaria</i> .
	Decay of Browns other than <i>Chordaria</i> .
middle	Predominance of <i>Chordaria</i> . Decay of nearly all the annuals.
late	Washing away of nearly all the annuals.

The seasonal description outlined above follows the main course of succession in the lagoon outlet, but it is not entirely applicable to the whole region. By itself it would be misleading. Certain forms which almost disappear from the outlet during the summer are found growing in large quantities at some other level. Filamentous Reds which may grow old in the outlet as early as March are washed up in a healthy condition from deeper waters much later in the season. For a complete picture of the sequence of crops of marine algae around Halifax, the outlet has certain deficiencies. The deficiencies were made up by observations at other suitable collecting stations. The additional information gained by the observations at these other places is dealt with, in part, in the comparative description of these stations, and in part, in the notes regarding each species.

COMPARISON OF THE PRINCIPAL COLLECTING STATIONS.

Other Stations in the Thrumcap Area.

Each of the other three collecting places at Thrumcap differ from the outlet in several respects, all of which are due to the individual nature of the various habitats. The way in which each of the other three stations at Thrumcap supplemented the information obtained at the outlet will be stated briefly for each place.

THE BARRIER BEACH at the south end of the lagoon yields additional deep water forms which do not grow in the outlet. *Agarum Turneri* is cast up in great quantities. *Ahnfeltia plicata* and occasional rare Reds can often be collected. All the deep water forms on the beach are large in size and total number. Also the collections on the beach provide very valuable corroborative evidence. When young *Laminaria*, *Alaria*, *Saccorhiza*, *Polysiphonia*, *Rhodomela*, etc. were observed in the outlet, the species was very often absent from

the wash on the beach, but when the plants in the outlet grew larger, plants of a similar size appeared in the wash. This indicated that the outlet represents correctly the conditions that exist in the deeper water.

THE SHALLOW TIDEPOOL at the north end of the lagoon supplied information typical of the upper part of the littoral zone. The growth was more transient and the plants matured faster than in the outlet. Although *Ilea*, *Scytosiphon*, *Dumontia*, *Monostroma*, and other forms not requiring deep water are common to both places, the seasonal progress is quite different and many species are entirely lacking. *Ilea*, *Scytosiphon*, and *Dumontia* appear later and disappear earlier in the pool, practically filling its lower end before becoming well advanced in the outlet. Toward late spring everything disintegrates and is washed away leaving only a few soft and unhealthy specimens. This is typical for most of the higher portions of the littoral zone.

THE LAGOON is a fairly large body of water. It contains a much greater variety of forms and many of the plants are larger than those in the outlet. Frequently a species was scarce in the outlet and escaped observation, but when the lagoon was examined this species was found; on subsequent closer examination the outlet was observed to contain it also. In respect to certain forms the lagoon is intermediate in growth between the pool and the outlet. In addition it has many forms not found in either of the other two places. *Bryopsis plumosa*, *Castagnea Zosteræ*, *Mesogloia divaricata*, and other species are very abundant here but never in the outlet or pool. *Melobesia LeJolisii* occurs in both lagoon and pool but never in the outlet for no *Zostera* is found there. Large plants of *Desmarestia viridis* grow abundantly in the lagoon, but only once has it been found in the outlet. Other instances could be cited but these are sufficient to indicate the way in which examination of the more extensive growth of the lagoon checked and supplemented the observations made at the outlet.

Stations Outside the Thrumcap Area.

The more important ways in which the succession of marine algal crops in other parts of the harbour vary from that of the outlet are as follows. In general the autumn débâcle was later at York Redoubt on the west side of the harbour than on the east side at Thrumcap. This may be associated with the fact that the prevailing winds at this time of year are from the northwest. The west side of the harbour is sheltered from these by high cliffs. As autumn approaches most annuals become bleached, but on the western side of the harbour, the annuals, both Browns and filamentous Reds, retain their colour for a longer period. This again may be associated with the shade provided by the cliffs. In the North West Arm and at the head of Bedford Basin, the season for many Browns and Reds comes to an end early in the summer. Most of the species of the Phaeophyceae and the Rhodophyceae become infected with *Ectocarpus* early in July, and in turn the *Ectocarpus* becomes infected with diatoms. The season for the Greens in these two places is exactly the reverse of that in the lagoon outlet. Species of *Enteromorpha*, *Cladophora*, *Chaetomorpha*, and *Phizoclonium* abound in both the North West Arm and at the head of Bedford Basin during July and August. In both places the woodwork becomes covered with various species of *Enteromorpha*. *Ectocarpus* and *Porphyra* usually accompany these Greens, but as already stated the *Ectocarpus* becomes infected with diatoms about August. The same quiet waters provide certain species that are rarely found elsewhere, such as *Laminaria longicruris* and also certain ecological freaks like inflated cylindrical bleached plants of *Dumontia filiformis*. There are shallow bays off Bedford Basin, of which Wright's Cove is the best example. These have a considerable tidal current that may become quite warm. The growth in these places is very rich. It matures early and is largely washed away by the middle of August. On the Breakwater and at places like Devil's Island and York Redoubt, luxuriant growths of *Laminaria*, especially

