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A study of succession on an acid peat bog in Kane County, Illinois

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A Study of Succession on an Acid Peat Bog in Kane County, Illinois

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Abstract

The vegetation on a bog located in Kane County, Illinois was studied. Interpretations of the bog were also made from aerial photographs of the area taken in 1939 and 1961. The strata of the peat were sampled for the types of pollen found in them and from this data, assumptions of the earlier vegetation types that covered the area around the bog were made. The peat was analyzed and correlated with the vegetation studies.

An interpretation of the results from the pollen analysis cannot be definite. Rather assumptions are made based upon the trends interpreted from the frequency of the various genera of tree pollen.

Four major plant associations and two minor associations were observed on the peat during the recent studies. Changes since 1939 in the size and composition of the associations are discussed. The ecological succession has been directed by the lowering of the water table and the responses among the different associations to this event. The amount of decomposition that is occurring in the peat is related to the successional stage under which it is found.

The development of the bog followed the classical interpretation of bog succession. However, the succession from the heath seral stage to the climax oak forest is presently occurring at an accelerated pace because of the drop in the water table.

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Table of Contents

Title Page i

Abstract ii

Signature Page iii

Acknowledgments iv

List of Tables vi

List of Figures vii

Introduction 1

Review of Literature 4

Methods and Materials 13

Results and Discussion 21

Conclusions 54

Literature Cited 57

List of Tables

Table	Title	Page
I	Pollen Count	24
II	Species List	30
III	Analyses of the Total Flora	38
IV	Analyses of the <u>Chamaedaphne</u> Association	39
V	Analyses of the <u>Pyrus</u> Association	40
VI	Analyses of the Interior Wooded Association	43
VII	Analyses of the Marginal Wooded Association	44
VIII	Peat Analyses	47

List of Figures

Figure	Description	Page
1	Vicinity of Hill's Bog	22
2	Pollen strata from Hill's Bog	25
3	Pollen strata from Lily Lake	27
4	Pollen strata from Volo Bog	28
5	Plant associations in 1939	33
6	Plant associations in 1961	37
7	Topography of Hill's Bog	49
8	Probable *Pyrus melanocarpa* expansion	52

Introduction

Hill's Bog, near the junction of Illinois Route 47 and Manning Road, was recognized as unique due to the presence of *Chamaedaphne calyculata* and *Sphagnum sp.*[1] Other bog species such as *Drosera intermedia*, *Hypericum virginicum*, *Betula pumila* var. *glandulifera*, and *Carex oligosperma* were also found with the *Chamaedaphne*. However, a continuous carpet of *Sphagnum* was not found and the peat substrate was dry. The total flora of the bog appeared to be in concentric associations but the species observed in the outer associations were not typical bog species. They were, in fact, species normally considered weeds. It was apparent that the area was a typical peat bog in the not too distant past but that it is presently undergoing succession away from a bog and towards a forested association.

On the basis of preliminary observations, the original purposes of this study were to (1) quantitatively and qualitatively analyze the vegetation found on the peat deposit, (2) explore the historical background of the area, (3) characterize the succession occurring on the peat, and (4) analyze the conspicuous differences in peat texture as seen in the different plant associations. As a supplement, it was decided to add a pollen analysis to the study. Hill's Bog is located in an intermediate area not studied by earlier

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[1] NW¼ SW¼ of Section 16, Rutland Twp. T 42N R7E, Kane Co. Illinois, Elgin Quadrangle.

workers in Illinois pollen studies. A pollen study here would correlate well with the earlier analyses.

Hill's Bog is owned by the Hill's Nursery of Dundee, Illinois. It came under Hill's control in 1902 when it was purchased by the founder of the nursery. Before this time the property had changed hands six times since it was originally obtained by Thomas Fraser as a part of his homestead grant in 1844.

Most of the bog is in the NW¼ of SW¼ of Section 16 but approximately eight acres of it is across the section line in Section 17 and that part is owned by Arthur Van Aker (Fig. 6). Van Aker has his part of the bog in pasturage. Manning Road follows the section line between Sections 16 and 17. It was built in the early part of this century. The adjoining property to the north is owned by George Preller and approximately two acres of the peat is found on his property. Attempts were made by the Preller family to effectively drain their segment of the bog around 1942-1943. It is presently in pasturage. Van Aker's and Preller's properties were not included in the study. According to Preller, high water existed over the bog in the spring and fall and bumper crops of ducks and other waterfowl were shot each year. However, the drought of the 1930's ended this and water does not accumulate as it did in the past.

Hill's Nursery was interested in the bog because of its extensive growth of *Sphagnum*. During the years of their ownership, the living Sphagnum was stripped and used for packing nursery stock. The stripping operation is evident in the 1939 aerial photograph of the bog area. Mr. Jack Hill, the president of the Nursery, said that a number of interesting bog plants were growing with the Sphagnum but these have disappeared in recent years. The only other disturbance caused by the Nursery occurred in 1956. An attempt was made to mine the peat and a drag line dug a trench approx. 130 feet long and 30 feet wide near the north edge of the property (Fig. 6). The peat proved to be of little value and most of it was left piled along the side of the trench.

Due to the presence of fireweed (Epilobium angustifolium) and blackberries (Rubus alleghaniensis) on the bog, both Hill and Preller were questioned about the occurrence of fire on the bog. Hill did not recall any extensive burning but said small fires have occurred along the road. Preller said that hunters would burn the vegetation during the winter in quest of the "last rabbit" but he does not remember this happening in recent years. Preller does not think that the peat itself was ever on fire.

From the cultural history obtainable, it does not appear that the direct activities of Man have altered the succession or vegetation of the bog but indirect effects of Man's activities will be examined later in this paper.

Review of the Literature

Studies of bogs have been conducted in North America throughout this century. However, nothing was found in the literature dealing with the characteristics of the bog under study. There are studies related to and allied with this study and the following discussion is devoted to (1) the definition of bogs and peat, (2) the general scheme of bog development, (3) the effect of disturbance to the bog habitat, (4) the changes in peat chemistry as a result of succession, and (5) the pollen record as preserved in the peat.

There is a problem of defining the study area after comparing observations of bogs in northern Wisconsin and Minnesota with those made at the study area. Since Hill's Bog is located on the edge of the prairie and does not have a Sphagnum cover, it was thought that this area could not technically be considered a bog. However, the review of the literature revealed that a precise definition of a bog has not been formulated. Heinselman (1963), in his "glossary of peatland terms," states that a bog is "a peat-covered or peat-filled area, generally with a high water table, dominated by mosses, especially Sphagnum. Although the water table is close to the surface, usually there is little standing water. ...Typically the upper peat and bog waters are strongly acid. Peat is usually formed <u>in situ</u>. May or may not be tree covered... Often loosely applied to any peat-covered land, especially in the North." Heinselman's definition is broad and not specific but it does summarize the major characteristics of bogs. Dansereau and Segadas-Vianna (1952) conclude that a precise definition cannot be made for bogs in general. They discuss many of the definitions proposed and group them according to the bias of the authors. The definitions were grouped as chemically, physiochemically, or vegetatively oriented. They found that no one definition encompassed all the ramifications of a bog. Thus, instead of attempting a definition, Dansereau and Segadas-Vianna presented a table contrasting the characteristics of bogs and swamps. The discussion of bog nomenclature by Dansereau and Segadas-Vianna is more than adequate for the scope of this paper.

Peat is an accumulation of plant remains in various stages of alteration by chemical, physical, and microbial processes, Heinselman (1963). It is usually formed anaerobically in the presence of a water table or at least on wet sites. Chemically, it is a mixture of celluloses, fats, pectins, sugars, alkaloids, proteins, and other plant products, Wakman (1928). It has a characteristically wide carbon-nitrogen ratio and a low mineral content, Kianl'nikov (1958) and Gorham (1956).

The successional sequence and zonation of bogs has been outlined since the early part of this century. Transeau (1903), Cooper (1913), and Dachnowski (1925) described the sequence of aquatics through the sedge mat to the heath mat ending in the regional mesophyllic climax. Dansereau and Segadas-Vianna also reviewed this scheme. They compiled a comprehensive literature and field notes on the subject. The following is a summary from their paper. Bogs, generally, are formed in recently glaciated areas. Glacial deposits form various drainage impediments which result in a scattering of small lakes. The obstruction of drainage is necessary for initial bog formation. Water is supplied from the melt of glaciers and rain. Drainage continues to be impaired as the development of the bog progresses. (The importance of drainage impediment is unique to Dansereau and Segadas-Vianna in the literature.) Drainage deteriorates continuously until the point is reached in which the evapotranspiration of the developing trees overcomes the incoming water. In the initial stage of bog formation the peat begins to accumulate because of two limnetic stages, the _Chara_ or submerged stage and the _Nymphea_ or floating stage. The _Chara_ and other algae are normally the first to invade the open water. The accumulation of the remains of these plants and other organic debris washed into the lake form an unconsolidated ooze or false bottom. The false bottom is essentially a colloid and is anaerobic, thus little breakdown of the organic matter occurs. The _Nymphea_ or floating stage forms after the false bottom has developed. The large rhizomes of _Nymphea_ and _Nuphar_ grow at the surface of the accumulated ooze. As the rhizomes grow an extensive root system develops and it consolidates the false bottom. Organic debris continues to be accumulated and consolidated into the peat mass. The pioneer mat or floating mat as it is sometimes called, can now develop because of the accumulated peat. Its outward extension into the open water is possible only if an already consolidated mass of peat exists or if a rock, a rotting log, or some solid object can serve as an anchoring point. Myrica gale is an important member of the pioneer mat.

