

PLANT DISTRIBUTION AT MUD LAKE.*

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Mud Lake is one of Michigan's numerous post glacial lakes. It is located about eleven miles northeast of Ann Arbor, and was at one time an arm of Independence Lake. Now, however, it is almost entirely filled with marl and peat deposits, the only open water being a strip about (60) sixty rods long and (20) twenty rods wide at its widest part. A glance at the map (Fig. 1) shows that the peat-forming plants have first come into the irregular arms of the old lake and made its margin very regular as compared to the original shore. Of the several arms Mud Lake presents the most interesting and instructive field of study, because it shows all stages in bog formation from open water to the spruce-tamarack forest and the marsh-meadow. Plant succession may be studied here under natural conditions as well as under changed conditions due to clearing and to burns. Many of the tamaracks have been taken away for fuel or fence posts, loads of spruces have been cut annually for Christmas trees, and severe fires, fifty years ago and again eighteen years ago, burned over large areas.

It is customary to group plants into various societies. For convenience we may divide the plants within and around the bog into two large groups of societies; first, the mineral soil societies, and second, the peat bog societies. Although some plants are common to both groups, and in some places the societies of one group merge into the societies of the other group so gradually that it is hard to draw a line between them, yet, as a rule, the plants are very different for the two groups and live under very different conditions.

The plants of the first group may be considered with respect to the three habitats in which they are found. These habitats are, first, the well-drained hills, covered with an oak-hickory society; second, the low ground or the level, poorly drained soil, covered with a white ash-beech-maple society or by an elm-black ash-swamp oak society; third, the old lake shore, covered by a great variety of species, due partly to the fact that within the space of a few feet there may be xerophytic, mesophytic, and hydrophytic conditions, and partly to the fact that this strip in many places has been changed but little by cultivation. Thus many introduced plants, commonly called weeds, as well as many native plants, grasses, sedges, composites, etc., become established here.

The peat bog societies were studied in detail. Writers have classified peat bog plants in various ways. Five principal zones will be taken up here; first, the zone of marginal plants; second, the zone of tamaracks

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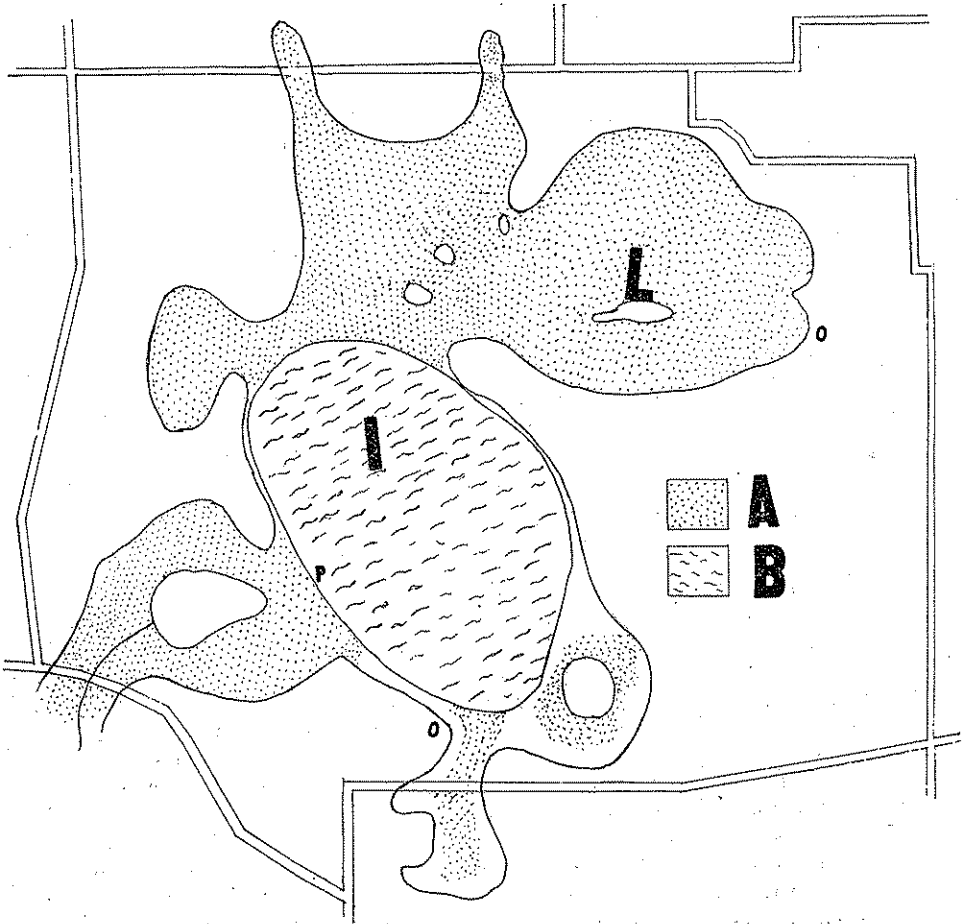


