INTERGLACIAL AND POSTGLACIAL VEGETATION OF ILLINOIS*

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AS THE OBSERVER explores the forests and the remnants of the grasslands of Illinois he is led to inquire what has been the past history of the vegetation of the State. Neglecting the cycads, the horsetails, the ferns, and their associates that formed the coal measures millions of years ago, and considering the past half-million years only, the picture of the plant cover of the hills and valleys is very incomplete. Such plant remains as have been found are encountered, for the most part, in various peat deposits; many of them deeply buried in glacial drift. During the past 50 or 60 years numerous reports have appeared of the finding of the remains of the interglacial vegetation which were encountered in well drillings, mine shafts, and road and stream cuts. These remains were seldom identified with any desirable degree of scientific accuracy. The wood, for example, was named usually on its external resemblance to that of living trees.

During the past quarter of a century there has been developed, however, a more exact and scientific technique for the examination of plant remains found in peat deposits. It is based on the fact that the exines or outer coats of many pollen grains are very resistant to decay when immersed in pond or bog waters and may be identified with accuracy even after intervals of tens or hundreds of thousands of years.

This technique was first developed in northern Europe about 25 years ago. There a group of Swedish workers led by von Post and Erdtman examined peat deposits microscopically and finding in them well preserved tree pollen elaborated a technique now well known under the designation "pollen analysis." Erdtman has been one of the foremost investigators in this field and has accumulated many valuable data (7). He has made the technique internationally known and has devoted much attention to its improvement (9, 10). Many European investigators have used these methods and there has accumulated a great mass of data indicated by the hundreds of titles listed by Erdtman (8) in his bibliography of the subject. The testimony of many investigators and some statistical observations have led to the acceptance of the data of pollen analysis as being reliable within certain limitations.

It is not our purpose to discuss the details of the technique of pollen analysis, except to say that instruments are available by which samples of peat may be taken from bogs from known depths. These samples are so treated that the extraneous substances are removed and the pollen grains made more recognizable. These grains are examined and counted under a compound microscope. Further details of the process may be found in the contributions of Erdtman (8), Sears (16, 17), Godwin (12), Voss (18, 19, 20, 21) and others. It may be significant, however, to examine some of the limitations to be observed in the interpretation of the results thus obtained.

Both American and European investigators have found the pollen of tree species more useful and better preserved than that of herbaceous plants. Such pollens may be recognized as belonging to the genera of the trees producing them, and as found in peat deposits, may be classified with regard to their source on the basis of distance of transport as:

1. Pollen from trees growing on the bog and its immediate margin;
2. Pollen from trees in the forest within a radius of 1000 yards of the margin of the bog;
3. Pollen from trees between 1000 yards and 5 miles of the bog;
4. Pollen from trees more than 5 miles from the bog.

These pollen components may be termed respectively the bog, regional, distant,

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and remote components. Von Post, Erdtman, and others have shown that the regional component is the largest and most important of these, with the distant component second in size and importance.

This may explain how pollen analysis gives, as a rule, a general picture of the forest type for a rather wide area, not a representation of the local tree growth on the bog itself and its immediate margin. That is to say, the pollen diagram points to the general character of the forest-cover of the whole countryside and this characteristic adds to its value as an indicator of the regional vegetation of past ages.

Amounts of pollen are expressed in percentages of the total tree pollen. It has been found impossible to express the amount of each pollen on an absolute scale. It is therefore true that the amount of pollen from any one species always affects the percentage values for all other species, hence although the results do not show the absolute abundance of any one tree they do indicate changes in the relative abundance of the pollen of different tree genera.

The pollen diagram must not be interpreted in detail, for the presence of a few scattered grains of any particular species cannot be accepted as proof that the species was growing in the immediate neighborhood of the deposit; they may have been windborne from a great distance. Hence they must be neglected unless the presence of the species in the vicinity is assured by other data. It should also be remembered that some tree genera produce much more pollen than others, that certain pollens are much better preserved in bogs and that certain tree genera, on account of their narrower ecological range, are much better indicators than others.

