PREHISTORIC FACTORS IN THE DEVELOPMENT OF THE VEGETATION OF OHIO

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During the half century that has elapsed since the organization of the Ohio Academy of Science numerous papers have been presented at its meetings in which the distribution of the flora and plant communities of Ohio was discussed. Most of these papers described local areas, county surveys, or the character of the successions in various parts of the state. Usually some attempt was made to relate the findings to climatic and soil factors. Others have discussed the relations of Ohio vegetation to that of surrounding states and have attempted to describe its origin.

During the past twenty-five years, the vegetation of numerous counties has been studied in some detail and checked with the survey records of pioneer days. At the same time our knowledge of the native flora of Ohio has been greatly increased through the finding of many unrecorded species and by the discovery of many new localities in which previously recorded species are living.

Meanwhile, additional details of preglacial, glacial, and postglacial changes in drainage in physiography and in soils have been brought to light by our geologists and pedologists.

The early authors who discussed the distribution of plants in Ohio were content to speak of the plants from the north and the south, or the east and the west. The publication of the glacial geologists, however, furnished a more intelligent basis for relating our present flora and vegetation to the climatic fluctuations of the past, especially the changes that resulted in the melting of the last ice sheet. This was followed by the northward migration of plants from south of the glacial boundary across the state to Canada. Certain authors talked of successive waves of tundra, boreal forest, and deciduous forest species moving northward into the lands uncovered by the ice. These generalizations definitely recognized the importance of (1) the historical factors as well as the complex of present day climatic and soil factors; and (2) distinguished clearly between the successions that are occurring under present conditions, and the successive vegetation types that may have occupied the state as a result of the larger prehistoric climatic shifts and physiographic changes (1, 2).

One of the members of this Academy also inaugurated in this country the now widespread study of peat deposits from the point of view of the kinds of pollen preserved in successive layers from the beginning of peat formation in ponds or lakes to the present time. These studies have given us by far the most definite records of the predominant vegetation types during prehistoric times (4). Most of the published records present the successive pollen frequencies of post-Wisconsin time, but it is not unlikely that in the course of time interglacial, and perhaps even preglacial peat deposits may yield similar information concerning

earlier migrations of vegetation during the Pleistocene and before. Fragments of this nature have been found, but apparently none covering very long periods.

From the pollen studies it now seems clear that during the post-Wisconsin epoch in central Ohio, forests of Jack pine, white spruce, and black spruce followed closely the retreating edge of the ice and that there was no distinct zone of tundra along the ice margin. White and black spruce forests were the predominant types for a very long time, perhaps the first half of post-Wisconsin time. This forest was at length invaded by northern oaks and pines. About the beginning of the last third of postglacial time, white pine with hemlock became the predominant species on the Ohio upland. Only during the last several thousand years have the oaks, hickories, and other deciduous species been dominant, following a rapid disappearance of the white pine and hemlock. The dominance of beech and maple over the greater portion of the state is the latest change in the prevailing vegetation.

At some time during the latter part of this record there was a long dry period that led to the invasion of Ohio by prairie species and communities similar to those of Illinois and Iowa. Whether it coincided with the dominance of white pine and hemlock or whether it resulted in the decline of this forest type remains to be determined (7).

The first effects of the Xeric period must have been the death by drought of trees in the swamp forests and the moderately moist habitats. This was followed by increased frequency and intensity of natural forest fires which opened up large areas of land to the prairie plant invaders. The prolonged droughts of the Xeric period also resulted in the elimination from the region of the prairie peninsula of many forest species which survived both north and south of this region.

The occurrence of many rare or out-of-range species on the peninsulas, lake shores, and islands of the upper Great Lakes is probably more related to their elimination elsewhere, especially from the area of the prairie peninsula by prolonged droughts in late post-Wisconsin time, than to the assumption that the areas in which they now occur were unglaciated. Most of these areas were not only glaciated, but were submerged in proglacial lakes for centuries following the slow retreat of the edge of the ice sheets.

At what time the upland hard pines and their associated shrubs and herbs came into Ohio from the Alleghany and Cumberland plateaus is unknown. Likewise, the time of the migration of sweet gum, pecan, pumpkin ash, and other species from the bottom lands of the Mississippi Embayment is not clear. It seems possible, however, that there were scattered upland pines here during the entire Pleistocene and that some of the Embayment species may have arrived in pre-Wisconsin time.

There are, however, some other isolated plant colonies in Ohio that seem to be definitely survivors of pre-Pleistocene time. They contain typically Appalachian species that may have come into the state by way of the pre-glacial Teays valley, or may at one time have been generally distributed throughout the Alleghany and Cumberland plateaus. At the present time, they are far separated from their next nearest stations in West Virginia and Kentucky and it is highly improb-

able that their occurrence here is accidental. As a rule they are hilltop and cove species.

We have called attention previously to the pre-glacial Teays valley which had its headwaters in West Virginia, Virginia, and western North Carolina. This great river system, together with other smaller rivers north and west, must be regarded not only as carriers of seeds and propagules to Ohio, but as agencies of erosion which carved a vast network of valleys and canyons across the mountains and plateaus. These valleys afforded not only a continuous series of bottom land habitats, but also parallel lines of steep slopes, cliffs, and ridge tops where the migration of upland species might readily proceed.

One of the striking facts about the species the distribution of which in Ohio may be directly or indirectly related to these river valleys and ridges is their absence at the lowest altitudes of the state. Among such isolated species are *Rhododendron maximum, Magnolia tripetala, Magnolia macrophylla, Styrax grandifolia, Pachystima canbyi, Calycanthus nanus, Azalea lutea, Oxydendrum arboreum, Chionanthus virginica, Polypodium polypodioides* and *Lygodium palmatum.*[1] The stations of these plants are singularly remote from other stations in the plateaus. Most isolated species are those which are characteristic of unoccupied or pioneer habitats, but most of these species are distinctly examples of undergrowth in well established forest communities.

