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ECOLOGICAL STUDY of BRUSH LAKE

BY

John H. Schaffner
Otto E. Jennings
Frederick J. Tyler



COLUMBUS, OHIO,

1904.

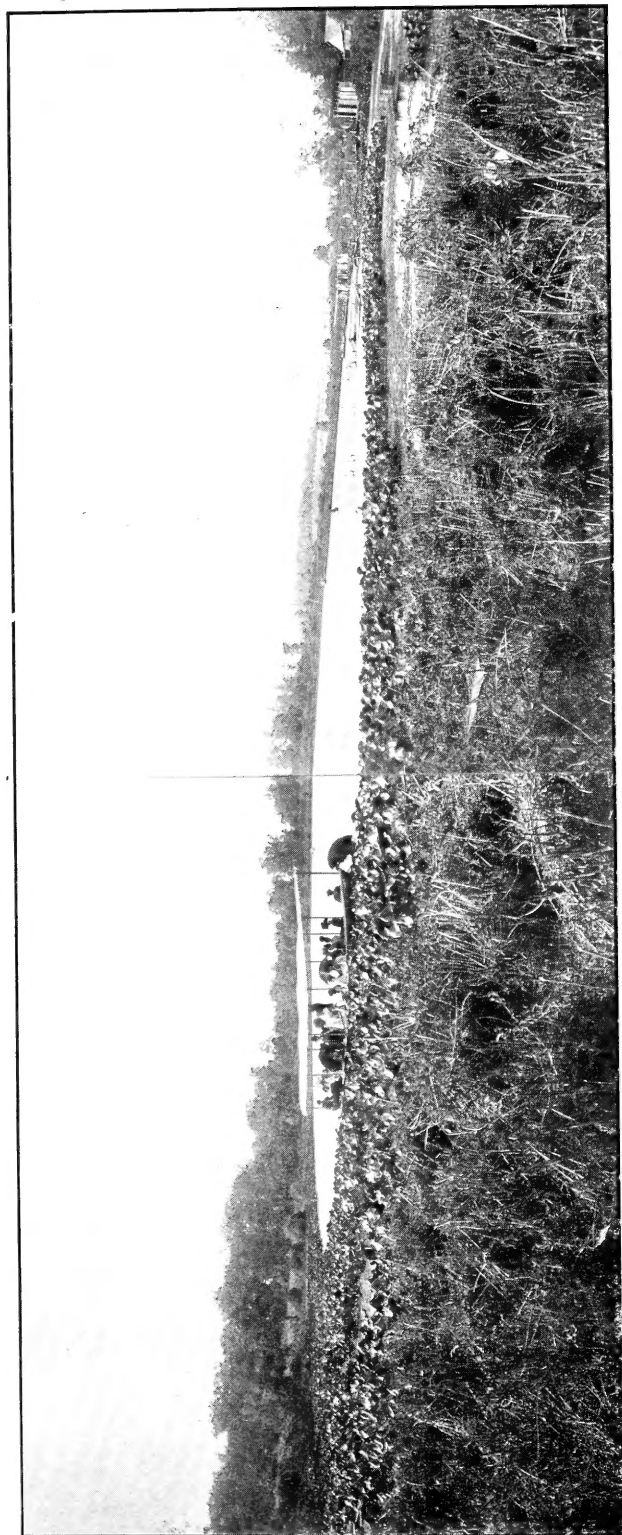


Fig. 1. Brush Lake from the south end ; Decodon and Water-lily Zones in the foreground. (*Photograph taken August 6, 1887.*)

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WILLIAM R. LAZENBY,

F. M. WEBSTER,

JOHN H. SCHAFFNER,

Trustees.

INTRODUCTION.

SINCE a considerable part of the State of Ohio was once covered by the continental glacier of the glacial epoch, the present surface is in many places covered by a thick deposit of drift. In the regions of terminal moraines and moraines of recession, the surface is usually diversified by hills and hollows with a comparatively new and irregular drainage system. The depressions thus formed give rise to the numerous swamps, ponds and lakelets, which constitute a very characteristic feature of the landscape and have a very important bearing on the plant distribution.

Being interested in the plant geography and ecology of the State, the authors proceeded to make a systematic study of one of these glacial lakelets. Brush Lake being favorably situated was chosen for study and the work of observation and collecting has been carried on for several years. To help defray necessary expenses, several small grants were obtained from the McMillin Fund of the Ohio State Academy of Science and we wish here to express our thanks to the Academy for the assistance received. Thanks are also due to Mr. C. F. Wheeler, of the United States Department of Agriculture, for kindly determining the species of Cyperaceae, and to Mr. Geo. Riddle, owner of the lake, for the photograph of the lake taken in 1887.