It is therefore evident that a pollen diagram (or diagrams) of an entirely unknown forest would not accurately reveal the tree population of such a forest. But such diagrams would permit a choice to be made from a score of known forest types—the predominating type, or types, could be distinguished in spite of the fact that not all its tree components were represented in the pollen diagram, thus an abundance of *Abies* and *Picea* pollen in the Great Lakes region would make it most highly probable that *Larix*, *Betula*, and *Fraxinus* were also present in considerable numbers in the region adjacent to the bog, and that the forest was of the northern conifer type.

Presentation of Results

From the nature of the data it is most desirable that generalizations based on pollen analysis should be made only upon very considerable accumulations of evidence. In other words, the data from a single bog, even though carefully collected and accurately analyzed, may be used for a general picture of the surrounding forest only when supported by other data. Such accumulations of data, until very recently, have been lacking in America and are still decidedly deficient. In this field, Voss of Peoria has been the outstanding American investigator, and the only one who has studied the interglacial deposits. To him the writer is indebted for the greater portion of the data on which this article is based. Other workers include Houdek of Illinois, a group of workers connected with Butler University in Indiana, Sears and his associates in the Lake Erie region, and Wilson and Hansen in Wisconsin.

The northern half of Illinois seems to be particularly well suited for such studies of past vegetation. At least four ice sheets have crept down from the North to cover portions of its surface, and retreating have left drift in which were depressions that became occupied by ponds and lakes. These have developed vegetation that decayed into peat bogs. Some of these peat deposits have been buried by the moraines of succeeding ice sheets, compressing the peat, but aiding in preserving its store of tree pollens.

The Pleistocene with its glaciations has been investigated by many geologists and many of their data have been presented in interesting form by Daly (6). Leighton (14, 15) and Ball (2) among others have studied the moraines and other evidences of the ice sheets that have visited Illinois. Various estimates have been made of the duration of the ice sheets and of the interval between them. It seems to be particularly difficult to estimate the length of time required for the accumulation and the subsequent disappearance of these immense glaciers. The following estimates taken from the best authorities available, must be regarded as tentative approximations for the past half-million years. The following stages are recognized:

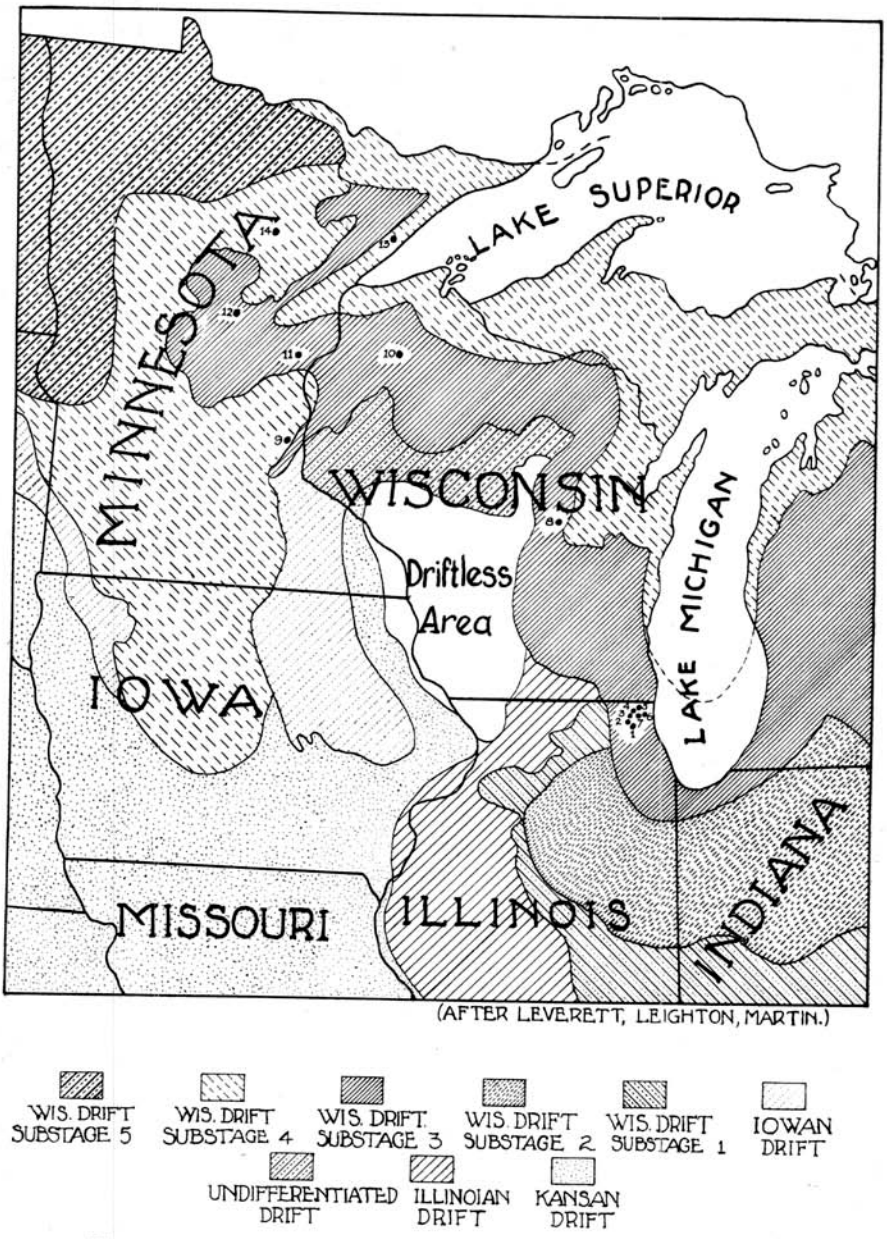

Fig. 1. Map of the Wisconsin drift sheets. Compiled by Voss.

Recent or postglacial time, 25,000 to 30,000 years
Wisconsin glacial stage, 100,000 years
Sangamon interglacial stage, 120,000 years
Illinoian glacial stage, 100,000 years
Yarmouth interglacial stage, 200,000 to 300,000 years
Kansan glacial stage, 100,000 years.

The most complete picture of the vegetation of the northern half of Illinois for the past 25,000 or 30,000 years comes from a group of seven bogs in Lake County found in Cary (3rd) substage of the Wisconsin drift, and investigated by Voss (19), (fig. 1).

The present vegetation of several of these bogs has been described by Waterman (22, 23) and by Kurz (13). They are found scattered in a rolling morainal area in a county that seems originally to have had at least three-fourths of its surface covered with deciduous forests.

The pollen analyses of these bogs show such remarkable agreement in their pollen diagrams that the results are most convincing. One of these diagrams may be taken as representative of the group (fig. 2). In interpreting these diagrams it must be remembered that the seven bogs, being in the same moraine and necessarily of similar age, differ considerably in depth. This necessitates some adjustments in the vertical length of the graphs when we attempt to synchronize the records.

It may be instructive to make such adjustments and to compare the pollen curves for the same species in the group of bogs.

The balsam fir, *Abies balsamea*, may be regarded as a good indicator species. It is found represented by its pollen in all seven Illinois bogs at the bottom of the deposits. The pollen curves from the seven bogs plotted together show an abundance of the species in the earliest centuries of the bog deposits but also show its disappearance relatively early in the history of the deposits (fig. 3). With our present limitations of knowledge it is impossible to more than approximate the time of the disappearance of *Abies* from the deposits and hence from the forests of Illinois, but if we accept the time of the recession of the last Wisconsin ice sheet as occurring some 25,000 years ago it seems likely that fir entirely disappeared during the first 5,000 or 6,000 years or about the end of the first quarter of that period. Data from the bogs of northern Indiana, collected by Houdek and others, although not yet as abundant as those from Illinois, give similar graphs for *Abies*.

These Illinois and Indiana bogs also show the early presence of spruce in the forests of the region and apparently the genus *Picea* persisted for a slightly longer period than did the fir but it also probably disappeared soon after the close of the first quarter of postglacial time. The curves representing the occurrence of *Picea* in the forests near all seven bogs are very similar (fig. 4).

As an indicator the genus *Quercus* seems to rank with *Abies* and *Picea* as very significant. Oak pollen appears in all the bogs of postglacial age that have been investigated. The pattern of its graphs is strikingly different from those of the fir and spruce but this pattern remains very constant throughout all the Illinois and Indiana bogs. It is found in small quantities at the bottom of the deposits, reaches a maximum about the time that the fir and spruce disappear and persists with irregular fluctuations to the present (fig. 5).