FIG. 1.—Independence and Mud Lakes, showing present distribution of plants.

- I—Independence Lake.
- L—Mud Lake.
- A—Peat deposit.
- B—Open water.
- O—Old Lake shore.
- P—Present lake shore.

and black spruces; third, the zone of *Cassandra* and *Sphagnum*; fourth, the zone of floating plants, and fifth, the zone of water plants. Under the head of marginal zone is included all that part of the bog which lies next to the shore and which now shows no signs of ever having borne tamaracks. Its plant societies are intermediate between those growing upon the mineral soil on one side and the typical bog societies on the other. The majority of its plants, however, are from the mineral soil societies. The width varies from fifty to four or five hundred feet. The principal societies in the marginal zone are, (a) the marsh-grass meadow society, (b) the cat-tail society, (c) the willow society, and (d)

the poplar-elm-osier society. This great variation in the marginal zone societies is due to several causes, chief among which are the following: the variation in the ground water level in the margin; the frequent denuding of the margins by fire; the ease with which plants get into these denuded areas from the surrounding country by means of wind and water; and the presence of mineral matter which is washed down from the high ground, together with that which the larger plants may get by sending their roots down through the peat.

The tamarack zone includes all those parts which are now or have lately been covered with tamarack or tamarack and spruce forests. At the present time there are, (a) the typical tamarack society, (b) the tamarack-spruce society, (c) the *Aronia-Vaccinium* society, and (d) the tamarack areas which have recently been denuded by fire.

The typical tamarack society is a three-layered forest in which the tamaracks form the upper layer, the shrubs, such as *Vaccinium corymbosum*, *Aronia nigra*, *Ilicioides mucronata*, and *Rhus vernix* from the second, and plants such as *Aralia nudicaulis*, *Pteridium aquilinum*, *Woodwardia Virginica*, *Rubus hispidus*, *Unifolium Canadense*, *Coptis trifolia*, and *Cornus Canadensis* the third.

In the spruce-tamarack society there are about an equal number of each species. The spruces, however, shut out so much light that very few plants grow under them.

Where man has cut away the tamaracks, the shrubs, *Vaccinium corymbosum* and *Aronia nigra*, make so rank a growth that nearly everything else is shaded out, and we find now what may be called a *Vaccinium-Aronia* society. If, however, the shrubs are cut away with the tamaracks, or if a spruce-tamarack society is cleared away, other plants get a foothold, principally those whose seeds are carried long distances by the wind, as *Carduus*, *Epilobium*, and *Chamaenerion*, or by birds, as *Rubus* and *Prunus*. Occasionally tamarack seedlings are found in these completely cleared areas.

