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**Influence of Cladonia Ground Cover on Soil Moisture
and Ecosis**

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*A contribution from the Biological Station of the University of Michigan, where the work was done under the direction of Dr. Frank C. Gates at the University of Michigan Biological Station during the summer of 1926.

Introduction

The statement is frequently made that a ground cover of moss and lichens is inimical to the ecosis of seeds. And it has also been thought that such a cover affected to a considerable degree the moisture conditions of the soil beneath. It was to get accurate data on these ideas that this piece of work was undertaken.

General Description of Area

In this region the aspen association covers considerable ground, occupying, among other situations, dry, sandy, well-drained uplands formerly covered with pine. This is an association of small trees irregularly spaced above a ground carpet of plants.

The most frequently occurring trees are *Populus grandidentata*, *P. tremuloides*, *Betula papyrifera*, *Acer rubrum* and *Quercus borealis*. The most common shrubs are *Dicorvilia lonicera* and *Rhus glabra borealis*. Among the herbaceous plants, *Pteris aquilina* has the highest frequency

index. Other commonly occurring plants are *Gaultheria procumbens*, *Vaccinium pennsylvanicum*, *V. canadense*, *Aster laevis*, *Solidago hispida*, *Convolvulus spithameus*, *Panicum meridionale*, *Crysepsis asperifolia* and *Danthonia spicata*. A moss and lichen cover may be a very important occurrence in the aspen association - present to some extent in almost all places and frequently occurring in mats of considerable size.

Cladonia frequently starts in spaces between the trees but as soon as shaded it gives place to other plants. Trees could shade out the *Cladonia* but this is unlikely to happen since tree seedlings are seldom able to start where a dense mass of *Cladonia* is present. There is no doubt that such a ground cover prevents the entrance of many plants, because of the inability of roots to penetrate the mat and further because seedlings which germinate on top of the mat are almost certain to dry up in a short time. *Pteris* is well suited to such a situation because of its deep rhizomes which penetrate the moss and lichen cover from below. This fact helps explain the high frequency index of *Pteris*. Oak trees have better chances for getting started than almost all other trees since the acorns are frequently buried by rodents beneath the lichen cover.

Methods

In order to determine soil moisture conditions, an area as thickly covered with *Cladonia rangiferina* as possible was selected. Near this spot an area a ~~net~~ square was staked off and denuded. As far as it was possible, samples were taken at the end of a light rain or during a heavy rain. In getting samples under the *Cladonia*, the lichen mat was lifted and the surface soil taken. With the denuded area, an amount of soil estimated as the thickness of the *Cladonia* covering was removed before taking samples.

Standard methods of soil moisture determination were then followed. In order to test out the assumption that a ground cover of moss and lichens may prevent the development of seedlings, about 200 seeds each of lettuce (*Lactuca sativa*) and radish (*Raphanus sativa*) and about 25 seeds of nasturtium (*Tropaeolum majus*) were planted, some on the surface of the mat, a second portion scattered on the surface of the ground directly beneath the mat and the remainder buried in the soil beneath the lichen cover.

Experimentation

In the following table the results of the soil moisture experiments are shown.

Table I.--Soil Moisture

Place where samples were taken.	Number of determinations	% water based on dry weight
1. Under Cladonia	:9 duplicates taken during or after rains :	10.5
2. Under Cladonia	:2 duplicates taken at peak of a dry period. :	2.0
3. Denuded Area	:9 duplicates taken during or after rains :	8.7
4. Denuded Area	:2 duplicates taken at peak of a dry period. :	0.8

With the seeds the results are shown in the following synopsis.

1. Seeds planted in the soil beneath the mat.

A fair number of the seeds germinated and as long as the mat was dry, the seedlings were visible between the cracks of the mat. However, either heaving or insufficient moisture brought about the death of all the seedlings.

2. Seeds scattered on the surface of the soil beneath the mat.

Quite a number of these germinated. The seedlings present occurred also on ground left bare by cracks in the Cladonia. These seedlings also dried up for the same reasons.

3. Seeds scattered on the surface of the Cladonia mat.

No nasturtium seeds germinated, these remaining on the surface of the mat during the time the experiment was carried on. The seeds which germinated, did so because they were fine enough to drop thru the mat and reach the soil beneath. Fewer of these seeds germinated than in the other two areas, but they also all dried up.

Discussion and Conclusions

From these results it is evident that such a ground cover is not favorable for the development of seedlings. First of all, because it may prevent the roots of seedlings from coming in contact with the soil. Seeds which do succeed in germinating are in the cracks between the dry Cladonia mats. When the Cladonia soaking up expands and closes the cracks,

it entangles the cotyledons and heaves them out of the ground. Later as the Cladonia dries in the hot sun, the seedlings in the developing cracks dry up. A close investigation shows that they have been partly or wholly pulled out of the ground. This would be the explanation for the death of such seedlings, but would not cause death to oak seedlings germinating from acorns buried well beneath the surface by rodents. In a dense Cladonia mat seedlings of oak are the most common to be found. The facts show that a Cladonia mat is able to prevent the establishment of most seeds in spite of the fact that the soil moisture is conserved by the presence of the lichen cover. (See Table I).

Summary

1. This work was done in Cheboygan County, Michigan, during the summer of 1926.
2. A mat of Cladonia rangiferina does conserve the soil moisture beneath it (as shown in Table I).
3. In spite of the added soil moisture beneath it, heaving due to the swelling of Cladonia in the presence of sufficient moisture, is responsible for the death of most seedlings, germinated from seeds which fall on a Cladonia mat.