Ecological Study of Brush Lake.

GENERAL DESCRIPTION OF THE LAKE.

BRUSH LAKE is situated in the north-east corner of Champaign County, on the north side of the "Panhandle" Railway, at Brush Lake Station, about thirty-five miles west of Columbus. It is a pond covering about eleven acres, occupying a depression of the glacial deposit which covers the entire region for miles around. This deposit represents a moraine of recession and the surface is diversified by hills and hollows, the district being one of the most beautiful in central Ohio. In the neighborhood there are numerous small swamps and ponds, some of which have been entirely filled up with sediment from the surrounding banks and hills. It is said that Brush Lake was formerly about eighty feet deep. If this is true there has been a large amount of filling in recent times from the adjoining cultivated hillsides; for at present the water is not over thirty-five feet deep in the deepest place. The elevation of the surface of the lake is given as 1,120 feet above sea level.

There is a small ravine opening into the lake at the north-west and an outlet at the south-east from which water usually flows, forming a small brook, except in very dry weather when the loss from evaporation and other causes is greater than the supply. The outlet seems to be eroded very slowly and the decrease in the size of the lake due to this cause is at present insignificant. The water supply comes from a small drainage area and from springs which are evident on the west and north-west sides. From wells drilled at Fountain Park, about one mile south-east of the lake, it appears that the underlying rock is the Cedarville Limestone, belonging to the Niagara formation. There are several shallow artesian wells from this limestone at Fountain Park, but whether any of this rock water comes up into Brush Lake is not known.

Around the margin of the lake is a fringe of trees, the remnants of the former general forest, and within this is a series of concentric zones of vegetation which finally disappear in the water, as is usual in such locations. Evidence of rapid filling is present on the west side, where a new series of zones has produced considerable confusion in the centripetal progression. On the east side there is a wide mud flat inside of the shrub zone, which is just now beginning to be invaded by hydroptic shrubs. The most perfect and primitive arrangement of the vegetation appears at the north end, where a small, low wood-lot has afforded protection from the cultivated field beyond. At the south end the natural conditions have been entirely changed; here the vegetation has been removed in order to enlarge the available ice-producing surface. The water is thus shallow and some of the zones are either entirely absent or represented only by isolated individuals. There is here also a patch of low woods which lies between the railroad and the lake and formerly the zones were very perfectly developed, as will appear from the photograph taken in 1887 (Fig. 1).

Glacial lakes are of interest in many ways, but especially because of the rapid changes which must have taken place in comparatively recent times in climate and soil. How far these lakes present similar plant societies as one passes from their southern limits northward is still to be determined. Several glacial lakes have recently been studied in detail, among which may be specially mentioned the "Three Sister Lakes," near Ann Arbor, Mich.¹

One of the authors of the present paper is quite familiar with the vegetation and surroundings of these "Three Sister Lakes," having often botanized on their banks, and though there are striking similarities in some of the zones, on the whole there are very great differences, as will appear by comparing the reports of Reed and Weld with the description of Brush Lake. That the difference is not primarily due to latitude will be evident from the fact that a number of plants characteristic of the Michigan lakelets also occur in the Licking Reservoir, about thirty miles east

1. REED, HOWARD S. A Survey of the Huron River Valley. I. The Ecology of a Glacial Lake. *Bot. Gaz.* **34**: 125-139. 1902

WELD, LEWIS H. Botanical Survey of the Huron River Valley. II. A Peat Bog and Morainal Lake. *Bot. Gaz.* **37**: 36-52. 1904.

of Columbus. Probably the most important factor is the presence of Sphagnum, which is abundant in some parts of the Licking Reservoir. But why the Sphagnum should be abundant in the reservoir and entirely absent in Brush Lake is not so apparent. The general character and surroundings of Brush Lake are much the same as those of the "Three Sisters."

For the present the writers will content themselves with a report of the conditions as found at Brush Lake, leaving generalizations to some future ecologist. No special work could be carried on in regard to physiological adaptations. In order to do such work it is necessary that one should be able to *live* with his plants for a considerable period of time. But ecological phytogeography is still in its embryonic stage and it is perhaps better for the present to continue work more along geographical lines until better facilities are at hand for accurate and continuous observations on physiological adaptations. Besides, our present plant societies are being destroyed so rapidly that it is of primary importance that an historical record should be made. This may be of the utmost importance in the future.

THE PLANT SOCIETIES.