No other tree genera give records, comparable in importance to those of *Abies*, *Picea* and *Quercus*. The *Pinus* record would indicate the presence of the genus throughout practically the entire postglacial period with no decided or regular times of maxima or minima. *Carya*, in the Illinois bogs roughly parallels *Quercus* with much smaller percentages of pollen. *Tilia* and *Acer* show a wide distribution both in time and space, but present narrow and irregular pollen curves that are difficult to interpret.

Comparable to the record of the 7 bogs from the Cary or Late Wisconsin stage is that from 9 bogs of the Tazewell or Early Wisconsin substage (2nd) also studied by Voss (20). They occur in moraines of similar age and are found in Bureau and adjacent counties. The bottom of these deposits was laid down 35,000 or 40,000 years ago or probably 10,000 years earlier than the base of the Cary deposits just discussed. The pollen record is similar to that of the more recent deposits except that the fir and spruce pollens appearing most abundantly at the bottom of the bogs persist for a relatively longer time and the period of the dominance of oak is relatively shorter. Doubtless portions of northeastern Illinois were still covered with Late Wisconsin ice while these peat deposits were being laid down.

Passing from the records connected with the Wisconsin Glaciation and the postglacial interval that has succeeded it, we come to the more remote Sangamon Interglacial Stage. The last centuries of this stage were probably some 125,000 or

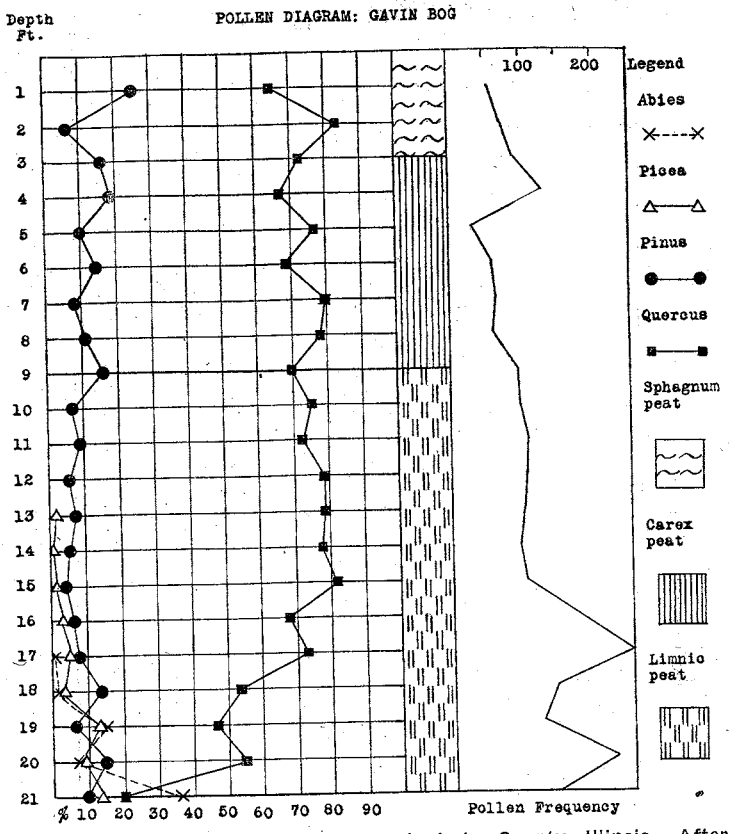

Fig. 2. Pollen diagram of a postglacial bog in Lake County, Illinois. After Voss.

150,000 years ago, and the interglacial period is supposed to have lasted for something like 120,000 years. Recently several peat deposits, known to belong to the Sangamon Interglacial and buried beneath many feet of gravel and loess, have been exposed. Two of these are so thick (135 and 78 inches) that it seems probable that they represent the greater portions of the period. Five of these deposits from Peoria, Bureau, Fulton, Tazewell and Woodford counties, investigated by Voss (21) give a good picture of the climate and vegetation of the period.