Sphagnum becomes a component of the floating mat stage after some consolidation has occurred. Sphagnum occupies an important niche in the development of a bog. Clymo (1964), Baas-Becking and Nicolai (1934), and other earlier workers have shown that species of Sphagnum can actively take up cations from their environs. Both living and dead material can do this. Clymo found that the site of this activity is the polyuronic acids in the cell walls of the plants. As cations are absorbed, hydrogen ions are released causing an acid reaction to the surrounding waters. Clymo also found that different species can take up cations at different rates. These species have different ecological amplitudes and these amplitudes appear to be related to microtopography. Reichle (1966), found that different species of Sphagnum are located in different successional zones.

A Carex mat may or may not follow the pioneer mat. This is followed by the consolidation stage or heath mat. It is the establishment of the consolidation stage that dictates the future development of the bog. The dominant species of this stage is *Chamaedaphne calyculata*. Dansereau and Segadas-Vianna describe this species as the most important characteristic of bogs. They also state that it enters as a part of the late pioneer mat. Conway (1949) disagrees and states that it does not belong to the pioneer mat and that the youngest shoots are always found away from the water margin. With the development of the consolidation stage the deposition of peat is hastened. The consolidation stage is the most important and the longest lasting of any of the bog stages.

As the conditions of the habitat change during the consolidation stage, *Larix laricina* and *Picea mariana* become established. As the Spruce-Tamarack stand develops, the evapotranspiration ratio of the habitat becomes more mesic. The moisture content of the substrate is lowered. As the habitat becomes more mesic, components of the regional climax become established. This eventually leads to the cessation of the bog habitat and it becomes an extension of the regional climax.

The surveys of bogs in Michigan (Gates 1942) and in Minnesota (Conway 1949) correspond with the general concepts presented by Dansereau and Segadas-Vianna. The bogs in Illinois appear to have followed the general scheme and are now in transition from the consolidation stage to the bog forest, Waterman (1923) and Reichle (1966). The bogs described by Brewer (1966) in southwestern Michigan are also in transition from the consolidation stage to the *Larix* forest. However, Brewer found an association not reported in the bogs to the north. Fifty-nine per cent of Brewer's study area was "low and high thickets" dominated by *Pyrus prunifolia* and young *Larix laricina*. It was invading the open areas. *Larix laricina* was a component of every association on that bog but it was most prevalent in the bog forest. The *Sphagnum* mat was not continuous and in parts of the bog the substrate was dry. There was no open water in Brewer's study area. Waterman also found a better developed shrub association than what was reported in the North. The shrub zones in Illinois were dominated by *Rhus vernix* and *Pyrus melanocarpa*. Man has disrupted the *Larix laricina* associations in Illinois by cutting and burning.

Frolick (1941) points out that the peatlands of Dane County, Wisconsin are under a different climatic regime than the bogs to the north. Dane County is in the prairie-forest ecotome and Frolick states that succession on peat in the ecotome is shrub to Aspen to Oak-Hickory forest. Kilburn (1959), showed that Kane County, Illinois is also a part of the prairie-forest ecotome.

Disturbance is an important feature of bogs and peatlands. Disturbance can be fire, logging, or drainage and can stop, reverse, or accelerate any of the stages in bog development, (Gates 1942, Dansereau and Segadas-Vianna 1952, Segadas-Vianna 1953, Vogl 1964, and Frolick 1941). Frolick found that disturbance was the dominant factor in peatland development in Dane County, and the type of vegetation depends on the kind and severity of the disturbance. However, he did not deal with peatlands supporting a bog flora. Frolick felt that some of his study area may have supported a bog flora in the past since bogs of this nature are found in adjacent counties. The activities of Man have eliminated all bog flora in Dane County. Drainage accelerated the growth of trees, especially *Populus tremuloides*, and shrubs. However, most of the drained peatlands in Dane County were mowed for hay and the invasion of woody plants was impeded. Fire produced a variety of effects depending on the severity of the fire. Vogl (1964) found that *Populus tremuloides*, *Betula pumila*, and *Calamogrostis canadensis* increased following fire in muskegs in northern Wisconsin. *Chamaedaphne*, *Ledum*, and *Vaccinium* decreased after fire and the abundance of *Carex oligosperma* was unaffected. *Rubus spp.* and *Scirpus cyperinus* invaded the muskeg after fire. Kadlec (1962) found that *Scirpus cyperinus* will establish in wet areas when there is a lack of competition. Segadas-Vianna (1953) states that *Chamaedaphne calyculata* tolerates some burning but fire is more important in an indirect manner.

Fire will destroy trees and shrubs which shade the *Chamaedaphne*. The minor setback caused by the fire is nullified by the importance of the release from shade. *Chamaedaphne* is very intolerant to shade. Segadas-Vianna also points out that, generally, a *Chamaedaphne* association is highly resistant to change and often persists for long periods of time. It can withstand drying, even past the disapperance of the *Sphagnum* cover.

Soil chemists appear to be the only ones to consider the chemical nature of peat. Nothing was found in the literature concerning the change in the chemical nature under natural successional conditions. Townsend (1963) found a decrease in hemicellulose and cellulose after agricultural practices on peatlands in eastern Canada and increase in humic acid and lignin. The peat farmed for a long period of time had more humic acid than newly-cropped areas or the control area. The pH was closer to neutral in the older agricultural peats. Smith, et. al. (1958) found similar results for peat in the Maritime Provinces. Vesser (1962) substantiated that the humic acid increases as peat and compost decompose.

The study of pollen trapped in peat deposits is a classical example of the use of bogs. Erdtman (1952) and other Europeans have done a great deal of pollen analysis to determine past climates in Europe. Sears (1932) and Voss (1933, 1934) carried out a survey of the peatlands of the post-glacial deposits in the Midwest. Sears concluded that the region of the last Wisconsin glaciation has undergone four climatic regimes since the retreat of the glaciers. They are a warm-wet period followed by a cold-wet period, Then a warm-dry period and finally a cool-dry period which is the present climate. During the warm-dry period the prairies returned to the Illinois area. Voss presented data that substantiated Sears' conclusions. Voss sampled bogs and peatlands in north and central Illinois.

Odom said that Hill's Bog is in the outwash plain of the Marseilles stage of the Wisconsin glacier. According to Frye (1960) this would make it 17,000 to 18,000 years old, 2,000 to 3,000 years older than the bogs of Lake County and 2,000 to 3,000 years younger than the peat deposits of central Illinois.

Methods and Materials

The vegetation of Hill's Bog was sampled both qualitatively and quantitatively. Qualitative analysis was conducted by traversing the area, noting and collecting the plants found on the peat. Nomenclature and identification followed _Gray's Manual of Botany_. Plant associations were also noted. Since there is a record of some disturbance to the bog, disturbed areas were sought out and noted as to the amount of change brought about by the disruption. Since a transition zone of _Pyrus melanocarpa_ exists between the _Chamaedaphne_ and the wooded associations, attempts were made to find the extent of the _Chamaedaphne_ in the transition zone and forested area and to note its condition. The immediate surroundings of the bog were also explored qualitatively.

The latest aerial photograph of the area, taken in 1961, was obtained from the U.S. Conservation Service. It is photograph number 1-BB-49, Kane County, Illinois and is enlarged to 1 inch to 400 feet (Fig. 6). The enlargement enabled a detailed correlation between ground observations and impressions on the photograph. Aerial photographs of Kane County were also taken in 1939 and are obtainable from the General Services Administration, National Archives and Records Service. Photograph number BWU-2-31 was obtained from the Record Service at an enlargement of 1 inch to 660 feet. Due to technical difficulties, the 1939 photograph was not obtainable at the scale of 1 inch to 400 feet. The marginal resolution of the 1939 photograph is not as clear as the 1961 photograph, but this does not affect its use for this study.

The 1961 photograph was taken on September 16 and the image depicts the autumnal changes of the trees on the bog. Thus, by noting the position of an isolated tree by ground observation and comparing it to its position on the photograph, tree identification could be conducted on the photograph. For example, Acer negundo is a light shade on the photograph whereas Populus tremuloides is a dark shade. Prunus serotina is an intermediate shade between the other two. The Chamaedaphne association can be identified by its position and by the fact that the other associations are high enough to cast definite shadows. The vegetation patterns on the 1939 photograph were determined by shade differences and by comparing the relative positions to the 1961 photograph. Figures 5 and 6 were made by tracing the outline of the deposit from the 1961 photograph and drawing the plant associations to the scale of 1 inch to 440 feet. A X3 magnifying glass proved valuable in studying the photographs.