Where fire has denuded a tamarack area, it has usually, not only destroyed all the plants, but burned away the peat to a depth of from two inches to three or more feet. In these denuded areas *Populus tremuloides* soon gets a foothold, then from one side, bog plants come in, and tamarack seedlings often get started, so that, in the course of many years, the tamarack society is restored. In the burned regions next to the margin, the bog plants are not able to compete with the plants from the upland, which quickly advance into the marginal zone after each fire.

The *Cassandra-Sphagnum* zone consists chiefly of two areas, entirely surrounded by the tamarack zone. The plants in this zone are chiefly *Chamaedaphne calyculata*, growing in and half covered by a thick mat of *Sphagnum*. This zone has never borne tamaracks nor spruces, but small clumps of *Vaccinium*, *Gaylussacia*, *Larix*, and *Picea*, which appear here and there, show that, in the natural course of succession, this *Sphagnum-Cassandra* zone will be covered by a tamarack or a spruce-tamarack forest.

The zone of floating plants entirely surrounds the open water. It is composed chiefly of sedges and the marsh fern, *Dryopteris Thelypteris*. A part of this mat is composed almost entirely of cat-tails.

The zone of water plants consists chiefly of *Scirpus lacustris*, *Pontederia cordata*, and large quantities of *Nymphaea advena*, which grow in the water and loose peat just in front of the sedge mat.

FACTORS DETERMINING DISTRIBUTION.

A considerable amount of discussion has been carried on about the historical factor¹ in the distribution of bog plants. In such work as the writer attempted, however, particular attention was paid to local factors, and the historical factor can be ignored.

A straight line, beginning at the northeast side and running south by southwest, was laid out across the bog in such a way as to cross all the zones mentioned above. (Fig. 2 AB.) To correlate the depth to the present distribution, borings were made every hundred feet to determine the depth and, in a general way, the nature of the deposits. All parts of the bog and the lake which have a depth of more than eight feet are underlaid with marl, which forms beds often sixteen to twenty-five feet in thickness. To determine accurately the relative position, size, and frequency of the plants and the relation of the societies to each other, a plot was made for a strip forty to fifty feet wide along this line.

Beginning at the north end the line first crosses a marshy meadow, which is one hundred fifty feet wide at this point. The peat is very dark and has a maximum depth of eight feet. The owner said that previous to the last fire he had mowed this meadow annually for marsh hay, but that since that time he had been unable to mow it at all because the surface is too uneven. He affirmed that the peat was burned to a depth of six feet in some places. The higher parts of this meadow, where it was burned the least, are now covered with marsh grasses and a few sedges; lower places are filled with wet-soil sedges, blue flags, sensitive ferns, and cowslips; and still lower places, which are seldom free from open water, contain water-plantains and cat-tails.

In the next two hundred feet the depth increases from eight to thirty-five feet. The peat becomes lighter as the depth increases. At the place of greatest depth, it is a yellowish brown and rests upon ten to twelve feet of marl. Evidently this area was once covered with tamaracks, which have been nearly all burned off. At the present time the first one hundred feet on the land side is covered with willows, and the rest of it on the bog side with *Populus tremuloides*. Very many other plants are found growing with the willows and with *Populus tremuloides*. Of thirty species listed for the willow society at this point, only eight species are characteristic of bog flora; of twenty-eight species listed with the Poplars, fifteen are characteristic of the bog. Almost exactly as the depth increases from ten to thirty-five feet, the *Populus tremuloides* decrease in size and numbers, and are replaced by a *Sphagnum-Cassandra* society. This society extends four hundred fifty feet across a basin twenty to thirty feet deep. Beyond this is another burned area very similar to the first Poplar area except that Poplars have not grown so large, young tamaracks are more common, and the number of mineral soil species is much less. Abruptly following this burned

¹Transeau, Bot. Gaz. 40, p. 351.