The fact that the five records agree so closely adds much to their credibility. The pollen of deciduous trees is conspicuous by its almost entire absence but throughout all the records there is a persistence of fir, spruce and pine with relatively little variation in the proportionate amounts. In one deposit only (the Canton) does oak and hemlock pollen appear. This is the only evidence at present uncovered that there was any marked climatic variation throughout the Sangamon Interglacial although its duration has been estimated at 120,000 years. The persistence of the spruce-fir record indicates a cool climate with a rainfall perhaps comparable to that at present; in other words, a climate similar to that existing today north of Lake Superior. The Canton record suggests that at two intervals there may have been such an amelioration of temperature that some areas of the forest possessed a small proportion of oak, hemlock and associated species. This might mean a climate and a vegetation like that at present existing on the south shore of Lake Superior. These two milder intervals may have occurred before the middle and towards the close of the Sangamon Interglacial Stage and each may have persisted for several thousand years (fig. 6).

The Yarmouth Interglacial Stage is much older than the Sangamon, being

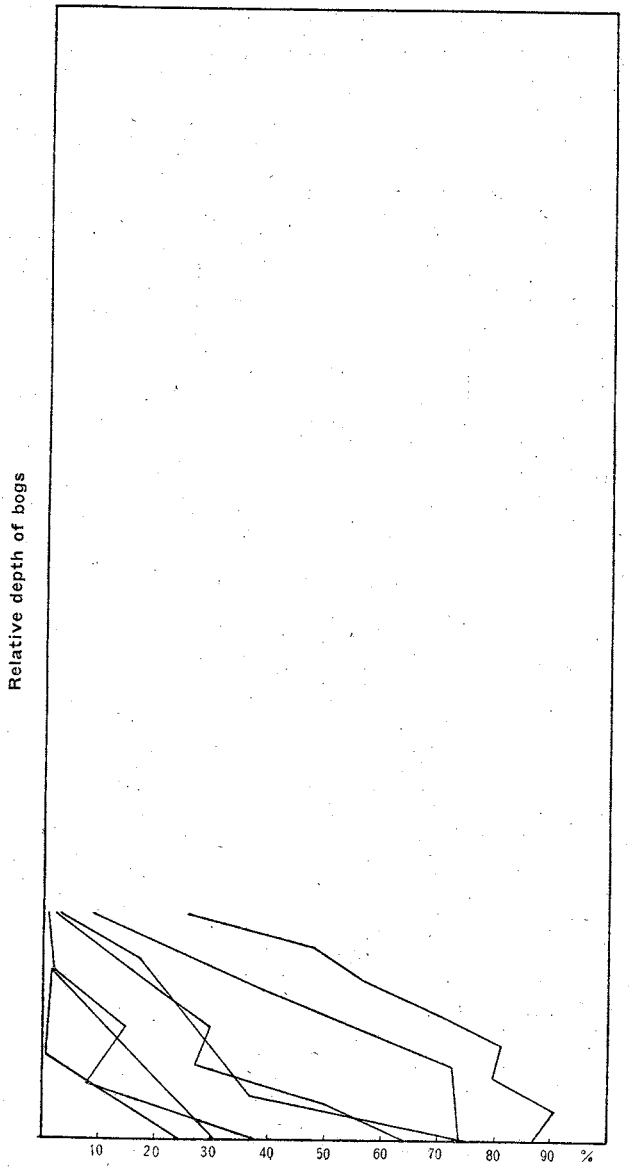

FIG. 3. Graphs showing the occurrence of *Abies* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by Voss.

separated from it by the Illinoian Glacial that had a duration of perhaps 100,000 years. This would mean that the Yarmouth began over half a million years ago and it seems to have persisted for some 200,000 to 300,000 years. With this prolonged existence it is unlikely that any one peat deposit represents more than a portion of the period. Two deposits of Yarmouth Age found in Adams and Macoupin counties, have recently been studied by Voss (21) partly through the assistance of a grant from this Academy of funds made available by the A. A. A. S.