L. Agardhii, may be found at all seasons of the year. During the fortunate combination of a calm sea and a very low tide it was possible to examine the surf beaten bed of *Polysiphonia violaceae* on the Hen and Chickens Shoal. This was in August, and the plants were growing luxuriantly and in a healthy condition. At Devil's Island plants of *Chondrus crispus* could be seen forming extensive beds over surf beaten rocks, showing that the species is really plentiful on this coast, but on account of the exposed localities in which it grows it is not always observed even in places where it is abundant. To use the succession of crops at the main outlet as a guide and to compare the other places with it, as has been done here, is the best way to arrive at a picture of the normal or average succession for the region.

TABULATED ACCOUNT OF SPECIES COLLECTED IN THE HARBOUR
DURING THE SURVEY.

CHLOROPHYCEAE.

Bryopsis plumosa

Frequency: rare.

Collected in Thrumcap lagoon only.

Habitat: on stones in shallow water.

Season: July and August.

**Chaetomorpha aerea*, forma *Linum*

Frequency: common.

Collected in lagoon outlet, Lagoon, North West Arm,
and Wright's Cove.

Habitat: floating in warm shallow water.

Season: summer.

Chaetomorpha melagonium, forma *typica*

Frequency: common.

Collected in Wright's Cove.

Habitat: sub littoral.

Season: summer.

Note: unattached masses floating near sandy bottom of cove among vascular plants. Frequently infested with epiphytes such as many small shellfish.

*Algae observed in lagoon outlet.

Cladophora

Species of this genus are said by Collins to be in part annual—most of them perennial, dying down to the base and growing again the following year. Seasons given here are of actual collections.

**Cladophora crystallina*

Frequency: occasional.

Collected in Thrumcap lagoon and outlet.

Habitat: attached to stones and *Fucus* about mid-tide and below.

Season: summer.

**Cladophora flexuosa*

Frequency: common.

Collected in Wright's Cove, Lagoon, North West Arm, etc.

Habitat: near low water.

Season: summer.

Cladophora flexuosa, forma densa.

Frequency: occasional.

Collected in Wright's Cove.

Habitat: usually near low tide mark and in deep pools.

Season: summer.

Cladophora gracilis

Frequency: common.

Collected in pools inside wooden breakwater at Maugher's Beach Light.

Habitat: from mid to low tide.

Season: summer and early autumn.

Note: often found in mats lying on sand at low tide.

Cladophora hirta

Frequency: occasional.

Collected at Point Pleasant.

Habitat: semi-exposed situations.

Season: summer.

Codiolum pusillum

Frequency: occasional.

Collected on the breakwater.

Habitat: on rocks below high tide level.

Season: spring.

Note: forms a mossy coating on rocks at end of breakwater. Undoubtedly in other similar situations.

Enteromorpha

Enteromorphas are found throughout the year but their largest crop is in Spring and summer. Along with *Monostroma* and *Hormiscia*, *Enteromorpha Linza* they form a constituent of the green season.

Enteromorpha compressa

Frequency: abundant.

Collected in North West Arm.

Habitat: woodwork.

Season: all seasons, most abundant in summer.

**Enteromorpha intestinalis forma clavata*

Frequency: abundant.

Collected in North West Arm, lagoon outlet, etc.

Habitat: woodwork and stones.

Season: summer.

Enteromorpha intestinalis forma cylindracea

Frequency: common.

Collected in Wright's Cove, Thrumcap lagoon, North West Arm.

Habitat: usually unattached.

Season: summer.

Note: *Enteromorpha intestinalis* usually occurs in quiet parts of the harbour.

**Enteromorpha Linza*

Frequency: abundant.

Collected in North West Arm, breakwater, lagoon outlet, etc.

Habitat: on stones, woodwork, etc.

Season: spring and summer and other seasons.

Note: of all the algae at Halifax this species is the most widely distributed. It is found at all seasons and in a wide variety of habitat.

Enteromorpha minima, forma glacialis

Frequency: common.

Collected at the breakwater, in the North West Arm, etc.

Habitat: on stones, woodwork, ironwork, etc. in upper littoral zone.

Season: all seasons, most abundant in summer.

Note: forms extensive green felt-like covering over sloping surfaces, completely covered only at high tide. At other times may be washed with spray.