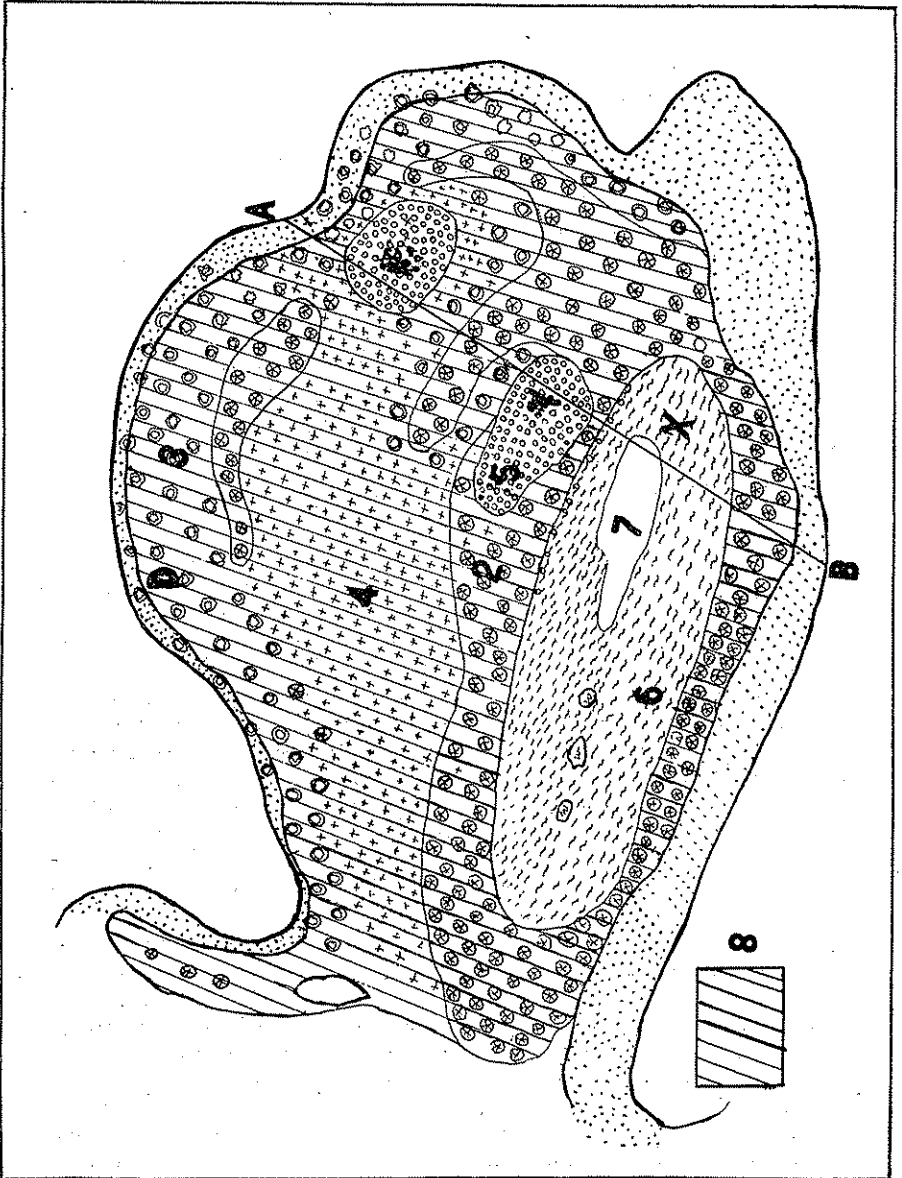


FIG. 2.—Mud Lake Bog.

A-B—Line of profile map.

