

OBSERVATIONS ON THE ANNUAL GROWTH OF
ASCOPHYLLUM NODOSUM.

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ABSTRACT.

Growth in length of *Ascophyllum nodosum* (L.) Le Jolis is continuous and the annual increment can be determined by measuring from air bladder to air bladder. At Point Pleasant, Halifax, N. S., the annual linear growth was irregular, ranging from 6 to 15 cm., the average being about 9 cm. The main air bladders appear about May each year. Secondary and smaller ones occur irregularly. The receptacle branches remain attached for about 14 months. They appear first in spring, usually during April or May, and grow in length until the time of ripening. They broaden at the tips during the fall and winter, become noticeably swollen in the spring and summer when they ripen, fall from the plant, and disintegrate. Before the branches ripen and fall, new ones are produced and thus the fruiting of the plant, like the growth of the tip is regular and cyclic.

Ascophyllum nodosum (L.) Le Jolis is a common rockweed in the upper limits of the intertidal zone. In the maritime provinces it is of general occurrence but is more abundant near the mouth of the Bay of Fundy and along the Atlantic coast than in the Gulf of St. Lawrence and Northumberland Strait. The purpose of this article is to give a short account of the changing appearance of the plant throughout the year. The work was done on plants collected at Point Pleasant, Halifax, N. S. During one year collections were made every two weeks, and in addition, regular observations extended over a period of more than four years (1928-32). During this time the findings for Point Pleasant were checked both by collections from many other parts of Halifax Harbour, and by observations at other points in the Maritime Provinces. Particular attention was paid to the rate and extent of growth of the plant as a whole, to the time of occurrence of the air bladders, and especially to the time of ripening of the receptacles.

APICAL GROWTH OF THE PLANT.

The thallus elongates by apical growth, and regularly branches dichotomously once each year. The embryonic

tissue producing this growth is never dormant but adds to the length of the plant continuously. Usually in May an air bladder develops by expansion and swelling of the thallus a few millimeters below the apex, in this manner cutting off a new region of the growing tip. This is not a new growing tip, as the growth is an uninterrupted cycle. With the occurrence of the air bladder, however, the plant has grown for a period of approximately a year and arbitrarily the portion of the thallus distal to the new air bladder may be termed the new growing tip. (See fig. for May 13.)

The growing tip is therefore measured from the apical end of the air bladder to the apex and the extent of a year's growth can be estimated by the distance between corresponding regions of two successive air bladders, since these form at about the same time each spring, accompanied by the initiation of the new growing tip. The most rapid growth takes place between early May and late August or early September, while during the late fall and winter the linear growth is not so extensive. Growth is often interrupted artificially, for frequently plants bear evidence, especially in spring and summer, of having been eaten off at the tip by *Littorina littorea*, an injury usually resulting in the compensating growth of one or more side branches occurring a short distance back of the apex. The extent of normal annual linear growth in the specimens collected was somewhat irregular, varying from 4 or 5 cm. in some plants to over 15 cm. in others, the average being about 9 cm. Variations in length appeared not only among different plants but also among branches of the same plant. Moreover growth in the side branches is often not so extensive as that in the main branches and may be as low as 2 cm. for one year as seen by the position of the air bladders in the small side branch in the figure for July 9.

AIR BLADDERS.

Air bladders are usually confined to the vegetative branches, although occasionally they appear near the base of the receptacle branches. Their occurrence on these branches, however, is comparatively rare and is usually accompanied

by other irregularities such as the bifurcation of the branch near the tip. (See fig. for March 12.) The main bladders as already noted, develop in May on the main branches, and are usually followed closely by dichotomy of the branch. Secondary air bladders may also occur but these can usually be distinguished by their size or position and therefore do not interfere with the determination of the annual growth. (See fig. for Aug. 15 where two air bladders are seen between two dichotomous branchings, and also the fig. for Sept. 14 where two bladders occur very close together, the secondary and younger one being much the smaller.)

RECEPTACLES.