Enteromorpha prolifera

Frequency: common.

Collected in North West Arm and Bedford Basin.

Habitat: in sheltered places, near low water mark.

Season: summer.

* *Hormiscia penicilliformis*

Frequency: common.

Collected at Point Pleasant, Thrumcap, York Redoubt, etc.

Habitat: chiefly on boulders between tide marks.

Season: winter and early spring becoming confined to limited areas in summer.

Note: Found on rocks in exposed situations, preferring smooth rounded boulders to more rugged rocks. Abundant from January to April. Occurs suddenly in winter at and slightly above the high water line along with *Bangia* and a small amount of the narrow *Porphyra*. With the advance of spring the growth proceeds down the shore leaving the upper rocks bare. Towards summer it becomes less abundant and by midsummer confines itself to small bay-like indentations in the boulder beaches, where it can be found in small quantities near low water.

* *Monostroma fuscum*

Frequency: abundant.

Collected throughout the harbour.

Habitat: on stones and woodwork, and epiphytic on *Chondrus*, etc. in outlet and at Point Pleasant.

Season: late winter and early spring. Small quantities at other seasons.

Note: Deep green glossy plants. Chief constituent of green season.

**Rhizoclonium tortuosum*

Frequency: fairly common.

Collected in Thrumcap lagoon, tidepools at Point Pleasant and Wright's Cove.

Habitat: in sheltered places.

Season: spring, summer, and other seasons.

Note: It is noticeable by its dark green colour and habit of growing in twisted skeins or masses. Often found entangled in the cleft fronds of *Chondrus crispus* and the byssus threads of mussels, etc. Not of such general occurrence or abundance as most of the other greens.

**Spongomorpha arcta*

Frequency: abundant.

Collected in lagoon outlet, on breakwater, North West Arm and other stations.

Habitat: on rocks, woodwork and other algae from mid-littoral zone to low water and below.

Season: all seasons—most abundant in Spring.

Note: This form is found in varying quantities throughout the year. Plants are noticeably increased in size and numbers in February. Fruiting begins about March. In April the plants are very abundant.

PHAEOPHYCEAE.

Agarum Turneri

Frequency: abundant.

Collected in wash on Devil's Island, Thrumcap barrier beach, etc.

Habitat: in deep water.

Season: all seasons—washed up most abundantly in autumn and winter.

Note: At no point in Halifax Harbour has this form been observed attached as it so frequently is seen in the Bay

of Fundy. Large amounts are washed in at Thrumcap, the winter wash often consisting entirely of great numbers of these plants.

**Alaria esculenta*

Frequency: abundant.

Collected at Devil's Island, York Redoubt, Point Pleasant lagoon outlet, and barrier beaches, etc.

Habitat: in exposed situations on rocks and woodwork at and below low water mark.

Season: all seasons.

Note: The special reproductive branches occur on all but very young plants, but fruiting occurs chiefly from June to September. Plants on the wooden breakwater at Devil's Island are very large. At York Redoubt they occur in great abundance but the upper plants of the association are very small. In the outlet the plant is an annual. On the beach young plants appear in the spring, older plants during the summer, very old plants in the autumn, and practically none during the early winter. This would suggest that the plants on the Thrumcap reef are also annuals. At York Redoubt the smaller plants are found throughout the year. The conclusion reached for *Laminaria Agardhii* apply also to this species.

Ascophyllum Mackaii

Frequency: common.

Collected in Wright's Cove, North West Arm, and Thrumcap lagoon.

Habitat: on stones at high water in warm sheltered waters.

Season: all seasons, perennial.

**Ascophyllum nodosum*

Frequency: abundant.

Collected throughout the harbour.

Habitat: on rocks and stones throughout the littoral zone.

Seasons: all seasons, perennial.

Note: Fruits chiefly in May. Unusually large plants in Wright's Cove.

Asperococcus echinatus

Frequency: common on Devil's Island.

Collected at Devil's Island.

Habitat: on rocks in lower littoral zone, and an atypical form on rocks near high water exposed to spray at low tide.

Season: spring and summer.

Note: No winter collections were made at Devil's Island.

Castagnea virescens

Frequency: not common.

Collected in Wright's Cove.

Habitat: in pools and sheltered situations.

Season: summer.

Castagnea Zosteræ

Frequency: locally abundant.

Collected in lagoon.

Habitat: on *Zostera*.

Season: summer.

Note: Unusually large quantities on eel grass in lagoon at end of June 1931. Completely disappeared by end of July. In 1932 this species was entirely absent. The *Zostera* was late in appearing this year.

**Chorda Filum*

Frequency: abundant.

Collected in all parts of the harbour.

Habitat: on rocks and stones at and below low water.

Season: March to August, disappearing completely in early autumn.