Of these deposits that at Quincy, Adams County, may be taken as revealing the

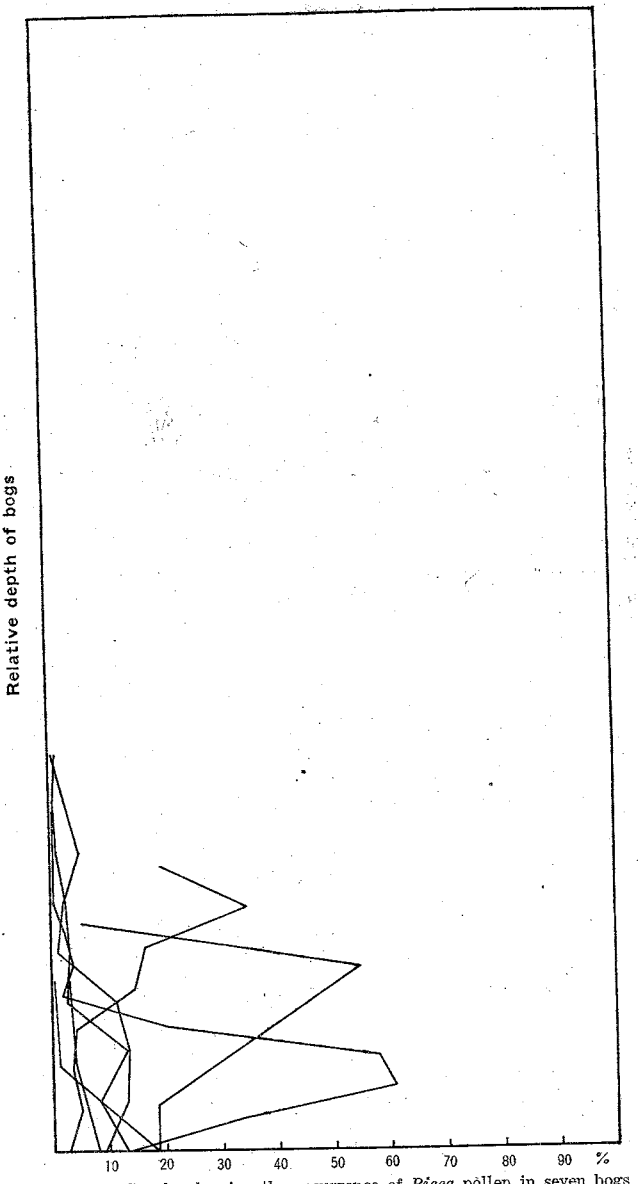

FIG. 4. Graphs showing the occurrence of *Picea* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by Voss.

forest vegetation of that remote period (fig. 7). The two deposits, however, disclose similar records showing the existence of fir, spruce, tamarack, and pine throughout. In other words, the plant remains indicate the northern conifer forest characteristic of a cool, rather moist climate. This agrees with the conclusions drawn by Baker (1) from his studies of the mollusca of Illinois associated with the Yarmouth period.

INTERPRETATION OF THE RECORDS

In attempting to obtain a more complete picture of the vegetation of Illinois during the past half-million years we