By using the 1961 aerial photograph and field notes, a representative quantitative sampling pattern was decided upon. Since the various associations could be identified from the photograph, estimates were made of their per cent cover as compared to the total study area on Hill's property. It was decided that the quadrats should be distributed in such a fashion as to represent similar percentages of the vegetation. The pattern which appeared to give a suitable distribution of the quadrats was along lines running north-south across the bog. In order to eliminate any bias in the selection of the lines, outside that mentioned above, the compass lines were selected at random. This was done by measuring an east-west base line through Preller's pasture on the north edge of Hill's property. Numbers were selected from a table of random numbers. These numbers represented one foot increments along the base line and were plotted on the aerial photograph. After the first line was established, the other lines were accepted or rejected depending upon the percentages of the various associations they crossed. Four lines were chosen, 114, 356, 689, and 853. The starting point for the base line was the fence row on the west edge of Preller's pasture. The base line was measured using a steel tape and following a compass bearing of 90°. At the increment where a quadrat line was to start, a piece of colored tape was hung on the fence which separates the two properties. The quadrats were established every 100 feet following the compass line South (180°). The first plot was established 100 feet from the fence in order to eliminate any edge effect. The distance between the plots was to be measured with the tape but due to the physical difficulty of penetrating the thick vegetation, the means of measuring the distance was altered. The measure of the investigator's pace was determined by traversing a sample of the vegetation and then backtracking the trampled path measuring the distance. It was found that fifty-five paces equalled approximately 100 feet. The pace was recomputed for the Chamaedaphne association and it was thirty-seven paces per 100 feet. Thirty-nine quadrats were set along the four compass lines.

The quadrats were two square meters for the survey of herbaceous plants and twenty-five square meters for the woody material. A species-area curve was computed and it was found that a one square meter plot would suffice for herbs in the forested areas. However, the two square meter plot was used to ensure a good analysis of the flora. The species-area curve computed for the Chamaedaphne association was inconclusive due to the lack of species diversity.

The quadrats were formed by measuring two meters (78.5 in.) at a right angle to the compass line and one meter (39.25 in.) along the compass line. Stakes were planted at the corners and a string was strung between the stakes. The plot was squared using the compass. The number and per cent cover of the species found were recorded.

The larger plot was formed by measuring five meters (16 ft. 4 in.) in each direction and planting the stakes. The trees were identified and the diameter of each was measured at 4.5 feet above ground, the diameter at breast height. Instead of counting all the stems of *Pyrus melanocarpa*, clumps were counted and noted as clumps. Stems growing separately were counted as individuals. Due to the growth form of the *Chamaedaphne*, no count was made of the individual stems since most of the stems in a quadrat would originate from one plant. The larger plots were also searched for the presence of tree seedlings.

The collected data were compiled as to frequency, density, and dominance, following Curtis and Cottam (1962). Frequency is the number of quadrats in which the species appeared. Density is the total number of stems of each species counted and divided by the number of quadrats. Dominance is the total of the per cent cover computed. The tree data are compiled as the total number of stems counted and the basal areas of the trees. Curtis and Cottam present a table of conversions for DBH to basal area and this was used. Various arrangements of this data are presented in the "Results" of this paper.

During the preliminary surveys of the bog, differences in the texture of the peat were noted. These differences appeared to be correlated with the plant associations in which they were found. Thus, while collecting vegetation data, peat samples were also collected. This was done by scraping away the top three inches of substrate to eliminate any influence from the litter, and removing a trowel level full of the peat to a jar. The sample was placed in one of five jars, one for each of the five major associations. Thus, each jar was a mixture of samples from different quadrats in a particular association. Determinations were made for each sample of the pH, field capacity, relative amounts of humic acid, and carbohydrates.

The pH was determined with a Corning Model 7 pH meter. An equal portion from each sample was placed into a beaker and two volumes of distilled water was added. The mixture was stirred and the pH read.

The field capacity of the peat was determined by drying a portion of the peat, weighing it and placing it in a filter paper cone in a funnel. Water was then added until it dripped free from the cone. The cone was allowed to stand until the excess water stopped dripping. The excess water was returned to the graduate cylinder and the amount used was determined by subtracting the amount left from the original volume.

The carbohydrate analysis follows a modification of the anthrone test reported by Brink, Dubach and Lynch (1960).

1. air dry peat
2. place 2 gm of sample into 50 ml 1 N H_2SO_4
3. hydrolyze for 1 hour
4. centrifuge, supernate carbohydrate, precipitate humic acid

Anthrone Test

1. .2% anthrone in 95% H_2SO_4
2. a standard curve was prepared using 5 ml glucose at dilutions of 20, 15, 10, and 5 ppm. and mixed

with 10 ml anthrone solution

3. transmittance was determined on a Bausch and Lomb "Spectronic 20"
4. carbohydrate solution from samples diluted to 1 to 50
5. 5 ml dilutions mixed with 10 ml anthrone solutions
6. transmittance recorded and compared to the standard curve (T. VIII).

Humic Acid Determination

1. precipitate from above dissolved in 50 ml 1 N NaOH
2. solution acidified with 2 N H_2SO_4
3. centrifuged and precipitate collected
4. precipitate air-dried and weighed
5. weight of humic acid recorded as a per cent of the original 2 grams peat sample (T. VIII).

To determine whether the depth of the peat had any effect on the distribution of the vegetation, the bottom of the peat deposit was mapped. This was done by establishing a grid of points 100 feet east-west and 200 feet north-south from each other and determining the depth at each point. A compass line was followed and the distances were paced. The rods of a peat sampler were used to determine the depth by pushing through the peat until the bottom was reached. A tracing of the bog outline was made from the 1961 photograph and the depths were plotted (Fig. 7).

Voss (1934, 1937) studied the pollen strata of bogs in northeastern and central Illinois but none from a bog intermediate to these. Since Hill's Bog is located in an intermediate glacial formation, it was decided to conduct a pollen strata study. Potzger (1954) warned that irregularities in the peat basin could cause variations in the strata collected, thus the depth was sampled to determine possible irregularities. The center of the bog was found to be fairly constant at twenty feet deep, so a sampling site was chosen there. The samples were collected with a Davis peat borer at two feet intervals. The samples were placed in separate paper bags, brought into the laboratory and air-dried.

Brown (1960) describes a number of methods for preparing the peat for pollen analysis but concludes that most workers develop their own procedure. The basic step underlying many of the procedures he describes is to boil the peat in potassium hydroxide. After experimenting with various procedures, the one chosen was the following.

1. add approx. 2 c.c. dry peat to 20 ml 10% KOH
2. boil until approx. half of the solution is gone, add 3-5 drops Safranin stain
3. continue boiling until most of the solution is gone, then bring back to volume with 10% KOH
4. boil until approx. half of the second volume is gone
5. centrifuge, saving precipitate
6. transfer a small portion to a slide and add approx. 4 drops glycerine and mix
7. transfer some of the mixture to a clean slide and place a cover slip over it (enough mixture should be used so that the underside of the cover slip is coated but not so much that the mixture can flow)
8. view at X430 and count

The identification of the pollen followed Erdtman (1953) and Potzger (1950). Since Voss only reported the tree pollen found, this study is likewise restricted to that data. Along with counting the tree pollen, a count of all the pollen seen was made. The data collected are compared to Voss's data.

Results and Discussion

Hill's Bog is located in the outwash plain of the Marseilles lobe of the Wisconsin glaciation. The area of the bog was originally considered as a part of the Marengo Moraine by Ekblaw (1942), but it has been changed due to later findings (Frye 1960). Odom (1967) points out that the glacial stages are difficult to recognize in northern Illinois because a great deal of overlap occurred during the advances of the various lobes. However, Odom states that two moraines are distinguishable in Rutland Township, the Cropsey and the Marseilles formations. The Cropsey crosses to the southwest of the township and is the older of the two. The Marseilles crosses through the northeast portion of the township. The presence of the Cropsey moraine during the time of the Marseilles glacier caused a definite pattern to the runoff as the Marseilles glacier melted. The probable direction of the water was either to the southeast into the Fox River drainage or to the northwest into the Kishwaukee watershed. It is doubtful that a definite channel formed during the time of the receding glacier because the topography of the area is generally flat. It is probable that a great deal of the sand and gravel washed from the glacier was deposited between the glacier front and the Cropsey moraine (Fig. 1).

Hill's Bog and the other peat deposits in and around Rutland Township were likely formed in lakes formed by huge blocks of ice that broke free from the glacier. These ice