Note: This species is listed by Knight and Parke as a pseudo-perennial on the Isle of Man. In Halifax it is annual in occurrence. Decaying specimens can be found as late as October in undisturbed situations such as at the head of the North West Arm but these are merely dead plants that have not yet been washed away.

**Chordaria flagelliformis*

Frequency: abundant.

Collected at all places in the harbour.

Habitat: Rocks, stones and woodwork at low water mark and below Higher levels in tide pools.

Season: summer.

Note: This species is the chief element of the "brown season". In late summer it frequently becomes infected with *Dictyosiphon foeniculaceus*. On the Isle of Man it occurs from the beginning of July to the end of November. In Halifax it appears first in March and by the end of August its season is definitely over. Some plants may persist even as late as December but most of it disappears during the autumn storms.

Desmarestia aculeata

Frequency: occasional.

Collected in wash on barrier beach.

Habitat: in deep water.

Note: Found washed up chiefly in summer.

**Desmarestia viridis*

Frequency: abundant.

Collected in Lagoon, lagoon outlet, North West Arm, and in wash on beaches.

Habitat: sublittoral on stones.

Note: Large plants seen growing in Lagoon and at mouth of North West Arm. One plant only in lagoon outlet. Washed in from reefs in large amounts to Thrumcap, Point Pleasant, and other beaches.

Desmotrichum undulatum

Frequency: occasional.

Collected at Thrumcap lagoon, Maugher's beach, and mouth of North West Arm.

Habitat: attached to *Chorda* and other algae and to *Zostera marina*.

Season: summer.

**Dictyosiphon foeniculaceus*

Frequency: very common.

Collected in all parts of Halifax Harbour.

Habitat: on rocks, small stones and other algae throughout the littoral zone.

Season: summer.

Note: Found in a variety of situations—rocky to muddy, often in pools. Usually epiphytic on *Scytosiphon* and *Chordaria*, particularly when the latter are beginning to age.

**Ectocarpus confervoides*

Frequency: abundant.

Collected in all parts of the area.

Habitat: rocks, woodwork, and other algae in lower littoral zone.

Season: spring and summer. Occasionally at other seasons.

Note: Often found with *Pylaiella*. Becomes covered with diatoms in summer. Other species are undoubtedly present in this area.

**Elachistea fucicola*

Frequency: common.

Collected at all points in the harbour.

Habitat: on *Ascophyllum* and *Fucus*.

Season: all seasons—most abundant in summer.

**Fucus evanescens*

Frequency: abundant.

Collected at Point Pleasant, York Redoubt, breakwater, lagoon outlet, North West Arm, Bedford Basin, etc.

Habitat: on rocks about mid-tide level.

Season: perennial.

Note: Grows at a slightly lower level than *Fucus vesiculosus* and is therefore more abundant in the lagoon outlet. Fruiting is most abundant in winter and very early spring.

Fucus platycarpus

Frequency: abundant.

Collected at all points in the area.

Habitat: on rocks in upper littoral zone.

Season: perennial.

Note: Found at a slightly higher level than *Fucus evanescens* and *Fucus vesiculosus*, but intertidal zone in this region is so narrow that overlapping occurs everywhere. Fruiting is most general from spring to autumn.

**Fucus vesiculosus*

Frequency: abundant.

Collected throughout the harbour.

Habitat: On rocks and stones between high and mid tide.

Season: perennial.

Note: In the lagoon outlet this species is less frequent than *Fucus evanescens* which grows at a slightly lower level.

Fruits at all seasons, most copiously in spring.

Fucus vesiculosus, variety *sphaerocarpus*

Frequency: occasional.

Collected throughout the area.

Habitat; same as type.

Season: perennial.

**Ilea fasciata*

Frequency: abundant.

Collected throughout the area.

Habitat: on rocks, stones and woodwork throughout the littoral zone and below.

Season: at all seasons, most easily collected in autumn and winter.

Note: A nomadic species, in great quantities in autumn at the level of dead low tide and slightly below, advancing up the shore during the late fall and winter, to recede again in spring. Remaining in summer in the littoral zone only in isolated patches but abundant near low water mark in certain exposed localities, where it is associated with *Enteromorpha Linza*.

**Ilea zosterifolia*

Frequency: occasional.

Collected in lagoon outlet, North West Arm, York Redoubt and elsewhere.

Habitat: on rocks, stones, and woodwork in littoral zone.

Season: all seasons.

**Laminaria Agardhii.*

Frequency: abundant.

Collected in all exposed and semi-exposed situations.

Habitat: on rocks below low tide mark.

Season: at all seasons.