As stated above, the plant societies of the lake are arranged in concentric zones, as is usual where there is a gradual change in the environment. The zones determined are as follows:

1. Submerged Zone.
2. Water-lily Zone.
3. Half-submerged Zone.
4. Decodon Zone.
5. Uliginous Zone.
6. Shrub Zone.
7. Forest Zone.

Of these, all may be regarded as normal except the uliginous zone, which to a large extent represents a recent society developed on the mud flats intercalated between the Decodon and shrub zones on the east and west sides of the lake.

I. SUBMERGED ZONE. In this zone existence is almost entirely under water, for rarely do any of the plants composing it have even their tips extending above the surface. It is essentially a Potamogeton-Ceratophyllum-Myriophyllum-Chara zone.

It extends in typical places from a depth of 5 feet on the outer side, where it is bounded by water-lilies, to a depth of 10 feet or more on the inner side. At the north end where conditions are ideal the zone is 15 feet wide between the 5 and 10-foot limits. On the west side it is 20 feet between these limits. Beyond the 10-foot limit the depth increases very rapidly. The water of the lake is considerably colored, which must have an important effect on the submerged vegetation. All the plants in this zone have slender, wand-like stems with narrow and slender or much dissected leaves or branches. They are all highly specialized and thoroughly adapted to their habitat. They appear to occupy the ground because no other plants are able to follow. On the outer side they are pushed back by the water-lilies as far as these are able to invade the water. The typical plants are :

Potamogeton zosteræfolius Schum.
 " *lucens* L.
Ceratophyllum demersum L.
Myriophyllum sp.
Chara sp.

Other species are :

Potamogeton foliosus Raf.
 " *pectinatus* L.
Najas flexilis (Willd.) R. & S.
Zannichellia palustris L.

On the surface are frequently found the free-floating duck-weeds :

Spirodela polyrhiza (L.) Schl.
Lemna minor L.
Wolffia columbiana Karst.

2. WATER-LILY ZONE. This is a *Nymphaea-Castalia* zone, the two plants that give character to the society being *Nymphaea advena* Soland. and *Castalia odorata* (Dryand) W. & W. It is said that the *Castalia* was introduced artificially, but it is now well established. At the north end the zone is 40 feet wide and extends from water five feet deep to two feet deep. On the west side it is 28 feet wide. This is a very striking zone on account of the large, upright leaves of *Nymphaea*. The comparative absence of *Nymphaea* in water shallower than two feet must be accounted for on the grounds of a severe struggle with the plants

of the next zone, since it will grow readily in much shallower water. The inner limit of the zone appears to be determined by the depth of water alone, the plants being able to advance readily so long as the petioles are able to elongate sufficiently to bring the leaf blades above the surface. On the west side there are several small gaps, probably because of the recent origin of the present zone on this side and these gaps are filled with great masses of *Chara*. Another prominent plant of this zone is *Potamogeton natans* L., which in several places covers considerable areas.

The water-lilies occupying the shallow water are very efficient agents in building up the shore of the lake. The stout rhizomes are able to creep inward and bind the loose soil together, while the petioles and leaves tend to produce a calm where debris may accumulate quite rapidly.

Among the floating and aerial leaves of the water-lilies and other plants are usually great swarms of duckweeds, especially *Spirodela polyrhiza* (L.) Schl., *Lemna minor* L., and *Wolffia columbiana* Karst. *Riccia fluitans* L. is also common. *Riccio-carpus natans* (L.) Corda., although occurring in large quantities in the swamps near by, was not collected in the lake. *Batrachium divaricatum* (Schr.) Wimm. is abundant in some places at the outer edge of the water-lilies, but *Ranunculus delphinifolius* Torr, common in the swamps and ponds of the region, was not present.

Other plants collected in the water-lily zone were :

- Sparganium eurycarpum* Engel.
- Potamogeton foliosus* Raf.
- “ *pectinatus* L.
- “ *lucens* L.
- Naias flexilis* (Willd.) R. & S.
- Zannichellia palustris* L.
- Ceratophyllum demersum* L.
- Myriophyllum* sp.

3. HALF-SUBMERGED ZONE. This is essentially a *Rumex*-*Polygonum*-*Typha* zone. It is characterized by plants which have their roots, rhizomes, and the lower parts of their erect stems under water, but the larger part of the erect stems is exposed to aerial conditions. It is much more complex and variable than the two preceding zones. It extends outwards from

the edge of the water-lily zone at a depth of two feet to water about one-half foot deep. At the north end it is twenty-four feet wide and on the west side about fifteen feet. It is most perfectly developed at the north end (Fig. 2), where *Rumex verticillatus* L., *Polygonum amphibium* L. and *Polygonum emersum* (Mx.)