- 1—Marginal zone, indicated by the dotted area within which are the following zones:
- 2—Tamaracks, or tamaracks and spruces.
- 3—Broad leaved trees on burned area.
- 4—Blueberries, etc., mostly cleared.
- 5—Cassandra and Sphagnum.
- 6—Floating mat.
- 7—Open water.
- 8—Zone lately covered with tamaracks.

area is a zone, two hundred feet wide, of old tamaracks and spruces, growing upon firm brown peat nine feet deep. Almost the only plant here besides the *Larix laricina* and *Picea Mariana* is *Vaccinium corymbosum*, which grows among the trees wherever the shade is not too dense. Beyond the tamarack-spruce society is another burned area, which is practically the same as the last one mentioned. The surface of these burned areas is even now, after eighteen years of filling by *Sphagnum*, often twelve to eighteen inches lower than the surface of the peat in the tamarack-spruce zone. The deepest of these burned depressions are often full of water for long periods so that sedges and cat-tails are found growing in them.

Next to the last burned strip is another *Sphagnum-Cassandra* society, five hundred feet across, growing over a basin twenty-five to sixty feet deep. Over the deepest parts the peat is very loose. Into this society besides the tamaracks and the blue-berries, the spruces are also making their way, following the tamaracks. An observation that the spruces are nearly always in circular clumps led to the discovery that in many instances a circle of spruces surrounds a dead or dying tamarack whose light has been nearly all shut off by the growing spruces. In some places younger stages may be seen where a fringe of young spruces is coming up under the lower branches of a tamarack, which has already made considerable growth and has shaded out the *Sphagnum* and *Cassandra* beneath its branches. Light is the controlling factor. The tamaracks shade out *Sphagnum* and *Cassandra* and give the spruces an opportunity to get started; the spruces, if they are numerous enough; shade out the tamaracks and nearly everything else within the shadow of their branches. Other plants within this society are *Sarracenia purpurea*, *Scheuchzeria palustris*, *Andromeda polifolia*, *Oxycoccus Oxycoccus*, *Eriophorum Virginicum*, *Blephariglottis ciliaris*, *Cypripedium acaule*, *Monotropa uniflora*, etc.

Between the last mentioned *Sphagnum-Cassandra* society and the zone of floating plants which surrounds the lake, there is a tamarack society, which is less than one hundred feet wide where the line crosses it. At this point the peat under the tamaracks is eight feet deep and the marl about fifteen feet. This tamarack society is a part of the continuous tamarack forest which entirely surrounds the floating mat except for short space at the southeast.

The bog enclosed within this zone of tamaracks is nearly elliptical in outline, about one hundred sixty (160) rods long east and west and forty-five (45) rods wide at its widest part. The lake which lies somewhat east of the centre of the bog, is fifty-eight (58) rods long and eighteen (18) rods wide. The bog here is from twenty-four (24) feet to forty (40) feet deep, the lower sixteen to twenty-five feet being marl and the upper eight to fifteen feet very loose peat. The mat at the northwest side and at the east end of the lake is composed almost entirely of cat-tails; the rest of it is composed largely of sedges and marsh ferns. From the south and the west sides tamaracks are advancing upon the bog, while *Sphagnum* is not very abundant. On the north side young tamaracks are rarely found, but *Sphagnum* and *Cassandra* are advancing rapidly and smothering out the other bog plants, so that a narrow strip on that part of the bog is a true *Sphagnum-Cassandra* society.