Moreover, there are certain localities in the state such as Liberty township in Jackson County, and the Blackhand sandstone area of Hocking County (3) which have remarkable isolated assemblages of species growing in habitats that apparently are not unlike those in many other parts of unglaciated Ohio, but in which comparable assemblages are lacking. I use the term assemblages because the plants included are strikingly heterogeneous, as to habitat, taxonomic relations, and community affiliations. They range all the way from species of pioneer communities to those of climax associations and various ones are usually considered to be characteristic of boreal, hemlock-hardwood, deciduous, or prairie associations. Morevoer, the disjuncts include flowering plants, conifers, ferns, mosses, lichens, and algae. Both areas have a marked diversity of edaphic and microclimatic situations, but scarcely more so than various other areas in Southeastern Ohio. Both are areas having elevations considerably above the 900 foot level.

Assuming that our data are relatively complete, it is at least possible that the absence of these species in ravines, coves, and rock ledges remote from the higher uplands is a consequence of geological events connected with the earliest invasion of Central Ohio by an ice sheet, long antedating the Illinoian epoch. The northwestward flowing Teays river was dammed when the ice pushed across its valley and there must have resulted a rising flood that became a proglacial lake of vast proportions. Its southern and southwestern boundaries at the time of its maximum depth are not clear, but the lake probably extended as far west as the Licking valley of Kentucky, as far east as the present

[1]Across the Ohio river from Lawrence and Scioto counties are isolated stations of *Pinus pungens* and *Quercus ilicifolia.*

Kanawha in West Virginia, as far north as Northern Ross and Athens Counties, and 40 to 50 miles south of the present day Ohio River.

Within the boundaries of this lake in Kentucky, which rose to levels above 900 feet, the geologists have discovered nearly a score of large glacial boulders. The composition of the rocks is reported to be unlike that of any rocks of the Ohio drainage basin, but similar to certain rocks of Eastern Ontario. These boulders must have been carried to their present location far beyond the Illinoian and Wisconsin terminal moraines, either directly in the ice of an earlier glacial invasion of Kentucky, or indirectly by icebergs floating on a deep proglacial lake. The evidence now available points to the latter alternative. Either alternative, however, would imply the formation of a large lake in southeastern Ohio, adjacent West Virginia, and Kentucky.

The duration of this lake is of the greatest significance as a destroyer of vegetation, since it existed a length of time sufficient for one to two hundred feet of silt and sand to accumulate. This silt eventually filled all the valleys to near the 900 foot level and obliterated the underlying topography. This conclusion is based on the fact that when an outlet was opened over a divide somewhere and the lake was gradually drained, many of the renewed streams did not return to their former valleys, but found new outlets to the Ohio River which was pieced together from various preglacial streams during the draining of this lake (5, 6).

A proglacial lake in this location must have been subject to great fluctuations in water level. To the north were the ice masses subject to rapid or slow melting, depending upon temperature and rainfall conditions. To the east and south the vast drainage area of the plateaus was subject to flooding through sudden melting of deep snows and heavy rainfall. The flood in the Ohio basin in the winter of 1937 caused the river to rise 60 to 80 feet in this same region. When the weather conditions at the edge of an ice sheet are compared with those of the present climate, and the fact that the outlets for the water were far more restricted than at the present time, it is not impossible to account for the large Kentucky boulder that was deposited at the 1000 foot level.

In speaking of the indirect effects of the ponding and reversal of drainage of this ancient lake, I have in mind the profound effect it had on the soils of the filled valleys, and the valley terraces. Thus, there was not only the destruction of all vegetation in the areas submerged, but a complete change in the soils to which plants that may have survived on islands and peninsulas might have subsequently migrated. When the stream flowed northwestward the soils of this area were derived from shales and sandstones of the plateaus. When the streams of the plateaus were ponded the streams from the glaciers carried calcium and magnesium carbonates from the limestone of central and northern Ohio. Moreover, it was not until the silts had been eroded and removed by subsequent streams that many of these habitats were uncovered and developed their present characteristics. Thus, today there are many localities in southern Ohio where, for example, rhododendron might be expected to occur, but in which it is absent.

It may at first thought seem difficult to believe that some of the rare plants in the Jackson and Hocking regions have been there during

the entire Pleistocene. Nevertheless, I am suggesting this possibility, and also that this earliest great proglacial lake[2] was one of the factors that contributed to the isolation of certain species in these remote localities. There may have been other and later factors that contributed to the extermination of these plants on other areas above the 900 foot level. One of my associates will in the near future publish further details concerning the possible boundaries of the lake and complete lists of the species in these two veritable living museum areas.

The impression is now growing that the historical factors are far more important in explaining the limits of associations and communities than we have ever imagined, and that vegetation patterns of the past remain for very long periods after the factors that initiated them have disappeared. In the list of papers below are other hypotheses concerning historic and prehistoric factors that may have influenced the present distribution of plants of Ohio. Also, there are other guesses as to how long some of the unusual habitats have been undisturbed, and when certain isolated groups of species migrated into Ohio. As more details of Pleistocene geography are discovered certain of these suggested explanations will be rendered either more plausible, more improbable, or definitely impossible and we shall be nearer a satisfactory history of Ohio vegetation.

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[2]This lake might very properly be called "Tight Lake" in honor of the geologist who first mapped the drainage modifications in southeastern Ohio.