Fig. 2. North end of the Lake, showing plant zones. The Half-submerged Zone and Decodon Zone are not well marked in the picture because of the undeveloped condition of the latter. (Photograph taken June 18, 1902.)

Britt. are the characteristic species. On the east and west sides, owing to more typical uliginous conditions, *Typha latifolia* L. and *Sparganium eurycarpum* become prominent. On the south

side the wide, shallow, artificial area of water corresponding to this zone is mostly covered with *Chara* sp., various pond weeds, *Batrachium divaricatum* (Schr.) Wimm., and *Zannichellia palustris* L.

An interesting plant also is *Cicuta bulbifera* L., which is covered in the fall with little bulbs. These drop off and float around on the surface of the water. Although found in several places this plant does not seem able to hold much ground considering the great advantage it has of being distributed into every favorable nook and corner by means of its brood buds. *Eleocharis palustris* (L.) R. & S. and *Scirpus lacustris* L. are also prominent in this zone. The floating plants of the water-lily zone are abundant, as would be expected. Other plants which are present are as follows :

Roripa palustris (L.) Bess.
Naumbergia thyrsoflora (L.) Duby.
Scutellaria lateriflora L.
Bidens cernua L.
Polygonum punctatum Ell.
Alisma plantago L.
Sagittaria latifolia Willd.

4. DECODON ZONE. This is one of the most remarkable societies surrounding the lake. It is a *Decodon-Solanum dulcamara* zone. The characteristic plant, which in many places forms almost a pure society, is the tall crownformer, *Decodon verticillatus* (L.) Ell. The twining bittersweet, *Solanum dulcamara* L., is also very prominent. Some of these plants develop as floating individuals, having no connection with the ground, but developing numerous water roots along the submerged part of the stem. This zone is 30 feet wide at the north end. It begins in water from one to one-half foot deep and ends at the outer edge in water of about three or four inches, or even beyond the water's edge. At the north end it is limited on the outside by the shrub zone which extends to the edge of the water or beyond. The tall shoots of the *Decodon*, many of which are fasciated, form a tangled mass through which it is very difficult to pass both when they are green and in winter when dry. The *Decodon* is especially well adapted for holding air in the cortical layer of the much branched base and is thus well fitted to carry on

the life of an aquatic crown-former. The Decodon zone is almost entirely wanting at the south end of the lake, having been recently destroyed as stated before. It was very perfect here formerly, as appears in Fig. 1, and at the south-east it is still very wide. On the west side the zone is rather narrow, being only about fifteen feet wide.

Other plants in this zone are :

<i>Alisma plantago</i> L.	<i>Ranunculus abortivus</i> L.
<i>Sagittaria latifolia</i> Willd	<i>Roripa hispida</i> (Desv.) Britt.
<i>Scirpus lacustris</i> L.	<i>Naumbergia thyrsoflora</i> (L.) Duby.
<i>Carex comosa</i> Boott.	<i>Cicuta bulbifera</i> L.
<i>Iris versicolor</i> L.	<i>Cephalanthus occidentalis</i> L.

The *Cephalanthus* is here and there an invader from the outside and will finally establish a new shrub zone because of the changed conditions produced by cultivation of the surrounding hillsides. Had the lake remained in its natural condition surrounded by dense forest the progress of the zones would probably have been gradual and continuous, but as it is there will be from time to time comparatively sudden advances, thus producing confusion in the established order of the old societies.

ULIGINOUS ZONE. The distinctive peculiarity of this zone is the presence of various species of *Carex*, *Eleocharis* and *Scirpus*, together with *Equisetum fluviatile* L., which is very abundant in some places. Besides these there are a number of other moisture and mud-loving species. This zone is intercalated on the east and west sides where wide mud flats have been formed between the Decodon and shrub zones. It is very prominent on the east side where there has been much filling in from the cultivated field beyond. The zone is absent at the north where there has been no such filling and was probably also absent from the south end when natural conditions still prevailed. In the moister parts the *Equisetum*, *Eleocharis* and *Scirpus* are characteristic, while in the outer, dryer margin the various species of *Carex* form a thick sod in which occur a number of uliginous herbs. Some isolated pioneers among the shrubs, especially *Cephalanthus*, have also taken a foothold on the east side although still few in numbers. On the west side the zone has been much invaded and is now in a transition state, progressing rapidly toward a thicket and forest society.

typical moisture-loving shrubs, forming at some places an almost impassable hedge. At the north-west where the small ditch opens into the lake the shrubs have invaded the water, *Salix sericea* Marsh. and *S. lucida* Muhl. advancing farthest.

