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# BRYOPHYTES AND LICHENS IN THE PASTURES OF THE MARITIME PROVINCES*

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ABSTRACT

A list is given of 26 species of mosses, lichens and hepatics found in the pastures of the Maritime Provinces of Canada, which in general are characterized by a high degree of moss cover. The total moss cover is greatest on soils with extreme drainage, either high or low. The dominant cryptogams are the mosses *Hypnum arcuatum*, *Atrichum undulatum* and *Polytrichum commune*. *Hypnum arcuatum* and *Atrichum undulatum* predominate on most soils, the former being especially plentiful in poorly drained pastures. *Polytrichum commune* dominates on highly drained soils; lichens and *Brachythecium salebrosum* being present there in larger quantities than elsewhere. Fertilization readily reduces moss cover.

Two of the most important phases of agriculture in the Maritime Provinces of Canada are those of dairying and stock raising. Both depend for their success on good pasturage. The pastures of the Maritimes are characterized by a high proportion of mosses, and some farmers and agricultural workers have thought that if these plants which do not provide forage were eliminated the forage species might thereby be increased.

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When a survey of pastures in the Maritime Provinces was undertaken in the summer of 1945 the mosses, lichens and hepatics found growing on the soil of 97 pastures were identified, and counts made for 72 fields as follows:

| | | | |
|---|---|---|---|
| Fredericton N. B. | 26 fields | Truro, N. S. | 1 field |
| Petitcodiac, N. B. | 2 " | New Glasgow, N. S. | 19 fields |
| Newcastle, N. B. | 3 " | Millview, P. E. I. | 1 field |
| Caraquet, N. B. | 6 " | Montague, P. E. I. | 4 fields |
| Kedgewick, N. B. | 1 field | Charlottetwon, P. E. I. | 4 " |
| Woodstock, N. B. | 5 fields | | |

Only established permanent pastures with stable swards were examined. New fields which had not had time to develop a natural flora under the combined influences of climate and grazing were excluded. Only the grazed sward was studied in these surveys, the extensive hummocks, frost-heaved areas and sloughs to be found in many Maritime pastures being disregarded. This treatment excludes *Sphagnum*, found in boggy hollows in many fields, from the list of mosses. It also results in a lower percentage figure for *Polytrichum commune* and *Cladonia* spp., these being often the dominant plants of hummocks.

In the course of the survey each species met with was identified, and the percentage cover of each estimated. Notes were also made on drainage and soil type. Small quadrat frames with an inside area of 60 square inches were placed at random over the grazed sward. Usually 5 or 10 frames were used for each field, the area selected for survey being generally less than 1 acre. The percentage of ground covered by each species was then estimated for each quadrat. The analysis is a subjective one, but in respect to moss cover is probably reasonably accurate, since these plants form mats and do not branch out above as do forage species. Cover estimation is therefore rendered much easier than is the case with grasses. The chief error lies probably in the lack of uniformity throughout each field. This in turn is due to the

numerous variations in micro-topography, and to the tendency of the species to form mats rather than to be distributed evenly over the sward.

The number of species found in each pasture ranges from 0 to 9, averaging 3. Cover may go as high as 80%, and averages 28%. The following is a list of the 26 species found in the course of this survey.

**Lichens**

*Peltigera polydactyla* (Neck.) Hoffm.
*Baeomyces roseus* Pers.
*Cladonia rangiferina* (L.) Web.
*Cladonia cristatella* Tuck.
*Cladonia pyxiadata* (L.) Hoffm.

**Hepatics**

*Ptilidium pulcherrimum* (Web.) Hampe.
*Radula* (2 spp.)

**Mosses**

*Ceratodon purpureus* (Hedw.) Brid
*Ditrichum pusillum* (Hedw.) E. G. Britton.
*Dicranella rufescens* (Dicks., Sm.) Schimp.
*Dicranum scoparium* (L.) Hedw.
*Atrichum undulatum* (Hedw.) Beauv.
*Polytrichum commune* L.
*Aulacomnium palustre* (Web. & Mohr.) Schwaegr.
*Philonotis fontana* Brid.
*Bryum caespiticium* L.
*Climacium dendroides* (L.) Web. & Mohr.
*Brachythecium salebrosum* (Hoffm.) Br. & Sch.
*Leptodictyum riparium* (L., Hedw.) Warnst.
*Calliergonella Schreberi* (Willd., Br. & Sch.) Grout.
*Calliergonella cuspidata* (L., Brid.) Warnst.
*Drepanocladus aduncus* (Hedw.) Warnst.
*Rhytidiadelphus triquetrus* (L., Hedw.) Warnst.
*Hypnum arcuatum* Lindb.
*Thuidium delicatulum* (L., Hedw.) Mitt.