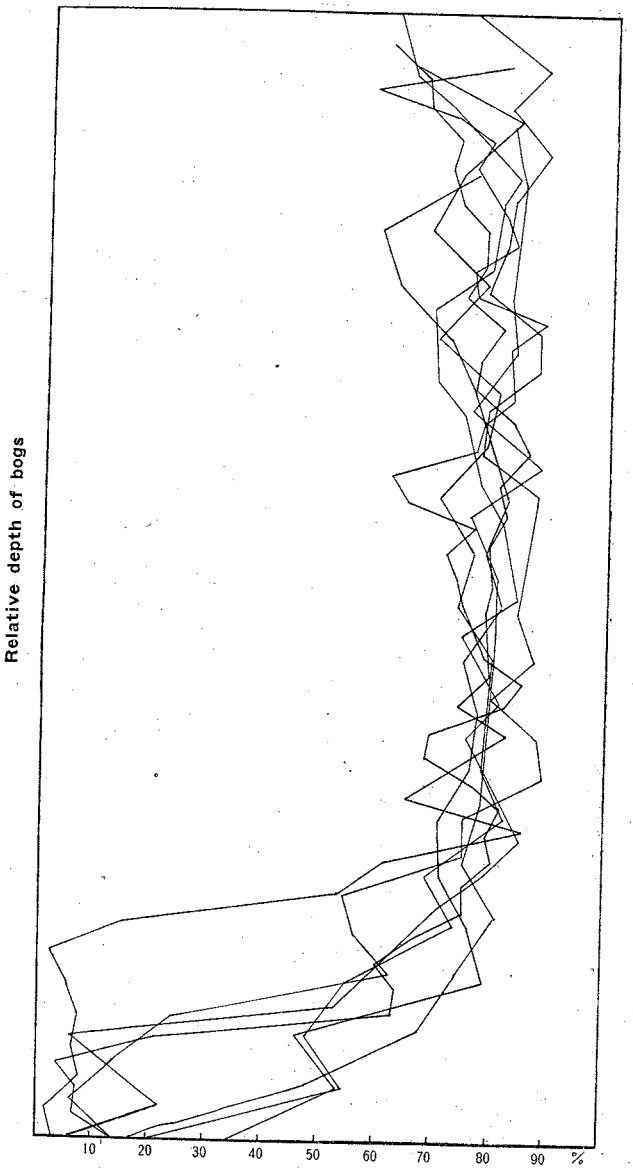

FIG. 5. Graphs showing the occurrence of *Quercus* pollen in seven bogs in Lake County, Illinois. The graphs represent depth of bogs vertically and percentages of pollen horizontally. From data by VOSS.

should have as a background the geologic data which have accumulated during the past few decades. These have been brought together in an interesting and relatively non-technical form by Daly (6). They indicate that a climate somewhat cooler than the present obtained for most if not all of Pleistocene time and that precipitation was at least equal to that of the present.

In attempting to translate the bog records into terms of climate and actual vegetation we are faced at the very beginning with the question of whether the forests followed closely upon the margin of the retreating ice sheet or whether a

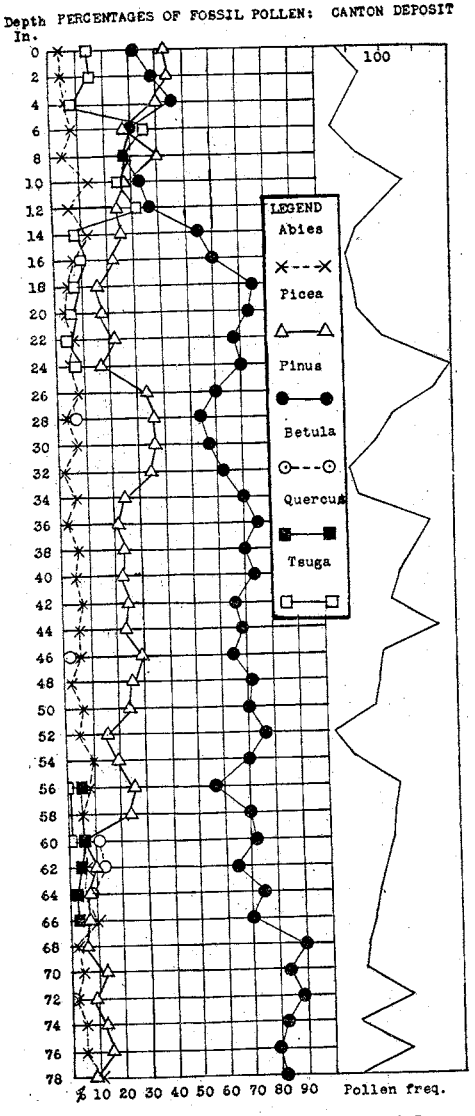

Fig. 6. Pollen diagram of a bog of Sangamon age in Fulton County, Illinois. After Voss.

rather extended period of tundra vegetation intervened. This question is particularly pertinent when applied to postglacial time since Woodard and others have argued in favor of an extended period of tundra vegetation which persisted until invaded by prairie grasses.

Certain facts, however, seem to indicate that there was no wide interval between the ice and the forest. The records of the Early Wisconsin stage and of the Sangamon Interglacial seem to prove that there were conifer forests in north-middle Illinois for many thousand years during which the Wisconsin ice sheet existed in the northern portions of the state. This makes it almost certain that such forests followed closely upon the retreating glaciers. Cooper (5) has recently found a spruce forest following within a few miles the retreating ice front of Alaskan glaciers.