Note: These plants can be seen at all seasons growing in deep water and on places like the breakwater, but in the lagoon outlet they have, in common with other kelps, a very definite season. In the outlet they are gradually washed away during the summer and in the early fall any remaining ones are torn off. In November new plants appear in the outlet while at the same time there is a large wash of old fruiting plants on the beach. During the winter the young ones in the outlet increase in number and size, and assume their undulated margin. In the deeper water of the exposed reefs, the new plants grow larger during the winter. This is evinced by the great number of young plants that appear in the wash by February. After the appearance of these young plants very few old ones are found in the wash. On the breakwater both old and young plants can be observed throughout the whole winter. Here to a greater extent than on the beach young and old growth are always intermixed. But there are never any very large or very old plants on the breakwater.

These observations have most striking inferences in regard to the life cycle of *Laminaria Agardhii*. In the outlet it is an annual that starts growing in November and persists for about nine months. The evidence from the beach would suggest the same cycle with a longer period of growth. The growth on the breakwater is found at all seasons but does not appear to include perennial plants. All this evidence would strongly suggest that *Laminaria Agardhii* so long considered a perennial is either but a pseudo-perennial which fruits extensively in the fall or an annual which may last almost the full twelve months.

**Laminaria digitata*

Frequency: abundant.

Collected on all exposed situations.

Habitat: on rocks below low tide.

Seasons: all seasons.

Note: On Devil's Island plants of this species are much larger than elsewhere in the harbour. In the lagoon outlet they are relatively small and less frequent than *Laminaria Agardhii*. Their time of occurrence in the outlet corresponds closely to that of *Laminaria Agardhii*.

Laminaria longicuris

Frequency: occasional.

Collected in Northwest Arm and on Thrumcap barrier beach.

Habitat: on rocks and stones in deep, quiet water.

Season: all seasons.

Note: Dredged in the North West Arm where it is fairly common. Washed up occasionally at Thrumcap and elsewhere. On the breakwater it is possible to observe plants of all graduations in shape and size between *Laminaria Agardhii* and *Laminaria longicuris*.

**Mesogloia divaricata*

Frequency: occasional.

Collected in the lagoon and in wash on sheltered side of Maugher's Beach.

Habitat: on stones near low water mark.

Season: summer.

Punctaria latifolia

Frequency: occasional.

Collected in the lagoon and in wash on sheltered side of Maugher's Beach.

Habitat: on stones near low water mark.

Season: summer.

Note: In lagoon occurs on slope near the edge and is not quite exposed at low tide. Grows also on ledges of reefs from where it is washed to sheltered (north) side of Maugher's beach. *Isactis* and *Rivularia* frequently found on it

giving plants a spotted appearance. Occasionally washed up in large quantities.

**Punctaria plantaginea*

Frequency: occasional.

Collected in lagoon, lagoon outlet, and on exposed side of Maugher's Beach.

Habitat: on stones below low water.

Season: spring and summer.

Note: Occasionally washed up in large quantities on the South (exposed) side of Maugher's Beach. It is usually old plants that are washed up and these are laden with *Isactis* and *Rivularia* covering the surface, and with *Polysiphonia*, *Ectocarpus*, etc. at the ends.

**Pylaiella littoralis*

Frequency: abundant.

Collected throughout the area.

Habitat: on stones, woodwork and other algae in littoral zone.

Season: all seasons.

Note: Most abundant in spring and summer, becoming laden with diatoms in latter part of summer and largely washed away in autumn. Particularly luxuriant in the North West Arm on woodwork.

**Ralfsia verrucosa*

Frequency: common.

Collected at Devil's Island, York Redoubt, Point Pleasant.

Habitat: on rocks, stones and shells in pools and near high tide.

Season: perennial.

Note: Extensive growth on sloping rocks at Devil's Island near high water line and above. In outlet is very scarce. All rocks in outlet are well covered with water at high tide.

**Saccorhiza dermatodea*

Frequency: abundant.

Collected in all exposed and semi-exposed places.

Habitat: on rocks below low water.

Season: at all seasons.

Note: In outlet has about the same cycle of growth as *Laminaria Agardhii*. In summer becomes very tough and laden with epiphytes. Fruiting most abundant in autumn and winter.

**Scytosiphon lomentarius*

Frequency: abundant.

Collected throughout the area.

Habitat: on rocks and stones throughout the littoral zone and below.

Season: all seasons, chiefly autumn and winter.

Note: Is most abundant in the lagoon outlet and at Point Pleasant in autumn and winter. It occurs along with *Ilea* and to a large extent follows the progress of that species. But its migration is not so clearly defined, for small amounts can be found at all levels at all times. Aging plants bear large amounts of *Dictyosiphon* and other epiphytes.

RHODOPHYCEAE.

Ahnfeltia plicata

Frequency: common.

Collected on Thrumcap barrier beach and similar beaches.