Certain other species have also been reported as occuring in pastures in the Maritimes. Roland (1946) states that *Polytrichum piliferum* and *Cladonia* spp. may become common in pastured wire birch-pine woods on the sandy soils of the Annapolis Valley. From the area around Windsor, N. S., Habeeb (1946) records an association of *Astomum Muhlenbergianum*, *Phascum cuspidatum* and *Weisia microstoma* in streile pastures, sometimes accompanied by *Pottia truncata.*

The predominating species as determined during this survey are *Hypnum arcuatum*, *Atrichum undulatum* and *Polytrichum commune.* The data are not sufficient to indicate a relation of any species to particular parts of the region studied. *Polytrichum* was most frequent in the Caraquet area, being very plentiful on some well drained sands. Elsewhere *Hypnum* and *Atrichum* were generally dominant. The following table indicates the relative abundance of the different species:

TABLE I

PER CENT ABUNDANCE OF IMPORTANT SPECIES

| Species | Frequency | Average Cover | Average Cover Where Present | Surveys Exceeding 10% |
|---|---|---|---|---|
| Hypnum | 70 | 12 | 17 | 39 |
| Atrichum | 57 | 5 | 8 | 18 |
| Polytrichum | 47 | 4 | 8 | 11 |
| Brachythecium | 21 | 1 | 6 | 7 |
| Aulacomnium | 15 | X | + | – |
| Climacium | 15 | X | + | – |
| Thuidium | 13 | X | + | – |
| Ceratodon | 11 | X | 5 | – |
| Leptodictyum | 11 | X | 5 | – |
| Cladonia pyxidata | 10 | X | + | – |
| Bryum | 8 | X | + | – |
| Calliergonella Schreberi | 8 | X | + | – |
| Rhytidiadelphus | 6 | X | 6 | – |
| Cladonia rangifernia | 6 | X | 10 | – |
| Others | + | X | + | – |

+ = less than 5%
X = less than 1%
– = less than 3%

It must be emphasized that a study of the ecology of these species would entail work on a wide variety of microhabitats such as sloughs, hummocks, frost-heaved areas, etc. All may be found in a single pasture, therefore the conclusions which may be drawn from data on the grazed sward of whole fields are rather limited. Some observations have been made, however, and are presented in Table II and Table III.

TABLE II. RELATION OF SPECIES TO DRAINAGE

| Species | % Cover | | | |
|---|---|---|---|---|
| | Drainage High | Good | Fair | Poor |
| | (10 fields) | (18 fields) | (25 fields) | (19 fields) |
| *Hypnum* | 3 | 7 | 8 | 29 |
| *Atrichum* | 2 | 4 | 6 | 4 |
| *Polytrichum* | 26 | + | 3 | + |
| *Brachythecium* | 3 | 2 | + | + |
| *Cladonia rangiferina* | 4 | – | – | + |
| *Cladonia pyxidata* | 3 | – | – | + |
| *Aulacomnium* | + | + | + | 1 |
| *Ceratodon* | + | + | 1 | + |
| *Leptodictyum* | + | + | 1 | + |
| *Drepanocladus* | – | – | – | 3 |
| *Total* | 41 | 13 | 19 | 37 |

TABLE III. RELATION OF SPECIES TO SOIL TYPE

| Species | % COVER | | | | |
|---|---|---|---|---|---|
| | Sand (14 fields) | Sandy Loam (28 fields) | Silt Loam (18 fields) | Silt (3 fields) | Clay Loam (3 fields) |
| *Hypnum* | 11 | 11 | 14 | 29 | 24 |
| *Atrichum* | 6 | 3 | 7 | + | + |
| *Polytrichum* | 16 | 3 | 2 | − | 2 |
| *Brachythecium* | 2 | + | 2 | 2 | − |
| *Cladonia rangiferina* | 2 | + | + | − | − |
| *Leptodictyum* | + | + | + | + | 7 |
| *Rhytidiadelphus* | − | + | − | − | 5 |
| *Total* | 37 | 17 | 25 | 31 | 38 |

+ = Less than 1%
− = Absent

It is clear that on the sandy highly-drained soils *Polytrichum* is dominant, and lichens reach their greatest abundance. These plants are often associated with hawkweed (*Hieracium Pilosella*) and poverty grass (*Danthonia spicata*), the lichens being most plentiful where the sward has been opened by frost heaving or other causes. *Brachythecium* is also most abundant on the drier soils. On most soils *Hypnum* and *Atrichum* predominate, the former becoming very plentiful on soils with poor drainage, such as silts and clay loams. *Drepanocladus* was found only once, but was there abundantly on a continually saturated peaty muck. The total moss cover is greatest on those soils with extreme drainage, either high or low, such as sand and clay loam. The average number of species present is three for each drainage class.