The most characteristic plants are a number of species of *Salix*, *Cephalanthus occidentalis* L., *Cornus stolonifera* Mx. and *Rosa carolina* L. The complete list of shrubs found numbers fifteen species and two forms, as follows:

<i>Salix discolor</i> Muhl.	<i>Rosa carolina</i> L.
“ <i>sericea</i> Marsh.	<i>Solanum dulcamara</i> L.
“ <i>cordata</i> Muhl.	<i>Cornus stolonifera</i> Mx.
“ <i>cordata angustata</i> (Pursh.) And.	“ <i>amomum</i> Mill.
“ <i>sericea</i> × <i>cordata</i> .	<i>Cephalanthus occidentalis</i> L.
“ <i>lucida</i> Muhl.	<i>Viburnum opulus</i> L.
“ <i>nigra</i> Marsh.	“ <i>lentago</i> L.
“ <i>amygdaloides</i> And.	<i>Sambucus canadensis</i> L.
<i>Ribes cynosbati</i> L.	

Several of these develop into large trees, but none had advanced beyond the shrub stage, either on account of age or other causes. Because of the great density of the shrub thicket very few herbs gain a footing in this zone except in the more open places. The following sixteen species were collected:

<i>Spathyema foetida</i> (L.) Raf.	<i>Naumbergia thyrsoflora</i> (L.) Duby.
<i>Polygonum persicaria</i> L.	<i>Asclepias incarnata</i> L.
<i>Caltha palustris</i> L.	<i>Blephilia hirsuta</i> (Ph.) Torr.
<i>Ranunculus abortivus</i> L.	<i>Mentha canadensis</i> L.
<i>Geum canadense</i> Jacq.	<i>Monarda fistulosa</i> L.
<i>Cassia marylandica</i> L.	<i>Veronica peregrina</i> L.
<i>Lathyrus palustris</i> L.	<i>Campanula americana</i> L.
<i>Viola obliqua</i> Hill.	<i>Rudbeckia speciosa</i> Wend.

7. FOREST ZONE. The inner part of the forest zone is hydrophytic or semi-hydrophytic. It is typically an *Acer-Ulmus-Fraxinus-Salix* zone. The soil is largely made up of vegetable and shell humus, in which, besides the tree growth, are found large numbers of semi-hydrophytic and mesophytic shrubs and herbs. On the east and west sides there is only a narrow fringe of forest left, the hillsides having been entirely denuded of their former mesophytic forest. On the north and south ends there are still rather wide strips of hydrophytic forest, but beyond these the forests have also been destroyed so that it is impossible at

present to obtain the transition from the lake shore forest to the culmination forest of the region. For this reason the normal upland forest will not be considered here. The typical trees are :

<i>Acer saccharinum</i> L.	<i>Salix nigra</i> Marsh.
<i>Fraxinus americana</i> L.	“ <i>amygdaloides</i> And.
“ <i>pennsylvanica</i> Marsh.	“ <i>discolor</i> Muhl.
<i>Ulmus americana</i> L.	

All of these are reproducing well and advancing inward upon the shrub zone.

In the drier, outer parts of the forest zone are also found the following trees :

<i>Gleditsia triacanthos</i> L.	<i>Prunus americana</i> Marsh.
<i>Populus deltoides</i> Marsh.	<i>Cornus florida</i> L.
<i>Morus rubra</i> L.	<i>Rhus glabra</i> L.
<i>Viburnum prunifolium</i> L.	<i>Juglans nigra</i> L.
<i>Viburnum lentago</i> L.	<i>Quercus macrocarpa</i> Mx.

There are comparatively few shrubs in the typical swamp forest. The following were collected :

<i>Cornus amomum</i> Mill.	<i>Opulaster opulifolius</i> (L.) Ktz.
<i>Sambucus canadensis</i> L.	<i>Rubus occidentalis</i> L.
<i>Viburnum opulus</i> L.	

In the drier parts the three lianas given below are quite abundant :

<i>Rhus radicans</i> L.
<i>Parthenocissus quinquefolia</i> (L.) Planch.
<i>Vitis vulpina</i> L.