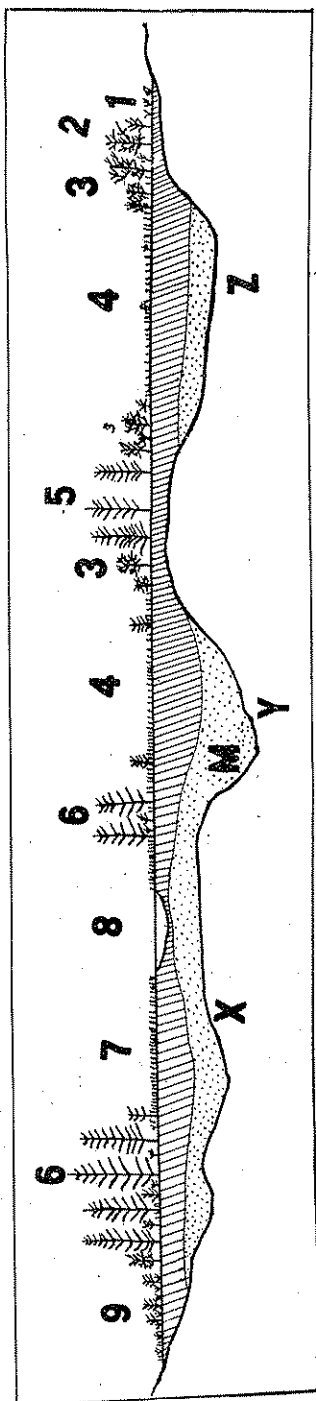


FIG. 3.—Profile along the line AB in figure 2.
 M—Marl; above this is a layer of peat.
 1—Grasses and sedges.
 2—Willows.
 3—Poplars.
 4—Cassandra and Sphagnum.

5—Tamaracks and spruces.
 6—Tamaracks.
 7—Floating mat.
 8—Open water.
 9—Grasses, sedges, and shrubs.

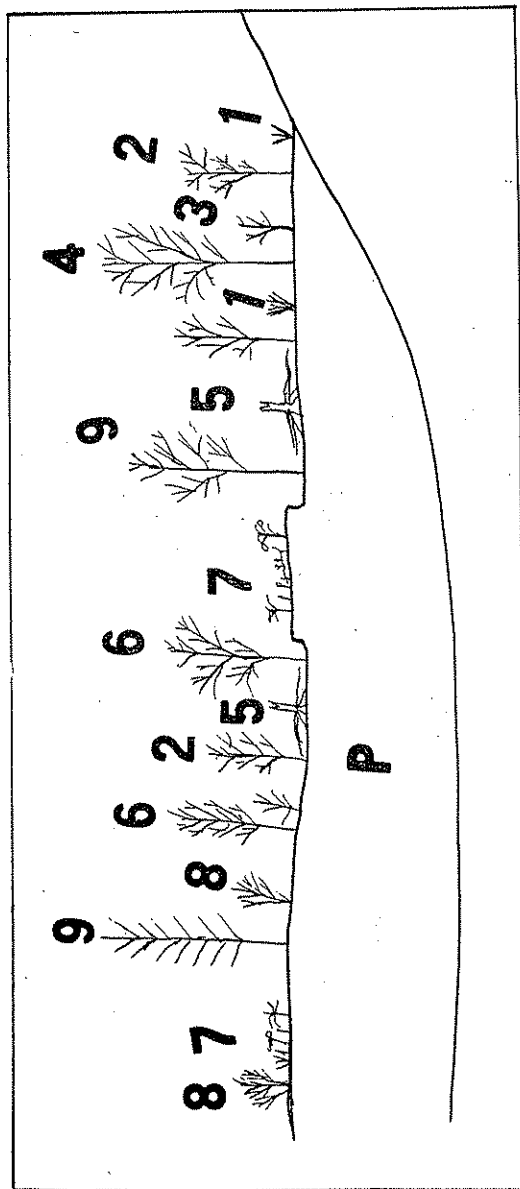


FIG. 4.—Diagram of burned margin.

- 1—Sedge.
- 2—Willow.
- 3—Osier.
- 4—Elm.

- 5—Tamarack stump.
- 6—Populus.
- 7—Typical bog plants.
- 8—Blueberry.
- 9—Tamarack.

The mat seems to be advancing rapidly over the lake by growing from the margin and by the increase in the size and number of detached pieces of the mat, which have floated out and become lodged upon the rootstocks of *Nymphaea advena*. Other plants found in this floating zone are *Zizania aquatica*, *Eriophorum polystachyon*, *Sagittaria latifolia*, *Comarum palustre*, *Menyanthes trifoliata*, *Decodon verticillatus*, *Salix myrtilloides*, *Marchantia polymorpha*, *Drosera rotundifolia*, etc.