Habitat: in deep water.

Season: perennial, washed up chiefly in summer and autumn.

Note: Collections are usually made from material cast up on the shore or dredged. At Point Pleasant it is possible to observe and make collections of attached living plants growing among the *Laminarias*, the large beds of which are exposed at extremely low tides.

Antithamnion cruciatum

Frequency: rare.

Collected in wash and dredged off Point Pleasant reef.

Habitat: in deep water. When found here it was usually attached to *Ptilota pectinata*.

Season: summer.

Antithamnion floccosum

Frequency: locally common.

Collected on Hen and Chickens reef and at York Redoubt.

Habitat: on rocks and mussels below low water mark.

Season: summer.

Note: This form usually grows among or beneath other filamentous red algae. When the habitat is once located, the plants are very noticeable because of their deep blood-red colour.

**Bangia fusco-purpurea*

Frequency: common.

Collected at boulder beaches at Point Pleasant and Thrumcap, and on exposed rocks in outlet and break-water.

Habitat: on rocks and woodwork. Especially on exposed sides of intertidal rocks and just above high water.

Season: winter and early spring.

Note: Davis lists this as a spring and summer form for Woods Hole but in Halifax it is chiefly important in winter and spring. It is found only rarely in summer and during that season is never found on any surface that becomes dry when the water recedes. In winter and spring usually accompanying *Hormiscia*.

Callithamnion Baileyi

Frequency: rare.

Collected at York Redoubt.

Habitat: rocks below low water mark.

Season: summer and early autumn.

Note: Found mixed with *Callithamnion corymbosum* and *Polysiphonia Olneyi*.

Callithamnion corymbosum

Frequency: rare.

Collected at York Redoubt and breakwater.

Habitat: rocks below low water mark.

Season: summer and early autumn.

Note: See *Callithamnion Baileyi*.

**Ceramium rubrum*

Frequency: common.

Collected in all parts of the harbour.

Habitat: on stones and other algae from mid tide to deep water.

Season: at all seasons.

Note: Found fruiting at all seasons—most copiously in summer. Washed up in largest quantities in July and August. In the lagoon outlet its "season" of vigorous growth is over earlier than this. The basal parts in the outlet are perennial.

**Chondrus crispus*

Frequency: common.

Collected in lagoon outlet, lagoon, Point Pleasant, Wright's Cove, Devil's Island, York Redoubt, etc.

Habitat: mid tide to low water mark and below.

Season: perennial.

Note: Found generally throughout the harbour, most abundant on Devil's Island, in the lagoon outlet, and at Point Pleasant. Shape varies from wiry and bushy to broad and flat. Colour varies from deep fluorescent purplish red to a light green. Dark red and light green plants may grow side by side. Fluorescent ones are usually found in the shade. Large amounts of fruiting plants are washed up on the barrier beaches in late summer. Fruiting plants are also found in the lagoon outlet in winter, and in the spring the *Chondrus* here forms a substratum for the large crop of *Monostroma*. Nowhere in Halifax Harbour does *Chondrus* occur in the large thin broadly laminated form so typical of the tide pools in the Bay of Fundy. Nor is it found in such abundance or so free from epiphytic shellfish as on the coast of Prince Edward Island.

**Corallina officinalis*

Frequency: common.

Collected generally throughout the harbour.

Habitat: on rocks from mid-tide downwards.

Season: at all seasons (perennial).

Note: Common in deep pools and at low water mark and below.

Cystoclonium purpurascens

Frequency: common.

Collected in wash at Thrumcap and Maugher's Beaches.

Habitat: in deep water.

Note: Commonly found here only during summer when it is cast upon the beaches. Cystocarpic material frequent

Delesseria alata

Frequency: rare.

Collected off Lighthouse Bank.

Habitat: in deep water.

Note: Dredged off Lighthouse Bank in August. One specimen only. Attached to *Ptilota pectinata*.

Delesseria sinuosa

Frequency: occasional.

Collected in wash and by dredging.

Habitat: deep water.

Season: perennial.

Note: Washed up most frequently in summer, occasionally at other times of the year. Frequently attached to holdfasts of *Laminaria*. Cystocarpic material observed occasionally in summer.

**Dumontia filiformis*

Frequency: common.

Collected in lagoon outlet, lagoon, and tide pools at Thrumcap and Point Pleasant.

Habitat: on stones near low water and below.

Season: December to June, scarce in summer.

Note: Knight and Parke list this species as a spring and early summer form for the Isle of Man. In Halifax it is a winter-spring form and corresponds more closely in seasonal distribution to that of the Maine tide pools as described by Roy M. Whelden. Cotton also reports it for Claire Island, Ireland; as occurring in rock pools at all times "except summer". A peculiar form is found in

the still waters of the North West Arm on rocks below the low tide level. The plants are hollow, cylindrical and of a peculiar pale colour, only the fruiting spots showing the characteristic red colour. A few plants may persist later but in general the season for *Dumontia* is over in June, to be resumed again in December.