In the outer, drier portions of the forest zone herbs are quite numerous. This is probably due to the changed and still changing conditions, as a considerable number would probably be absent if conditions were normal as formerly, when the hydrophytic forest was continuous with the vast mesophytic forest of the region. Probably most of the herbs present were collected, and the following is the complete list of species, none of which is especially prominent over others in the society :

<i>Equisetum arvense</i> L.	<i>Cinna arundinacea</i> L.
<i>Arisaema triphyllum</i> (L.) Torr.	<i>Poa pratensis</i> L.
<i>Spathyema foetida</i> (L.) Raf.	<i>Elymus striatus</i> Willd.
<i>Panicum capillare</i> L.	“ <i>virginicus</i> L.
<i>Muhlenbergia mexicana</i> (L.) Trin.	“ <i>canadensis</i> L.

- Cyperus diandrus Torr.
 Carex comosa Boott.
 " frankii Kunth.
 " grisea Wahl.
 " stipata Muhl.
 " cristatella Britt.
 Allium canadense L.
 Iris versicolor L.
 Sisyrinchium graminoides Bickn.
 Urtica gracilis Ait.
 Adicea pumila (L.) Raf.
 Boehmeria cylindrica (L.) Willd.
 Parietaria pennsylvanica Muhl.
 Rumex altissimus Wood.
 Polygonum lapathifolium L.
 " punctatum Ell.
 Phytolacca decandra L.
 Claytonia virginica L.
 Alsine media L.
 Syndesmon thalictroides (L.) Hoff.
 Ranunculus abortivus L.
 " recurvatus Poir.
 " hispidus Mx.
 Thalictrum dioicum L.
 " purpurascens L.
 Caulophyllum thalictroides (L.) Mx.
 Podophyllum peltatum L.
 Sanguinaria canadensis L.
 Barbarea barbarea (L.) MacM.
 Roripa palustris (L.) Bess.
 Cardamine purpurea (Torr.) Britt.
 Bursa bursa pastoris (L.) Britt.
 Camelina sativa (L.) Crantz.
 Arabis hirsuta (L.) Scop.
 " laevigata (Muhl.) Poir.
 Fragaria virginiana Duches.
 Potentilla monspeliensis L.
 " canadensis L.
 Geum canadense Jacq.
 " virginianum L.
 Cassia marylandica L.
 Lathyrus palustris L.
 Oxalis grandis Small.
 " violacea L.
 Euphorbia corollata L.
 Impatiens biflora Walt.
 Hypericum maculatum Walt.
 " mutilum L.
 Viola papilionacea Ph.
 " pubescens Ait.
 Samolus floribundus H. B. R.
 Asclepias incarnata L.
 Cuscuta gronovii Willd.
 Phlox divaricata L.
 Verbena urticifolia L.
 " hastata L.
 Scutellaria lateriflora L.
 Glecoma hederacea L.
 Prunella vulgaris L.
 Monarda fistulosa L.
 Blephilia hirsuta (Ph.) Torr.
 Koellia virginiana (L.) MacM.
 Mentha canadensis L.
 Solanum carolinense L.
 " dulcamara L.
 Verbascum thapsus L.
 Scrophularia marylandica L.
 Chelone glabra L.
 Veronica officinalis L.
 " serpyllifolia L.
 " peregrina L.
 " arvensis L.
 Afzelia macrophylla (Nutt.) Ktz.
 Ruellia ciliosa Ph.
 Plantago lanceolata L.
 " major L.
 Sanicula gregaria Bick.
 " canadensis L.
 " trifoliata Bick.
 Washingtonia claytoni (Mx.) Britt.
 Thaspium barbinode (Mx.) Nutt.
 Pastinaca sativa L.
 Galium aparine L.
 " tinctorium L.
 " claytoni Mx.
 " asprellum Mx.
 Valerianella radiata (L.) Dufr.
 Campanula americana L.
 Lobelia cardinalis L.
 " syphilitica L.
 Ambrosia trifida L.
 Vernonia maxima Sm.
 Eupatorium maculatum L.
 " perfoliatum L.
 " ageratoides L. f.
 Solidago canadensis L.
 Aster novae-angliae L.
 " puniceus L.
 " tradescanti L.
 Erigeron philadelphicus L.
 " annuus (L.) Pers.
 Polymnia canadensis L.
 Heliopsis scabra Duval.
 Rudbeckia triloba L.
 " speciosa Wend.
 Bidens, cernua L.
 " connata Muhl.
 " trichosperma (Mx.) Britt.
 Carduus discolor (Muhl.) Nutt.
 " muticus (Mx.) Pers.
 Taraxacum taraxacum (L.) Karst.
 Lactuca canadensis L.

GENERAL CONSIDERATIONS.