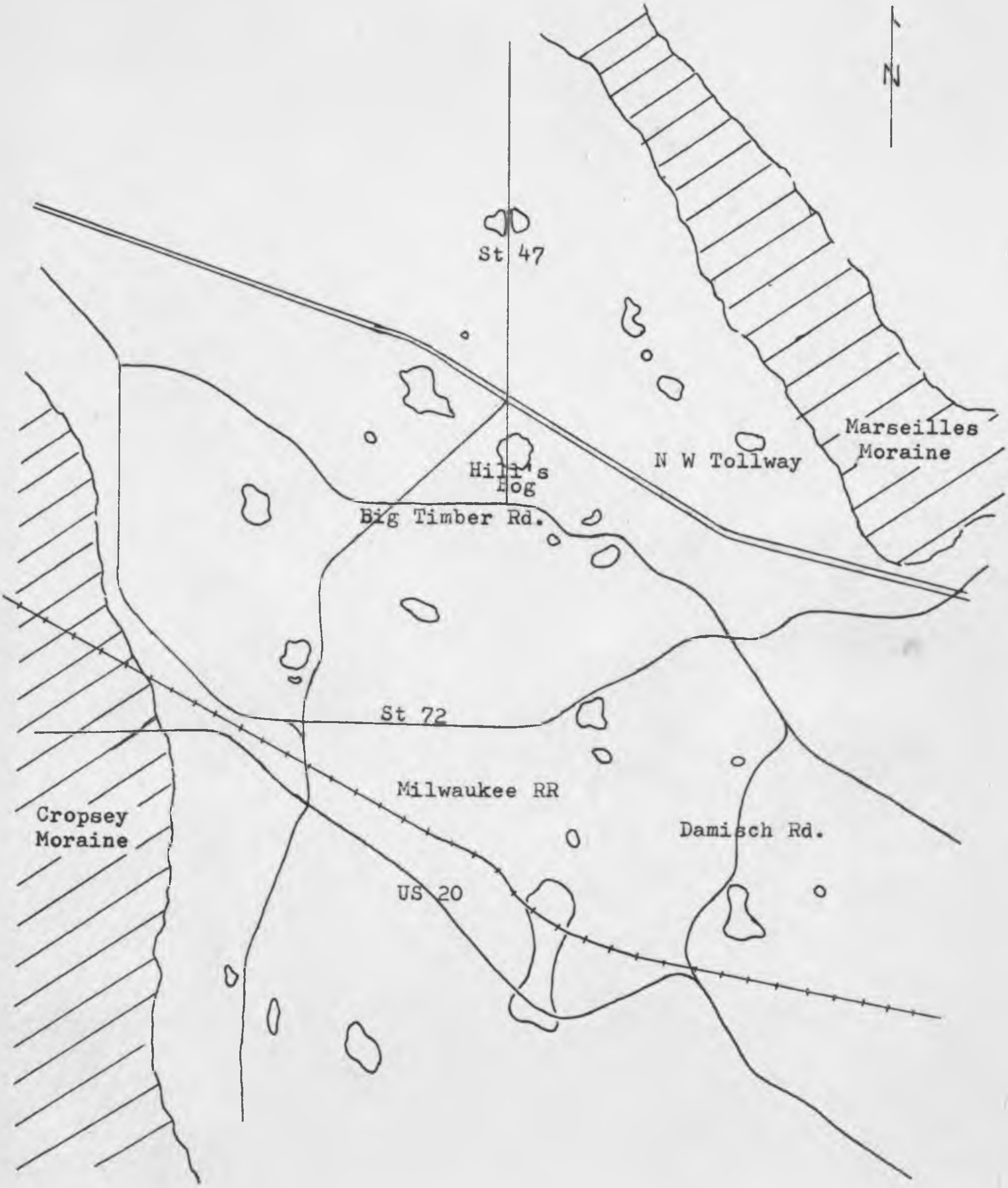


Fig. 1. The vicinity of Hill's Bog showing distribution of peat deposits on the outwash plain of the Marseilles glaciation.

blocks became lodged in the runoff pattern and the suspended sand and gravel filled around them. Sand and gravel deposits are now found surrounding Hill's Bog. As the glacier receded, the runoff abated, and the ice blocks melted, an outwash plain pocked with numerous ponds and lakes was left. The substrate surrounding the lakes was mostly sand and gravel. The topography was generally flat so drainage of these lakes was slow or nonexistant. Frye estimates the age of the Marseilles moraine at 15,000 to 17,000 years.

The pollen spectrum from Hill's Bog (Fig. 2) is similar to the pollen strata data found in other bogs in northern Illinois (Figs. 2,3,4). The pollen collected in the bottom two samples indicate that a coniferous forest existed in the area of the bog in the early post-glacial years. Thirty per cent of the pollen sampled from two feet above the bottom was a combination of Pinus, Picea, and Abies (T. I). Voss (1934, 1937) also found a large portion of the pollen sampled near the bottom of his study areas to be coniferous pollen. It is generally assumed from the early pollen work that Illinois sustained a coniferous forest after the glaciation (Fuller 1935). This period would correspond to the cool-moist period as discussed by Sears (1934). Figures 2, 3, and 4 and other pollen diagrams published show a drop in the coniferous pollen above the bottom quarter of the peat deposits in Illinois. This is attributed to a warming trend that brought about the present flora (Fuller, Sears). Sears also feels that it was

Table I. Pollen Count

Sampled depth feet from top	Abies	Picea	Pinus	Quercus	Total Trees	Total Pollen
6	0	6	4	16	26	605
8	0	7	5	6	18	625
10	0	5	16	21	42	664
12	0	2	5	20	27	650
14	0	6	12	31	49	635
16	25	20	64	23	132	410
18	29	40	46	30	145	418

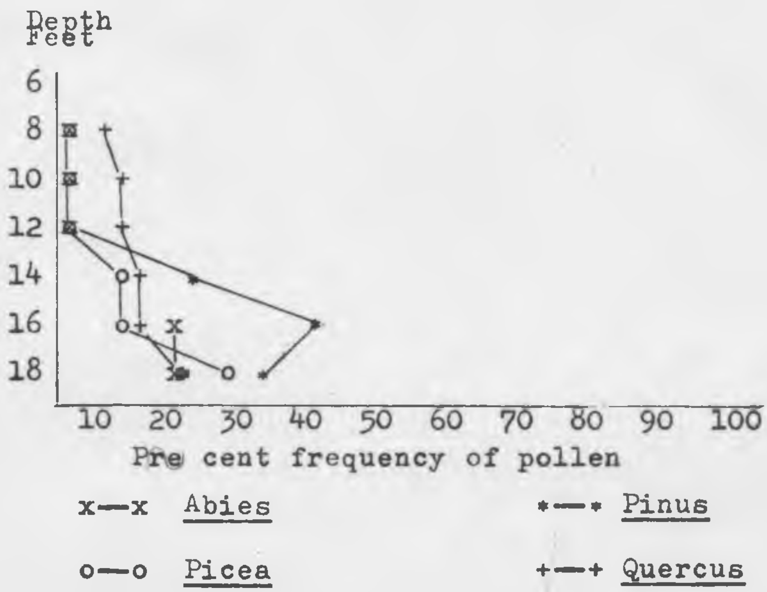


Fig. 2. Pollen strata from Hill's Bog

during this warming trend that the prairie returned to the Midwest.

Abies pollen is absent from all but the bottom two samples of Hill's Bog. However, *Picea* and *Pinus* pollen continue to be found into the top samples. *Quercus* pollen, unlike Voss's data, is found in roughly the same numbers throughout the study. Voss found that the *Quercus* increased after the conifers became reduced. The only explanation this investigator can make for the difference would be that after the evergreen forest left the area of Hill's Bog a prairie, rather than a forest situation, became established. The *Quercus* pollen found may represent oaks that formed a savanna in the vicinity of the bog. The *Picea* pollen may be *Picea mariana* and would indicate that a bog forest was becoming established on the bog mat. The *Pinus* pollen is difficult to assess. A highly speculative explanation for its presence would be to assume that *Pinus* may have lingered in the sterile conditions on the Marseilles moraine which is just one mile to the northeast of the bog.

Actually, it is difficult to speculate about the composition of the area around Hill's Bog after the drop in the coniferous pollen. It is easy to see from Voss's data that a forest situation continued around the Volo Bog (Fig. 3) and that Quercus species were frequent near the Lily Lake deposit (Fig. 4) but the data collected from Hill's Bog leads only to speculation. Kilburn (1959) points out that Kane County was

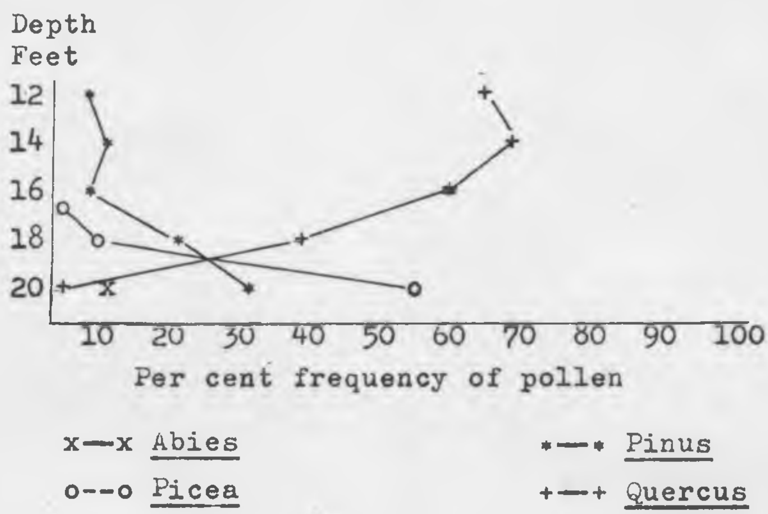


Fig. 3. Pollen strata from Lily Lake (after Voss 1937)