The gametes are born in terminal receptacles on specialized, distinct, simple, lateral branches, limited to a little more than the distal half of the frond. These lateral receptacle branches, according to Oltmanns¹, develop from embryonic cells in slit-like crypts on the sides of the thallus. They occur also at the top or sides of the air bladders and usually make their appearance in April or May, although in some plants they have been observed as early as January.

During the first few months the chief growth is linear. There is no indication of receptacles until late summer and autumn when in addition to growth of the branches in length there is a noticeable enlargement at the tips. This enlargement continues throughout the winter and the receptacle branches attain their maximum size about April. As a rule the developing receptacles are evident shortly after the differentiation of the swollen receptacles. From this time on the receptacles become more clearly defined, until by April a few gametes may be discharged. During the months of May and June the plants attract attention by their heavy burden of large ripe receptacles. These discharge gametes until about the end of the month when they all fall off leaving the plants suddenly bare. Occasional exceptions are found, some

1. Oltmanns, *Morphologie u. Biologie d. Algen.*, 2nd edit. II Bd. Jena, 1922. p. 195.

plants losing their receptacles at an earlier date and some retaining healthy fruiting branches until late September. In spite of these rare exceptions, the sudden shedding of the fruiting branches is an outstanding feature of *Ascophyllum*.

Since the new branches as previously stated arise in spring, and the old ones do not drop off until the end of June, there are attached to the plant during the season of ripening and fruiting two sets of receptacle branches. The reproductive cycle of one year overlaps that of the next and in this way it is different from the unbroken cycle of linear growth in the main vegetative axis and its branches.

IRREGULARITIES IN THE LATERAL BRANCHES.

Not all lateral branches become fertile. Some remain vegetative exhibiting the lack of differentiation which is a prominent feature common to all algae. A great deal of embryonic tissue is present at all times and in the event of injury to or loss of branches or growing tips, it develops adventitious branches. These grow out from embryonic cells situated in the slit-like crypts near the base of the old branch or near the site of the injury if it be to the main thallus. (See fig. for Oct. 12.) Another irregularity is that two bifurcations may occur in a branch in one year. Sometimes the second bifurcation follows so closely upon the first that three branches appear to arise from the one spot. This irregular branching is more common after any form of injury but may occur where no injury is apparent. (See branch on right of fig. for Sept. 26 or branches on left of fig. for Nov. 15.) The fate of the young lateral branches cannot be determined with certainty until after several months' growth. If the branch shows a dichotomy in its early stages, it is likely to remain vegetative. The fruiting branches usually show no such branching, and dichotomy when it does occur here is usually late and confined to the swollen tips. The irregularities of dichotomy, development of air bladders, and other variations in the side branches have no effect on the development of receptacles or main air bladders.

COMPARISON WITH OTHER REGIONS.

The yearly growth of *Ascophyllum nodosum* at Halifax as given in this account corresponds closely with that of plants elsewhere in the maritime provinces. The size and quantity vary in different places. In general, plants found in the Bay of Fundy are much larger and more plentiful than those at Halifax, while in the Northumberland Strait and Gulf of St. Lawrence they are smaller and less abundant. But these differences do not affect the life cycle, and from observations that it was possible to make, it was found that the air bladders appear and the receptacles develop, fruit, and drop off at about the same time throughout the whole region.

EXPLANATION OF PLATES.

- June 23. New growing tip well developed. Air bladders large. Old receptacles large and ripe. New receptacle branches developing in length.
- July 9—Sept. 26. Growing tip elongating and bifurcating. Old receptacles fallen. New receptacle branches showing further development.
- Oct. 12—Nov. 15. Receptacle branches growing in length and broadening and swelling at tips. Conceptacles appearing.
- Dec. 12—March 27. Further development of receptacles and conceptacles.
- April 25—May 13. Growing tip reaching full length, air bladders formed and new growing tip initiated. Receptacles ripe. New receptacle branches appearing.
- May 22—June 7. Further development of growing tip and of new receptacle branches. Old receptacles ripening and ripe.