That the plants around the lake are arranged in rather definite zones appears to be due to two general causes: first, because of the gradual change in the character of the substratum and other factors from one condition to another; second, because certain plants are especially adapted to certain conditions and are thus able to hold their ground against invaders from the outside. In an ordinary pond the successive modifications of the substratum occur in concentric belts and hence the succession of more or less perfect zones or belts of vegetation. Between each two contiguous zones there is a tension line where the struggle for existence among the opposing individuals becomes very severe. Each zone, therefore, has a fighting line on its inner and outer edge, while in the central part the struggle is only between plants of the community, both old and young, and such chance strangers which may be able to gain a foothold in the less densely populated areas. That many plants almost entirely, restricted to a single zone can hold their own, either farther in or out, if once established is readily seen where normal conditions have been disturbed. There may thus be considerable difference in the result, depending on whether plants have had the opportunity of occupying a bare soil or whether they must contend for the soil already occupied by others. Certain species might hold their own indefinitely in a certain environment if once firmly established, while they might not be able to gain a foothold if the soil is already occupied by others.

The seven zones of Brush Lake are slowly traveling inward, as the lake is filling up with the wash from the surrounding hills. Each zone follows up its ideal environment and is crowded out on the outer margin by its next neighbor. The filling must have been quite slow and gradual in former times, but at present it is rather cataclysmic and will continue to be so in the future. There are therefore unusual disturbances in the progression of the zonal societies which have been alluded to above. The physiographic changes determine the changes in the zones. If these are gradual and slow in their progression the same will be true of the plant societies, but if the filling is sudden and large additions are made

to the lake shore, in a comparatively short time the societies become disturbed and may make sudden advances without definitely occupying the intervening ground.

The final result of the filling of the lake and the progression of the zonal societies will be a moist mesophytic forest. Near Brush Lake there are many small swamps and ponds, in various stages of destruction, which show quite strikingly what the actual history with any given set of conditions will be. If the filling is slow and uniform, the final stage before the hydrophytic forest is a swamp, shrub society. In these swamps the same shrubs mentioned above as occurring in the shrub zone of Brush Lake are the predominant vegetation. *Cephalanthus*, various willows, dogwoods, and swamp roses take possession and these are followed by the silver maple, white elm, white and red ash, black and peach-leaf willow, and other trees.

There is an interesting extinct or nearly extinct pond about three-fourths of a mile north of Brush Lake on rather high ground in a small, unpastured forest. A ploughed field extends near one side which has evidently been responsible for some rapid filling in recent years. The fringe of hydrophytic shrubs is still near the margin and just outside of this is a young and very thick zone of white ash. The whole centre inside of the shrub zone is an open, flat, nearly circular area with a small depression in the centre about ten feet across. During dry seasons the water disappears entirely and the area is covered with rank moisture-loving weeds, while in a wet season it is covered with water several feet deep.

In the fall of 1902, *Nymphaea advena* Sol. was present in the small depression in the centre, although the leaves were mostly dry. No pond lilies were evident outside of this depression, although the area was carefully searched. Along with the *Nymphaea* and around it was an abundance of *Polygonum punctatum* Ell., and surrounding this was a dense growth of *Polygonum hydropiperoides* Mx. The last mentioned plant extended outward to the shrub zone. But at some distance from the centre the *Polygonum* was interspersed with very tall plants of *Erechtites hieracifolia* (L.) Raf. and other moist ground weeds as—

<i>Echinochloa crus-galli</i> (L.) Beauv.	<i>Solanum nigrum</i> L.
<i>Panicum capillare</i> L.	<i>Ambrosia artemisiaefolia</i> L.
<i>Polygonum pennsylvanicum</i> L.	<i>Leptilon canadense</i> (L.) Britt.
<i>Phytolacca decandra</i> L.	<i>Carduus lanceolatus</i> L.