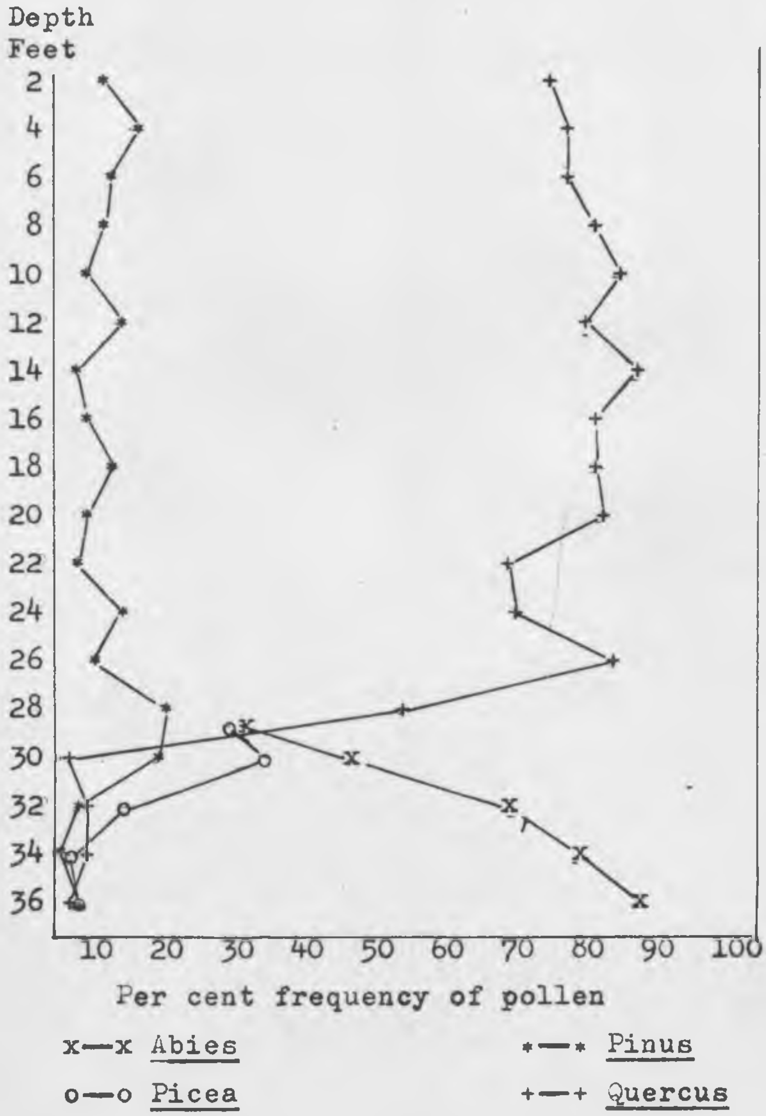


Fig. 4. Pollen strata from Volo Bog (after Voss 1934)

a patchwork of forest and prairie at the time of the original land survey. North of Kane County in McHenry and Lake Counties a forest was present. To the south and west, including parts of Kane County, the prairie was found. Kane County was the forest-prairie ecotone. The data collected by the surveyors in 1844 indicate that Rutland Township was approximately half prairie and half burr oak (Q. macrocarpa) savanna. It is possible that a similar situation existed throughout most of the history of Hill's Bog after the retreat of the coniferous forest. Lily Lake was in the vicinity of a forest, according to Kilburn, and this may explain the higher occurrence of Quercus pollen in its top strata as contrasted to the pollen record of Hill's Bog.

Frolick (1941) feels that the bog forest sere is highly restricted on the peatlands of Dane County, Wisconsin, because Dane County is located on the forest-prairie ecotone in Wisconsin. He feels that the frequent occurrence of prairie fires was important in the elimination of the conifers. A similar situation may have occurred on the Hill property prior to settlement times. Segadas-Vianna (1953) and Vogl (1960) point out that a wet Chamaedaphne association is not adversely affected by fire. It is probable that fires may have swept the prairie in the vicinity of the bog. The crowns of the trees would be weakened or destroyed. Segadas-Vianna also reports that Chamaedaphne can benefit from fire because fire eliminates tall plants shading the Chamaedaphne. Chamaedaphne

Table II. Species found on Hill's Bog

name	common name
MOSSES	
Dicranum rugosum	
Mnium sp.	
Polytrichum commune	
Sphagnum magellanicum	
Others	
VASCULAR PLANTS	
Acer negundo L.	box-elder
Acer saccharinum L.	silver-maple
Agrostis tenuis Sibth.	bent grass
Alnus rugosa (Du Roi) Spreng.	speckled alder
Ambrosia artemisiifolia L.	common ragweed
Ambrosia trifida L.	giant ragweed
Atriplex patula L.	orach
Betula pumila var. glandulifera Regel	bog birch
Betula X Sandbergi Britt.	Sandberg's birch
Bidens coronata (L.) Britt.	tickseed
Carex oligosperma Michx.	bog sedge
Carex sp.	sedge
Chamaedaphne calyculata (L.) Moench	leatherleaf
Crataegus sp.	hawthorn
Drosera intermedia Hayne	sundew
Dryopteris cristata (L.) Gray	crested wood-fern
Dryopteris thelypteris (L.) Gray	marsh-fern
Eleocharis sp.	spike-rush
Epilobium angustifolium L.	fireweed
Galium aparine L.	bedstraw
Helianthus annuus L.	sunflower
Hypericum virginicum L.	St. John's-wort
Juncus acuminatus Michx.	rush
Lactuca sp.	wild lettuce
Panicum sp.	panic-grass
Parthenocissus quinquefolia (L.) Plch.	Virginia creeper
Parietaria pensylvanica Muhl.	pellitory
Phalaris arundinacea L.	canary-grass
Polygonatum biflorum (Walt.) Ell.	Solomon's seal
Polygonum cilinoda Michx.	black bindweed
Polygonum pensylvanicum L.	pink smartweed
Polygonum punctatum var. leptostachyum (Meism.) Small	water smartweed
Populus deltoides Marsh.	cottonwood

continued

Table II (continued)

name	common name
Populus tremuloides Michx.	aspen
Prunus serotina Ehrh.	black-cherry
Pteridium aquilinum (L.) Kuhn	bracken fern
Pyrus melanocarpa (Michx.) Willd.	black chokeberry
Quercus macrocarpa Michx.	burr oak
Quercus rubra var. *borealis* (Michx.f.) Farw.	northern red oak
Rhus radicans L.	poison ivy
Rubus allegheniensis Porter	blackberry
Rubus idaeus L.	raspberry
Rumex acetosella L.	sheep-sorrel
Salix nigra Marsh.	black willow
Salix sp.	willow
Sambucus canadensis L.	elderberry
Sanicula gregana Bickn.	black snakeroot
Scirpus cyperinus (L.) Kunth	wool grass
Smilacina racemosa (L.) Desf.	false spikenard
Smilax rotundifolia L.	common greenbrier
Solanum dulcamara L.	nightshade
Spirea tomentosa L.	bridal bush
Tradescantia virginiana L.	spiderwort
Urtica procera Muhl.	nettle
Xyris torta Sm.	yellow-eyed grass

is more intolerant to shade than it is to superficial burning. The finding of _Picea_ pollen throughout the peat strata and the absence of _Picea_ and _Larix_ in historical times would suggest that a bog forest was developing on the bog mat but it was eliminated by frequent prairie fires. _Larix_ is found today on the Volo Bog. Volo is less than fifty miles from Hill's Bog but it is on the forest side of the ecotone. Fires, of course, occur in forested areas but not as frequently as on the prairie (Curtis, 1959).

Hill's Bog was evidently in the _Chamaedaphne_ sere during the early part of this century. According to Jack Hill a larger complement of bog species existed on the bog in the early years of the nursery's ownership. He also stated that the _Sphagnum_ carpeted the bog and was abundant enough for economical exploitation for the nursery business.

An analysis of the 1939 aerial photograph revealed four distinct plant associations on the bog. The largest was the _Chamaedaphne_ association which covered approximately sixty-five per cent of the bog area (Fig. 5). The association appeared uniform on the photograph and it is assumed that very few shrubs taller than the _Chamaedaphne_ were growing there. Ground observations made during this study within the boundary of the 1939 Chamaedaphne association would substantiate the conclusions drawn from the study of the photograph.

A wide border association is discerned on the 1939

Scale: 1 inch to 440 feet

Fig. 5. Diagram of plant associations in 1939 (Drawn from U.S.D.A. aerial photograph BWU-2-31, 1939)

1. Areas of stripped Sphagnum
2. Chamaedaphne association
3. Acer saccharinum association
4. Pyrus association
5. Salix association
6. Phalaris-Urtica association

photograph. Little woody vegetation can be seen there. From shade differences on the photograph and from the investigator's recent observations, it is concluded that this belt was a Phalaris-Urtica association. Marginal or edge effect is a common occurrence with bogs. Conway (1948) and Gates (1942) discuss this phenomenon as it occurs in Minnesota and Michigan. The marginal phenomenon is caused by aerated mineral-rich water running off the adjoining uplands and collecting at the margin of bogs. As a consequence, the peat is decomposed here and the once sterile peat is altered and the invasion occurs by plants of the uplands. The margin effect is restricted from continuing throughout the bog because its effect is governed by the downward movement of water off the upland. The bog mat is generally flat so this water does not flow into the interior of the bog. Frolick reports that the Phalaris-Urtica association is the best invader of burned peat. It is assumed that the prairie fires discussed above may have burned some peat along the margin. The peat here has been shallow as seen in Figure 7 and the decomposing peat of the margin was losing its water-holding capacity (see peat analysis below) so during dry years this peat may have burned. The peat to the interior of the margin was not decomposing and was under Sphagnum. This peat is assumed to have contained enough water, even during dry years, to stop the proposed fire. A small Salix stand is also found on the 1939 photograph. Frolick states that Salix can also enter the plant association on peat after fire. The <u>Salix</u> on Hill's Bog are restricted to the southwest corner in 1939 and also in 1967.

A dark shaded association is depicted on the 1939 photograph along the southeast and east side of the bog. It is assumed that this was composed of <u>Pyrus melanocarpa</u>. It was not a forested situation as it is today. Trees can be identified on the photograph by the shadows they cast and by the differences in the color between species. Ground observations support the idea of a <u>Pyrus</u> association since scattered large clumps of <u>Pyrus</u> are found in this area today. It is possible that <u>Populus tremuloides</u> and <u>Prunus serotina</u> were growing with the <u>Pyrus</u> but this cannot be determined from the photograph.