Most of the moss species were sterile; *Ceratodon Bryum* and *Polytrichum* being the only ones among the more common

species frequently observed fruiting. In most cases the mosses form dense mats, especially where abundant. A creeping, intertwining type is formed by the pleurocarpous species; a cushion-like mass of upright stems by the acrocarpous forms. An extreme example of the latter type of growth is the *Polytrichum* hummock described by Dore (1940). Nichols (1918) states that the carpets of *Polytrichum* found in old pastures are ideal seed beds for white spruce (*Picea glauca*); where this moss is absent, invading spruce seedlings are much scarcer. The same author claims that as the transition from pasture to woodland takes place, *Polytrichum* is replaced by *Calliergonella Schreberi*.

The economic significance of moss in pastures is not clear. Fertilization will markedly reduce the moss cover as may be seen from Tables IV, V, and VI.

TABLE IV. PASTURE PLOTS, KENTVILLE, N. S.

UNDER TREATMENT FOR 14 YEARS

| Plot No. | Treatment (per acre) | % Basal Cover | | | |
|---|---|---|---|---|---|
| | | Bare Ground | Mosses | Forage Grasses | White Clover |
| 1 | 600 lb. superphosphate every 3 years..... 100 lb. potash every 3 years... 100 lb. nitrate of soda annually..... | 11 | 3 | 48 | 34 |
| 2 | Untreated control plot..... | 11 | 36 | 28 | 2 |
| 3 | 600 lb. superphosphate every 3 years..... | 21 | 4 | 50 | 15 |

TABLE V. PASTURE PLOTS, KENTVILLE, N. S. UNDER TREATMENT FOR 5 YEARS

| Plot No. | Treatment (per acre) | % Basal Cover | | | |
|---|---|---|---|---|---|
| | | Bare Ground | Mosses | Forage Grasses | White Clover |
| 6 | 600 lb. superphosphate every 3 years<br>100 lb. potash every 3 years...<br>300 lb. nitrate of soda annually | 31 | 1 | 57 | 8 |
| 7 | 600 lb. superphosphate annually<br>100 lb. potash annually<br>300 lb. nitrate of soda annually | 24 | + | 55 | 16 |

TABLE VI. PASTURE PLOTS, FREDERICTON, N. B.

| Plot No. | Treatment | % Basal Cover | | | |
|---|---|---|---|---|---|
| | | Bare Ground | Mosses | Forage Grasses | White Clover |
| 6a | Untreated control plot | 3 | 55 | 19 | 7 |
| 6b | Lime only | 15 | 32 | 29 | 10 |

At Kentville the use of fertilizer has resulted in a much greater cover and more luxuriant growth of the forage grasses and white clover than in the untreated control plot. There is a marked decrease of mosses and an increase in bare ground. The latter is probably due to the fact that grasses branch out both above and below ground, so that if they are replacing the moss, then their basal cover will not be as great as that of the mosses. A similar picture was obtained at Frederic-

ton, and a single fertilized field at Truro was found to have less than 1% of moss species. A comparison at Fredericton of limed and unlimed fields indicates that such treatment decreases moss cover, increases forage species and bare ground, but has less effect than fertilizers.

There remains the problem of how the fertilizer acts in eliminating the mosses. Beaumont (1932) finds that in New England the presence of *Polytrichum commune* is inversely proportional to the amount of available nutrients in the soil. Using sodium nitrate as a soil treatment he reports that the moss is killed in proportion to the amount of nitrate applied. He further states that the action is immediate, and not due to subsequent overcrowding by other plants. A toxic effect might be expected, since mosses are superficial and lack the deep root systems of grasses. However, it is possible that there is also an indirect effect operating in the case of fertilization at least to prevent reinfestation. The luxuriant growth of grasses and clover in fertilized fields results in a good deal of shading, not found in closely grazed infertile pastures. Accumulation of organic debris is also accelerated. These factors may perhaps be sufficiently deleterious to reduce or prevent high moss cover. They have previously been suggested by Summerhayes (1941) to account for a decrease of mosses following enclosure of vole-grazed grass plots.

It would seem that rather than being harmful, an abundance of mosses in pastures merely indicates extreme drainage conditions, and possibly a low level of fertility. In the case of the poorer dry pastures it may be an important factor in holding the particles of the surface soil together, and in retarding runoff. In dry weather mosses are not strong competitors for available water, since they lack deep root systems.

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