Gigartina mamillosa

Frequency: not common.

Collected in exposed situations only.

Habitat: in crevices of rocks.

Season: at all seasons (perennial).

Note: This species is less common for Halifax Harbour than for most places on the Atlantic Coast. Nowhere on this coast is it so abundant as in the Bay of Fundy.

**Gloiosiphonia capillaris*

Frequency: rare, spasmodic.

Collected in lagoon outlet only.

Habitat: on stones along with *Polysiphonia* and *Ceramium*.

Season: summer, disappearing in August.

Note: The lagoon outlet was the only place where this form was observed during the whole of the Maritime Provinces survey. In 1931 fruiting plants were very plentiful in the outlet, but in 1932 the form was surprisingly scarce. An even more spasmodic occurrence is reported by Cotton for Claire Island, Ireland. He found the plant in several spots in 1909 but none at all in 1910.

Halosaccion ramentaceum

Frequency: abundant.

Collected at York Redoubt, Devil's Island, and breakwater.

Habitat: Upper margin of the sub-littoral belt.

Season: perennial, often reduced to basal parts in autumn.

Note: Not found in lagoon outlet though often cast up on Thrumcap beach. Most abundant at York Redoubt, Devil's Island, and breakwater. Beginning of growing season is in fall, being somewhat earlier in exposed than in sheltered places. In winter and early spring the growth

is so extensive that by itself it may form an association covering rocks just above the *Laminaria* zone. In exposed situations the plants are usually wiry and much branched. In the comparative shelter of the breakwater many of the plants lose their wiry appearance, the main axis and branches growing in length and becoming broad and inflated. In this condition the plants are soft and easily washed away. The inflated plants are more common at the breakwater than elsewhere and it is possibly due to this character that the plants in autumn are scarcer here than at York Reboub. Tetrasporic plants have been collected as early as January.

* *Hildenbrandtia rosea*

Frequency: occasional.

Collected in Bedford Basin, Point Pleasant, and other parts of the harbour.

Habitat: often with *Petrocelis cruenta* covering otherwise bare stones in the littoral zone.

Season: all seasons (perennial).

Note: Frequent in pools.

* *Lithothamnion spp.*

Frequency: common.

Collected in all parts of the harbour.

Habitat: on stones and shells throughout the littoral zone.

Season: all seasons (perennial).

Note: The quantity here is very small as compared with such points as Whitehead and other places on this coast.

Melobesia LeJolisii

Frequency: abundant.

Collected in the lagoon, Thrumcap tidepool, Eastern Passage, Wright's Cove, etc.

Habitat: on *Zostera marina*.

Season: summer.

Note: Abundant in 1930 and 1931. In 1932 none was found up to the beginning of August. This deficiency was inevitable owing to the late development of the *Zostera* in this season. Reported by Howe from Long Island in

winter. The winter condition here has not been determined owing to the freezing of the lagoon and the bays where eelgrass was known to exist. In the tidepool the *Zostera* had largely died down by winter, the *Melobesia* being washed away with it.

Nemalion multifidum

Frequency: occasional.

Collected on breakwater, in outlet, Thrumcap barrier beach, etc.

Habitat: rocks exposed at low tide.

Season: various seasons. Sporadic.

Note: Knight and Parke list this form for the Isle of Man as a "summer annual" in pools. Cotton also describes it as a purely summer growth in Claire Island. Davis for Woods Hole found it growing in "summer and possibly at other seasons". In Halifax Harbour it is usually found without other algae in somewhat exposed situations, often on the sloping surfaces of rocks washed by the surf. It has been found in November and January as well as in the warmer months.

**Petrocelis cruenta*

Frequency: occasional.

Collected in Bedford Basin, Point Pleasant, and other places in the area.

Habitat: on stones in littoral zone.

Season: perennial.

Note: Found with *Hildenbrandtia rosea* on otherwise bare stones.

Polyides rotundus

Frequency: occasional.

Collected in wash at Barrie's Beach.

Habitat: deep water.

Note: During the late summer and early autumn this form is occasionally washed ashore in large quantities, but as a rule it is entirely absent from the wash.

**Polysiphonia fastigiata*

Frequency: common.

Collected generally throughout the harbour.

Habitat: on *Ascophyllum nodosum*.

Season: all seasons (perennial).

**Polysiphonia nigrescens*

Frequency: common.

Collected at lagoon outlet, Point Pleasant, Hen and Chickens, York Redoubt, and other places.