The tamarack forest on the south side is from one hundred feet to three hundred feet wide, and rests upon from eleven to twenty-eight feet of brown peat and marl. Between this tamarack forest and the shore is the marginal zone, which shows little evidence of having ever been burned over and which has no distinct marginal depression. Besides grasses and sedges, growing in this zone there are several low shrubs, *Rosa Carolina*, *Spiraea salicifolia*, *Dasiphora fruticosa*, etc.

The profile through the several zones (Fig. 3) shows that the younger zones of floating plants and of *Sphagnum* and *Cassandra* lie over deeper basins which must be the last places to be filled with peat and to be covered with bog plants. The water plants fill the water nearly to the top with very loose peat, the mat grows out upon this, then tamaracks come upon the mat, either directly, as upon the south and west sides, or after an intervening *Sphagnum-Cassandra* stage, as upon the north side of the large basin (Fig. 2 and 3, X) and in the smaller basins (Y and Z). Although tamaracks may come directly upon the sedge mat, young spruces are first found in the *Sphagnum-Cassandra* zone. These results correspond with the results which have been obtained by Burns* and Pettee.† From Fig. 3, it might seem that the basin X should have been filled before the deeper basin Y, but Fig. 2 shows that X is very much larger than Y. Moreover, borings show that parts of X are deeper than the part through which the profile was taken. It is reasonable to suppose that a zone of water plants could fill the small basin Y in much less time than an equally wide zone could fill the large basin X.

In a consideration of the burned areas, it is evident that the peat is seldom burned evenly or to a uniform depth. There may be irregular depressions, where every living thing was totally destroyed, lying adjacent to strips which were merely burned over and in which the majority of the plants were not killed. A good illustration of this is found in the north part of the swamp (Fig. 2, D), (Fig. 4). Along the margin is a common marginal society of *Salix*, *Populus*, *Ulmus*, *Cornus*, *Solanum*, *Caltha*, etc. In wet seasons the ground is covered with more or less water. There are no evidences of burns near the shore, but several rods from it, half burned tamarack stumps with all their upper roots exposed and partly burned show that fires must have lowered the level at least eighteen to twenty-four inches. The plants, however, are in no way different here from those found near the shore. About fifteen rods from the shore there is a strip from one to several rods in width, which does not seem to have been burned out. It is higher than the rest of the ground so that its surface is comparatively dry at all seasons of the year, and upon it are such plants as *Aralia*.

* Report Michigan Academy of Science, 1934, P. 76.

† Report Michigan Academy of Science, 1905, P. 126.

nudicaulis, *Pteridium aquilinum*, *Rubus hispidus*, and *Unifolium Canadense*, none of which are found in the lower burned places, and all of which are common in the tamarack society. Beyond this higher strip there is more of the burned area with practically the same plants that are found near the shore, in addition to a few bog plants, *Vaccinium*, *Aronia*, *Betula*, etc.

Fire has been commonly used for the last century in clearing this country. In dry seasons fire, spreading from the uplands, naturally comes first into the margins, which are known to be the driest parts of a bog in a dry season. Every year many bogs are burned over, and the effects of a single fire may remain for many years. Since there are places on the margin having little or no depression, since the marginal depression is most marked where fires are known to have occurred, and since plant societies in depressions known to have been caused by fire are the same as the plant societies usually found in marginal zones, it is reasonable to think that marginal depressions and marginal plant societies are due largely to the destruction of the peat and the bog plants by fire.

CONCLUSIONS.

1. Peat bogs are heterogeneous habitats and require detailed study.
2. Depth of water is a primary factor in the distribution of the plant societies in a bog.
3. Plant succession in older parts of this bog is brought about largely by fires.
4. The replacing of tamarack forests by blueberry swamps is due to clearing.

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