A small association of <u>Acer saccharinum</u> is depicted in the northeast corner of the bog. George Preller explained that the original owners of his farm planted <u>Acer saccharinum</u> around the farm house and down the slope to the bog. These trees have spread to the bog in the intervening years. However, this association has remained as a local effect in the northeast corner.

Along the south margin of the bog a small peninsula extends into the bog area. A large burr oak (<u>Quercus macrocarpa</u>) is seen on the 1939 and 1961 photographs. <u>Populus tremuloides</u> is also seen on the 1939 photograph growing near the fence along the southern border of Hill's property.

The large *Quercus* is, no doubt, the seed source for the young oaks presently found on the peat.

The vegetation has graphically changed in the intervening years between the 1939 and 1961 photographs. In addition to the four associations discussed above, two others have formed. The trench dug by the nursery has caused an increase in the bog flora in the immediate area of the trench. The trench will be discussed later in this paper. The other new association is the *Populus-Prunus* wooded area.

The following discussion of the associations is in relation to the 1961 photograph and field data. The *Chamaedaphne* association has been reduced to less than one-third its original size since 1939. It is characterized by the cushion-like growth of the *Chamaedaphne* and the taller *Betula pumila*. The *Chamaedaphne* forms a cover of sixty-five per cent within the association. The birch represents four per cent of the cover (T. IV). *Sphagnum* is reduced from its abundance in 1939. It is only found around the stems of the *Chamaedaphne*. The substrate is exposed between the clumps of *Chamaedaphne* whereas in wet bogs these openings support a vigorous growth of *Sphagnum* (as seen in other bogs by the investigator). Occasionally *Rumex acetosella* or *Dryopteris thelypteris* is found growing between the clumps of *Chamaedaphne*. The characteristic bog plants are restricted to the patches of *Sphagnum* under the *Chamaedaphne*. These plants were not frequent enough to be sampled in the quantitative analysis. In addition to the bog

Scale: 1 inch to 440 feet

Figure 6. Diagram of plant associations in 1961. (Drawn from U.S.D.A. aerial photograph 1-BB-49)

1. Trench dug in 1956
2. Chamaedaphne association
3. Pyrus association
4. Populus-Prunus association
5. Salix association
6. Phalaris-Urtica association
7. Acer saccharinum association

Table III. Analyses of the Total Flora

39 quadrats sampled
(two square-meter quadrats)

Species	Frequency (percent)	Density	Dominance (percent)
Rubus allegheniensis	80	9.0	25.0
Pyrus melanocarpa	62	9.0	14.0
Chamaedaphne calyculata	31	--	14.0
Parietaria pensylvanica	28	8.0	2.0
Solanum dulcamara	33	.8	1.5
Smilacina racemosa	18	.6	.2
Rubus idaeus	10	2.0	6.2
Betula pumila	10	.2	1.0
Lactuca sp.	18	.3	.3
Prunus serotina	10	.3	.3
Populus tremuloides	10	.2	+
Acer negundo	10	.2	+
Polygonum cilinoda	10	.3	+
Polygonum pensylvanicum	10	.3	+
Galium aparine	10	.3	+
Dryopteris thelypteris	7	1.0	1.0
Pteridium aquilinum	7	.3	1.0
Sphagnum sp.	7	--	.5
Phalaris arundinacea	7	--	2.5
Quercus rubra var. borealis	7	.2	.2
Urtica procera	5	1.0	.5
Parthenocissus quinquefolia	5	+	+
Dryopteris cristata	5	.3	+
Smilax rotundifolia	5	+	+
Carex sp.	5	+	+
Quercus macrocarpa	3	+	+
Epilobium angustifolium	3	+	+
Sambucus canadensis	3	+	+
Sanicula gregana	3	.1	+

25 square-meter quadrats

Species (trees)	Number	Basal area (sq. in.)
Populus tremuloides	52	503.3
Prunus serotina	45	401.9
Acer negundo	2	1.6
Quercus rubra var. borealis	1	.8
Acer saccharinum	1	.8

Table IV. Analyses of the *Chamaedaphne* Association

8 two square meter quadrats sampled

Species	Frequency (percent)	Density	Dominance (percent)
Chamaedaphne calyculata	88	--	65.0
Betula pumila	38	.5	4.0
Rubus allegheniensis	38	4.5	11.0
Pyrus melanocarpa	38	1.6	8.0
Sphagnum sp.	38	--	2.5
Rubus idaeus	12	2.3	3.0
Dryopteris thelypteris	12	.4	.1
Pteridium aquilinum	12	.6	1.2
Prunus serotina	12	.2	1.5

25 square meter quadrats

Trees

Species	Number	Basal area (sq. in.)
Prunus serotina	1	.8

Table V. Analyses of the *Pyrus* Association

8 two square meter quadrats sampled

Species	Frequency (percent)	Density	Dominance (percent)
Rubus allegheniensis	100	10.0	31.0
Pyrus melanocarpa	88	28.0	43.0
Parietaria pensylvanica	25	6.4	.5
Solanum dulcamara	38	2.4	1.5
Prunus serotina	12	.4	.1
Betula pumila	12	.2	.6
Lactuca sp.	12	.3	.1
Chamaedaphne calyculata	38	--	1.5
Populus tremuloides	12	.3	.1

25 square meter quadrats

Trees

Species	Number	Basal area (sq. in.)
Populus tremuloides	13	65.9
Prunus serotina	10	40.8

species, Pyrus and Rubus are found in the bog association. The Rubus, like the Rumex and Dryopteris, is restricted to the openings between the Chamaedaphne clumps. Stems of Pyrus are scattered throughout the bog association. It is interesting to note that Pyrus comprises eight per cent cover of the quadrat samples. However, the stems are scattered and do not form an extensive canopy as is found in the Pyrus association.

The Pyrus association is characterized by the extensive growth of Pyrus and Rubus and the low frequency of other species. The Pyrus association in 1967 has shifted to the outer two-thirds of the 1939 Chamaedaphne association. Rubus allegheniensis covers thirty-one per cent of the area of the quadrats in this association. However, it is not found under the canopy of the Pyrus but rather where the canopy is not formed or where the Pyrus clumps are far apart. The Rubus is not found as separate canes but as colonies where the canes form tangles which are difficult to penetrate.

The negative relation between the Pyrus and Chamaedaphne, as described by Segadas-Vianna (1953) is clearly evident on Hill's Bog. Segadas-Vianna classes Pyrus melanocarpa as a destructive member of the Chamaedaphne association in Canada. As the Pyrus develops it forms a dense canopy above the Chamaedaphne and the shade eliminates the Chamaedaphne. At the ecotone of the two associations both Chamaedaphne and Pyrus are growing well. However, into the Pyrus association under its canopy, morphological changes in the Chamaedaphne are noted. The leaves of the Chamaedaphne are larger (3-5 cm.) under the shade than the normal leaf size (1-2 cm.). Lems (1956) reports a similar phenomenon in his study of Chamaedaphne. The clumps of Chamaedaphne deeper into the Pyrus association are less vigorous and often found with half of the branches dead. Throughout the center of the Pyrus association, numerous clumps of dead Chamaedaphne are found.

The outer margin of the Pyrus association is not as distinct as the interface between the Pyrus and Chamaedaphne. The invasion of the Pyrus association is sampled in the quantitative analysis (T. V). The Parietaria and Solanum sampled in this association were found near the outer edge with the Populus and Prunus. The Pyrus is still dominant along the outer edge but the trend towards a forested condition can be discerned.

The forest or Populus-Prunus association covers almost half the area of the bog in 1967. It has become prominant during the past twenty-eight years. The forest association has been divided into two parts in the tables of this paper (Tabs. VI, VII), and will be referred to as the "interior" and "marginal" associations. This separation is based upon the position of the quadrats in relation to the edge of the bog. A clear change in the dominant species is not distinguished in this division as in the division of the other associations. The composition of the herbaceous plants is similar between the two areas. The marginal quadrats contain

Table VI. Analyses of the Interior Wooded Association

12 two square meter quadrats sampled

Species	Frequency (percent)	Density	Dominance (percent)
Rubus allegheniensis	92	9.8	28.0
Solanum dulcamara	58	3.0	2.0
Smilacina racemosa	25	1.0	.3
Pyrus melanocarpa	83	7.7	8.0
Parietaria pensylvanica	33	10.0	4.5
Populus tremuloides	25	.3	.3
Quercus rubra var. borealis	17	.2	.1
Dryopteris cristata	8	.6	.2
Dryopteris thelypteris	17	3.3	3.3
Acer negundo	8	.1	.1
Lactuca sp.	25	.5	.1
Chamaedaphne calyculata	8	--	2.0
Parthenocissus quinquefolia	8	.1	.1
Carex sp.	8	.1	.1
Polygonum pensylvanicum	17	.4	.1
Polygonum cilinoda	25	.9	.2
Epilobium angustifolium	8	.1	.1
Galium aparine	8	.3	.1

25 square meter quadrats

Trees

Species	Number	Basal area (sq. in.)
Prunus serotina	18	205.1
Populus tremuloides	19	131.9
Crataegus sp.	1	.8
Acer negundo	1	.8
Acer saccharinum	1	.8
Quercus rubra var. borealis	1	.3