Habitat: on rocks and stones in lower littoral zone and below.

Season: all seasons.

Note: Listed by Davis as a spring and summer form for Woods Hole. Knight and Parke class it as a "perennial or pseudo-perennial". Farlow and Howe also regard it as perennial. In the lagoon outlet it can be observed during the whole year.

Polysiphonia Olneyi

Frequency: occasional.

Collected at York Redoubt and breakwater.

Habitat: rocks below low water.

Season: summer.

Note: Has been found only occasionally in late summer along with *Callithamnion Baileyi* and *Callithamnion corymbosum*.

**Polysiphonia urceolata*

Frequency: common.

Collected in all but extremely sheltered situations.

Habitat: rocks, stones, and woodwork, in lower littoral zone.

Season: all seasons.

Note: Reported for Woods Hole by Davis as common in spring "passing out of season in early summer". Knight and Parke list it as a pseudo-perennial. Howe records a sterile plant of *Polysiphonia urceolata formosa* as having been cast up on Long Island Sound in February 1914. In the North West Arm it has a bright red colour in spring but becomes brown with diatoms in summer. In the

lagoon outlet it can be observed at all seasons, being very noticeable in late fall and winter.

**Polysiphonia violacea*

Frequency: common.

Collected in all exposed and semi-exposed situations.

Habitat: rocks and stones near low water mark and below.

Season: all seasons. Washed up in large quantities in summer.

Note: This species is also given as a summer form for Woods Hole but like *Polysiphonia negrescens*, *Polysiphonia urceolata* can be found here all during the year.

**Porphyra laciniata*

Frequency: abundant.

Collected everywhere in the area.

Habitat: On almost every kind of substratum (except other algae) in the littoral zone.

Season: all seasons.

Note: A wide-spread alga of the littoral zone. Fruiting plants can be found at all seasons and epiphytes are never found on its lubricous surface. The plants in this harbour are dark in colour and never attain the size or shape of the large plants of the Bay of Fundy.

In January young narrow plants were found abundantly covering the otherwise bare boulders at Thrumcap and Point Pleasant. These boulders are very much exposed and at low tide are entirely unprotected from the sun. The plants remained for a short time only, and are totally absent from this position in spring and summer.

Knight and Parke report a narrow form, *Porphyra liniaris*, which is "common in winter" on the Isle of Man and which "appears to be the winter form of *Prophyra umbilicalis*, Kutz., var. *laciniata*, J. Ag".

The narrow plants at Halifax were carefully examined and were found to be like *Porphyra laciniata* in all but shape. They were undoubtedly young and in all likelihood are the same as those described by Knight & Parke.

Ptilota pectinata

Frequency: occasional.

Collected in wash on all beaches.

Habitat: deep water often on holdfasts of larger algae.

Season: all seasons (perennial).

Note: Cystocarpic plants have been collected occasionally in summer and autumn.

Rhodochorton Rothii

Frequency: occasional.

Collected on the breakwater.

Habitat: on rocks between tide marks, forming a deep red mossy coating.

Seasons: all seasons.

Note: Cruciate tetraspores abundant from January to March. Plants in January are of a bright colour and are more easily detected at this season, when the rocks at that level are bare of larger forms. In summer, plants become mixed with sand, short *Ectocarpus*, and other small algae, and are obscured by the growth of *Enteromorpha*, *Polysiphonia*, and other species. Thus this species is very inconspicuous during the summer although it may be quite plentiful. It appears to prefer somewhat shaded positions and on the breakwater is abundant only on the sheltered side.

**Rhodomela subfusca*

Frequency: abundant.

Collected in all exposed and semi-exposed positions.

Habitat: on rocks from about half time to low tide and below.

Seasons: all seasons (perennial).

Note: This robust species is more persistent than the other filamentous Reds, (*Polysiphonia*, etc.) during the barren season but otherwise follows the same development as they. Fruiting occurs at all seasons, most abundantly in winter and spring.

**Rhodymenia palmata*

Frequency: common.

Collected at York Redoubt, breakwater, Point Pleasant, lagoon outlet, and washed upon beaches.

Habitat: on rocks and larger algae in lower littoral and sub-littoral zones.

Season: all seasons.

Note: In lower littoral zone it usually occurs on rocks protected from direct surf at low tide. In sub-littoral zone it often occurs along with *Laminaria* and other kelps, and is often washed ashore attached to their stipes and laminae. Atypical plants were observed in the extreme lower limits of the outlet. Though submerged, they were surrounded by *Chordaria* and subjected to both the current from the outlet and the surf which advances on the shoreline at an angle. These plants are of a pale green colour and bear many epiphytes. On July 27, 1931 large plants of a similar nature were observed in the current flowing past North Cape, Prince Edward Island.