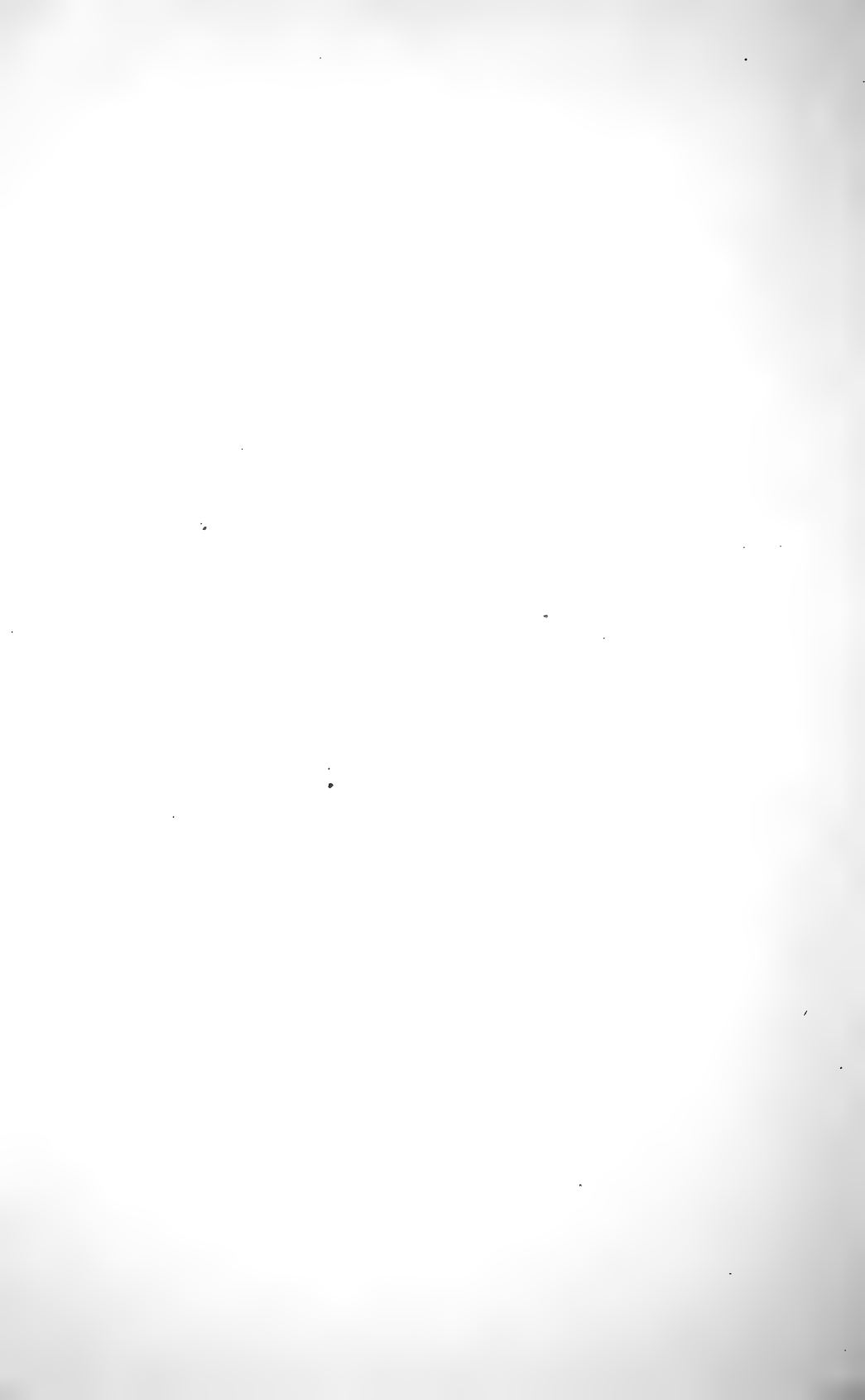
The *Phytolacca* did not extend very far beyond the shrub zone. In and outside of the shrub zone, which was composed mainly of *Cephalanthus*, willows, dogwood and rose, there was an abundance of sedges belonging mainly to the species—

<i>Carex lupulina</i> Muhl.	<i>Carex muskingumensis</i> Schw.
“ <i>squarrosa</i> L.	

As stated above, in and about this sedge society and extending down to the narrow shrub zone there is a remarkable zone of young saplings and seedlings of *Fraxinus americana* L., forming almost a continuous circle around the shallow bank of the filled pond. These trees have probably developed within recent years since the pond has practically become extinct. The forest zone just outside of the sapling zone is rather dry and mesophytic and consists of elms, ashes, cottonwoods, oaks, hickories, hackberries, dogwoods, etc.

In the spring of 1903 there was a partial reversion to former conditions. A long period of abundant rains had filled the dry basin, flooding even the shrub zone; and the surface of the pond was diversified by an abundance of the green leaves of *Nymphaea advena* Sol. One visiting this spot for the first time would never have dreamed of the moist-ground weed society which had covered the place eight months before. With the return of the water the pond lillies revived, although had the dry season continued for a year longer they would probably have mostly perished.

In this pond there will be an oscillation between hydrophyte and mesophyte societies for many years to come. But finally the last pond lily will disappear, having struggled not only against living enemies, but against the inevitable change in the physiographic conditions. The surface of the pond will then be rapidly covered by a mesophytic forest, if man does not overrule the orderly process of nature. At some distant day Brush Lake will be in the same condition as the dying pond and only the spade or drill will reveal the former existence of the present basin with its hydrophytic flora.







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