Table VII. Analyses of the Marginal Association

11 two square meter quadrats sampled

Species	Frequency (percent)	Density	Dominance (percent)
Rubus allegheniensis	82	10.0	29.0
Urtica procera	18	3.8	2.0
Lactuca sp.	27	.4	.1
Solanum dulcamara	36	2.0	3.0
Parthenocissus quinquefolia	9	.1	.1
Parietaria pensylvanica	45	8.0	2.3
Dryopteris cristata	9	.5	.2
Phalaris arundinacea	27	--	9.4
Carex sp.	9	.1	.1
Polygonum cilinoda	9	.1	.1
Polygonum pensylvanicum	18	.3	.1
Galium aparine	27	.6	.1
Pyrus melanocarpa	36	3.7	3.6
Pteridium aquilinum	18	1.0	2.4
Smilacina racemosa	36	1.0	.4
Rubus idaeus	18	4.4	16.0
Prunus serotina	18	.7	.2
Acer negundo	27	.3	.2
Quercus macrocarpa	9	.1	.1
Sanicula gregana	9	.3	.2
Quercus rubra var. borealis	9	.3	.5
Smilax rotundifolia	18	.4	.1
Sambucus canadensis	9	.1	.1

25 square meter quadrats

Trees

Species	Number	Basal area (sq. in.)
Acer negundo	2	1.6
Populus tremuloides	20	305.5
Prunus serotina	16	153.9

more of a species diversity but the added species do not contribute to the total cover. Parietaria averages twelve plants per plot in the interior wooded area and eight plants per plot in the marginal area. Solanum averages three plants per plot in the interior and two per plot in the margin. Smilacina averages one plant per plot throughout the forest area. Rubus allegheniensis averages ten canes throughout the wooded area. The major difference between the arbitrary zones is the difference in the size of the Prunus and Populus as is explained below.

The average basal area (total basal area/number of plots) for Prunus in the interior is 17.1 square inches per plot while it is only 14.0 square inches in the marginal woods. The reverse is found with Populus where the average is 11.0 square inches in the interior and 27.8 square inches in the marginal plots. The average number of stems per plot is not significantly different between the two zones.

A sapling and two seedling of Quercus rubra var. borealis are found in the interior plots and seedlings of Q. rubra var. borealis (3) and Q. macrocarpa (1) are found in the marginal plots. This may indicate a beginning of an oak association. The Pyrus found in the forest area are large clumps but the dense uniform canopy discussed earlier is absent from this area.

The trench dug in the Chamaedaphne association caused a local change in the flora. The trench exposed the water table and an extensive growth of Sphagnum has occurred along the shore. Drosera intermedia and Carex oligosperma are also growing vigorously in the wet area. The general appearance of the area around the trench is one of vigorous growth of all the plants found there.

The areas where Sphagnum stripping occurred during the 1930's have been revegetated by Chamaedaphne. However, in some of the stripped areas near the road, Populus and Rubus have become established and are shading the Chamaedaphne. The edge of the roadside drainage ditch is largely covered by Pyrus and Populus.

Except for pH, chemical and physical changes are found in the peat from the different associations. The field capacity is highest for the peat from the bog association (T. VIII). It decreases in the Pyrus association and is lowest in the forest area. The amount of humic acid per gram of substrate increases from the Chamaedaphne to the Populus-Prunus association. Smith (1960) reported an increase in the amount of humic acid with an increase in the decomposition of peat. The amount of carbohydrates among the different zones is not as easy to assess. The Chamaedaphne peat contains 500 parts per million of hexoses as does the Pyrus-Chamaedaphne border. However, the peat samples collected in the Pyrus zone contain 550 parts per million. This increase may not be significant but it may indicate a trend in the decomposition of large molecules, such as cellulose, into the smaller molecules which

Table VIII. Peat Analyses

Samples from:
1. *Chamaedaphne* association
2. *Chamaedaphne-Pyrus* ecotone
3. *Pyrus* association
4. Interior forest association
5. Marginal forest association

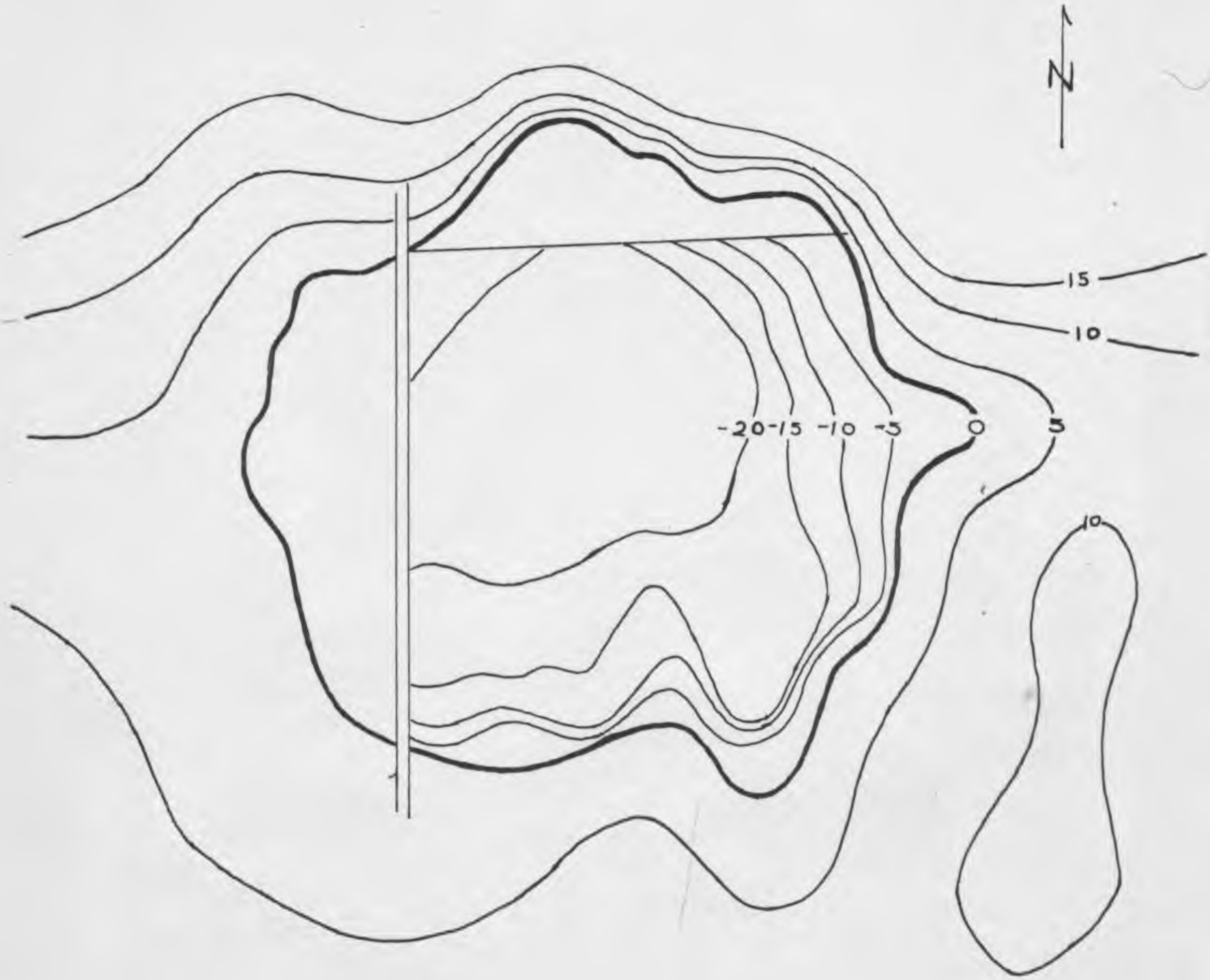
Sample	pH	Field Capacity (per 1 g peat)	Carbohydrates (parts per million)	Humic Acid (percent of peat)
1.	3.7	3.9 ml	500	18%
2.	4.1	3.2 ml	500	20%
3.	4.0	2.6 ml	550	21%
4.	3.9	2.7 ml	450	28%
5.	4.0	2.5 ml	350	35%

can be measured by the Anthrone Test (Brink, et al, 1959). The interior wooded area samples contain 450 parts per million and the marginal wooded zone peat contains 350 parts per million hexoses. It is assumed that the decrease in carbohydrates is caused by a larger microflora in the older associations.

The earth substrate beneath the peat deposit is gradually sloping upward from the center except near the south margin (Fig. 7). The vegetation patterns as described above do not appear to be correlated with the bottom topography. The only possible effect the depth of the peat may have had is in relation to the development of the margin effect as discussed above.

The general scheme of bog initiation as outlined by Dansereau and Segadas-Vianna is the most probable explanation for Hill's Bog. The presence of limnetic peat and fragments of Sphagnum at the bottom would substantiate this. The succession progressed to the Chamaedaphne association. It is difficult to determine when this sere began but it may have begun early since a change in the composition of the peat is noted five feet from the bottom. The Chamaedaphne was able to persist into this century because the bog-forest sere was eliminated by prairie fires.

However, the Chamaedaphne association was altered by the runoff waters of the uplands along the margin. The marginal vegetation became a Phalaris-Urtica association. Some Salix sp.