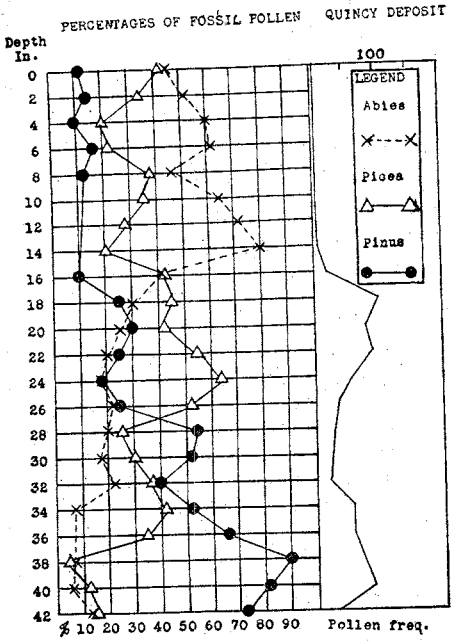

Fig. 7. Pollen diagram of a bog of Yarmouth age in Adams County, Illinois. After Voss.

All these records seem to point to the various substages of the Wisconsin glaciation having been followed closely by a forest of the northern conifer type such as now exists about the shores of Lake Superior. Such a forest must have consisted principally of spruce, balsam fir, species of birch together with some maple. Tamarack, ash and alder also doubtless grew on the swampy areas. This forest seems to have persisted for probably 10,000 to 15,000 years in middle Illinois and perhaps for half that time in the northern portion where the ice sheet had a longer duration.

The greater remoteness in time makes the interpretation of the vegetation of the

Sangamon and Yarmouth periods still more difficult. Recent studies by Braun (3) and by Cain (4), made in parts of the continent not subjected to Pleistocene glaciation, seem to indicate that a flora essentially similar to the present has existed in North America for more than a million years. This means that the same tree genera and probably the same species that now exist in Illinois were present on the continent, and had the same climatic requirements during the Sangamon and Yarmouth, that they have today.

Unfortunately we have little or no direct information as to the relative areas occupied by forest and grassland during those remote periods. The fact, however, that the grassland soils now existing are composed of materials deposited much more recently than the Sangamon and Yarmouth seems to make it highly probable that forests covered a much larger portion of the state than during recent times.

Conclusions

The fossil pollen of Yarmouth, Sangamon and Early Wisconsin interglacial periods supports geological and other evidence that these periods were characterized by cool and moist climates and that during these periods the northern half of Illinois was covered largely with northern conifer forests.

These forests appear to have been similar to those now existing north of Lake Superior, being composed of balsam fir, *Abies balsamea*, spruce, *Picea* spp., pine (*Pinus banksiana* and *Pinus* spp.), tamarack, *Larix laricina*, birch, *Betula* spp., and smaller amounts of associated species. There is at present no evidence that deciduous forests were present during the long Yarmouth period.

Twice during the Sangamon period, there seems to have been a mixture of oaks and hemlocks along with the elements of the more northern conifer forest. These would indicate a somewhat milder climate during some centuries (or thousands of years) in the earlier portion and again towards the end of the period. The data, however, indicate the dominance of northern conifers throughout.

In postglacial times the ice sheet seems to have been rather closely followed by a forest similar to the existing northern conifer forest in which spruce, fir, and pine were notable genera.

This forest seems to have been replaced in Illinois before the end of the first quarter of postglacial time, by a mixed deciduous forest in which oak, hickory, maple, and elm were dominant trees. This deciduous forest seems to have continued, relatively unchanged throughout the later three-fourths of postglacial time.

The pollen record in the Lake Michigan region seems to show no evidence of alternating moist and dry periods during postglacial time.

The pollen record seems to indicate that the forested areas of Illinois were much more extensive during the Yarmouth and Sangamon Interglacial periods and in the early portion of postglacial times than at present. It seems possible that the increasing warmth of the middle and later parts of the postglacial period and greater relative dryness favored the invasion of the forest by the grassland. Our present data are too scanty, however, to determine the relative extent of forest and grassland throughout these interglacial periods.

Acknowledgements

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