Scale: 1 inch to 440 feet

Fig. 7. Topography of the bog basin and adjoining upland

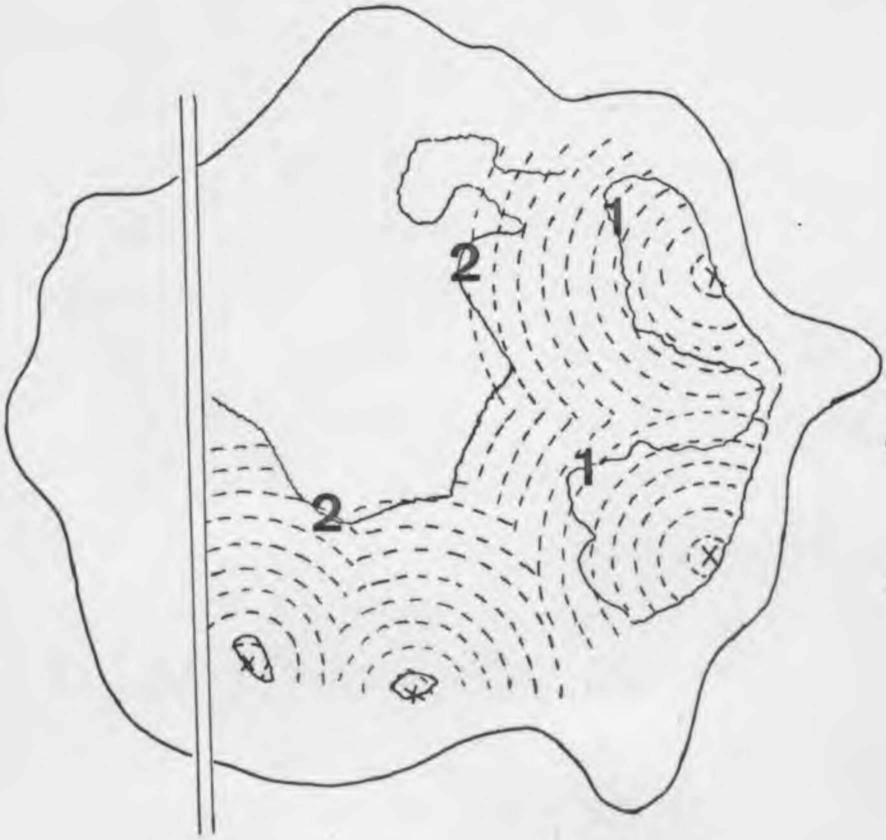
and *Pyrus melanocarpa* also became established in the marginal association. The woody shrubs did not grow with the *Phalaris* but rather between the *Phalaris* and the *Chamaedaphne* association. It is not known when these shrubs became established but they remained restricted to the marginal area until modern times. The drought of the 1930's may have lowered the water table to some extent and the *Pyrus* began a limited vegetative expansion into the bog association.

The Prellers attempted to drain the portion of the bog on their property in 1942-1943. It is assumed that the drainage effectively lowered the water table of the bog to the point where the top one foot of the peat became dry. The *Pyrus* responded to the dryer peat and the vegetative expansion into the *Chamaedaphne* association was accelerated. As the *Pyrus* developed its canopy, the *Chamaedaphne* underneath was weakened and destroyed. The combination of the *Pyrus* canopy and the dry peat, no doubt, was detrimental to the *Sphagnum* and it too succumbed. The invasion of the area by *Rubus* was also accelerated by the dry peat. Behind the invasion front of the *Pyrus* very little herbaceous growth was found. Only the dead and dying bog flora were present. Similar conditions exist today within the *Pyrus* association. The older portion of the *Pyrus* association, as it was found in the 1940's, was an invasion point where *Populus* and *Prunus* were becoming established. Using an increment borer, the ages of two of the larger *Populus* were sampled and they were found to be from twenty to twenty-five years old. The combination of shade, the tree invasion, and natural thinning because of age were decreasing the vigor of the Pyrus.

As the heavy shade of the Pyrus decreased, replaced by the less dense shade of Populus and Prunus, opportunist species such as Solanum dulcamara, Parietaria pensylvanica, and Rubus allegheniensis increased on the peat deposit under the trees.

The original development of the Pyrus association is illustrated in Figure eight. Assuming three original establishment points of the species and vegetative spread, the positions of the present vegetation can be better understood. The assumed concentric growth of the Pyrus corresponds with encroachment patterns into the Chamaedaphne association. The distribution of Populus is also better understood if it is assumed to be spreading vegetatively. The largest Populus are found on the peat near the margin while this species becomes progressively smaller centripetally.

The distribution of Prunus is better understood if it is considered to be spreading by seeds. The interior wooded plots have a larger basal area of Prunus than the marginal wooded plots. This can be explained by the fact that if seeds germinated where the competition was reduced, i.e., the older portion of the Pyrus association, the trees would grow better and faster. The number of Prunus in the marginal quadrats is the same as in the interior but the basal area is reduced. In the marginal area the Populus are older and would offer



Scale: 1 inch to 440 feet

Fig. 8. Diagram of probable <u>Pyrus</u> <u>melanocarpa</u> vegetative expansion on Hill's Bog

X Possible points of original establishment

1 Limit of expansion in 1939

2 Limit of expansion in 1961

more competition to the developing Prunus. The different means of spreading is further substantiated by the presence of an occasional Prunus in the Chamaedaphne association and the lack of any Populus there.

The Pyrus is a short-lived plant in competition. This is seen when the average per cent cover for Pyrus is compared between associations. Pyrus forms eight per cent in the bog association, forty-three per cent in the Pyrus, eight per cent in the interior forest and four per cent in the marginal forest. The Pyrus association is a short sere in time. It is a transition between the bog sere and the Populus-Prunus forest.

It can be predicted that the area will eventually become an oak forest. The oaks are becoming established with the Populus and Prunus and appear to be growing well. It is highly doubtful that the bog flora could ever regain its past dominance where the trees are established. The evapo-transpiration ratio has, no doubt, reached the point where more water is being lost than is entering the bog. The peat is also becoming decomposed and its water-retaining capacity is reduced. The present Chamaedaphne association will no doubt be replaced by the invading Pyrus. Thus, the total area of the peat deposit will become a forest of Populus and Prunus and later Quercus. This follows the successional scheme as it has occurred on the peat of Dane County, Wisconsin as described by Frolick.

Conclusions

Hill's Bog developed in a lake formed on the outwash plain of the Marseilles glaciation. A pollen analysis of the peat from the bog indicates that a coniferous forest existed in the vicinity of the bog in the early post-glacial years. The pollen sequence from bottom to top follows a pattern similar to those reported in the literature for bogs in Illinois. The coniferous pollen becomes less frequent above the bottom one-quarter of the deposit. In other Illinois studies deciduous tree pollen becomes dominant after the coniferous pollen becomes reduced but the study of Hill's peat reveals a continual low frequency of deciduous tree pollen. It is assumed that a prairie or savanna replaced the coniferous forest in the vicinity of Hill's Bog rather than a deciduous forest.

Because of the presence of limnetic peat near the bottom of the deposit, it is assumed that the classical scheme of lake filling occurred in the formation of Hill's Bog. A submerged algae stage, a rooted emergent Nymphea stage, and a floating mat stage preceded the heath stage which persisted into the present century. Since Picea pollen is found into the top stratum studied, it is assumed that a bog-forest of Larix and Picea may have been developing on the heath mat at one time. However, the occurrence of prairie fires eliminated this stage before historic times. The wet heath mat was not adversely affected by the fires.

An examination of the 1939 aerial photograph of the area of Hill's Bog reveals that the *Chamaedaphne* association covered most of the bog at that time. A marginal association of *Phalaris* and *Urtica* and a restricted *Pyrus* association are also discernible. A small *Acer saccharinum* was growing on the northeast corner of the bog.

From the examination of the 1961 aerial photograph and quantitative data collected, six associations are defined in the present flora of the bog. The *Chamaedaphne*, or heath association is still present but is reduced from its area in 1939. The *Pyrus* association has shifted from its position in 1939 and now is found covering much of the area of the former *Chamaedaphne* association. The *Pyrus* forms a dense canopy and effectively destroys other plants by shading them out. *Rubus allegheniensis* is found abundantly in the *Pyrus* association where the canopy is not formed. A forest of *Populus tremuloides* and *Prunus serotina* presently covers almost half the area of the bog. It is found outside the above two associations. Weed species such as *Solanum dulcamara* and *Parietaria pensylvanica* are found with the forest association. The marginal association of *Phalaris* and *Urtica* is reduced from its area in 1939 and does not appear to be expanding.

A trench was dug in the peat in 1956 by the nursery and it is presently filled with water. The available moisture has caused an increase in growth by the bog species along the shore of the trench.

Peat decomposition is occurring on the bog and the amount of decomposition appears related to the plant association from which the peat was sampled. A decrease in carbohydrates and an increase in humic acid are found in the peat from the forest association as compared to the *Chamaedaphne* association.

The draining of part of the peat bog in 1942-1943 accelerated the vegetative expansion of the *Pyrus* into the *Chamaedaphne* association. The dense canopy of the *Pyrus* shaded the *Chamaedaphne* and the *Chamaedaphne* was weakened and destroyed. The *Pyrus* association in turn was invaded by the *Populus* and *Prunus* and the *Pyrus* association gave way to the forest association. This succession is continuing today where the *Pyrus* is invading the *Chamaedaphne* association and the trees are invading the *Pyrus* association. *Quercus* seedlings are found under the *Populus* and *Prunus*. These *Quercus* will, no doubt, replace the *Populus* and *Prunus* in dominance. The future vegetation over the total bog will probably be dominated by a mesic *Quercus* forest. The *Chamaedaphne* will be completely eliminated and the *Pyrus* will be reduced to scattered clumps.

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