CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

MEMOIR 162

Peat Bogs in Southeastern Canada

BY

Vaino Auer

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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INTRODUCTION

This report[1] gives the results of an investigation, made in 1926, of thirty-four peat bogs in southeastern Canada, in the region stretching from Niagara district, Ontario, east to and including Nova Scotia (*See* Figure 1). The aim was to investigate as large a region as possible in order to determine what were the general conditions pertaining to the peat bogs of this region and to outline the problems awaiting detailed investigations.

The methods employed were those generally used in Europe, except that botanical studies were neglected. In the course of the field work, a level was used, and drillings were made with a peat drill of the Hillier type by which depths of 9 metres could be reached. The profiles of the peat bogs were made along lines of section located, as nearly as might be, so that they would follow the general inclination of the bogs and also pass over their deepest parts; in a few cases it was necessary to deviate from this general plan. The bogs proved to have unusually homogeneous structures and, therefore, many of the drill holes were sunk merely to determine the depth of the peat. The positions of such holes are not indicated on the profiles.

Drillings extended to the bottoms of the bogs and, except in the case of drillings made to determine depth only, samples were taken at intervals of about a half metre or, in critical cases, at intervals of 30 cm. About six hundred samples were taken for investigation in the laboratory; some of these were the size of the peat drill box (30 cm. long). About one hundred of the samples were megascopically examined to determine the flora; the remainder were microscopically examined, chiefly to determine fossil pollen, but also to investigate peat and sphagnum samples.

Most of the samples taken for megascopic examination were treated, for about twenty-four hours, with nitric acid to remove humus. They were then washed with water. Samples containing shells of molluscs were prepared with water only.

The samples used in the study of pollen species were taken from the middle of the peat drill box and particular care was exercised to avoid contamination with other layers. In the laboratory a small part of each sample was boiled in a solution of potassium hydroxide and from the boiled material a microscopic preparation was made using glycerine. Permanent preparations with glycerine-gelatine were also made. The microscopic preparations measure 8 by 8 mm. and are as nearly as possible of equal thickness.

[1]Mr. Vaino Auer furnished the Geological Survey with a lengthy report, presenting the results obtained by him from his investigations of peat bogs in southeastern Canada. For various reasons it was deemed advisable to condense the report. Unfortunately Mr. Auer could not readily be reached and the abridgment was undertaken without his assistance. Any errors that appear in this volume should, therefore, not be attributed to Mr. Auer.

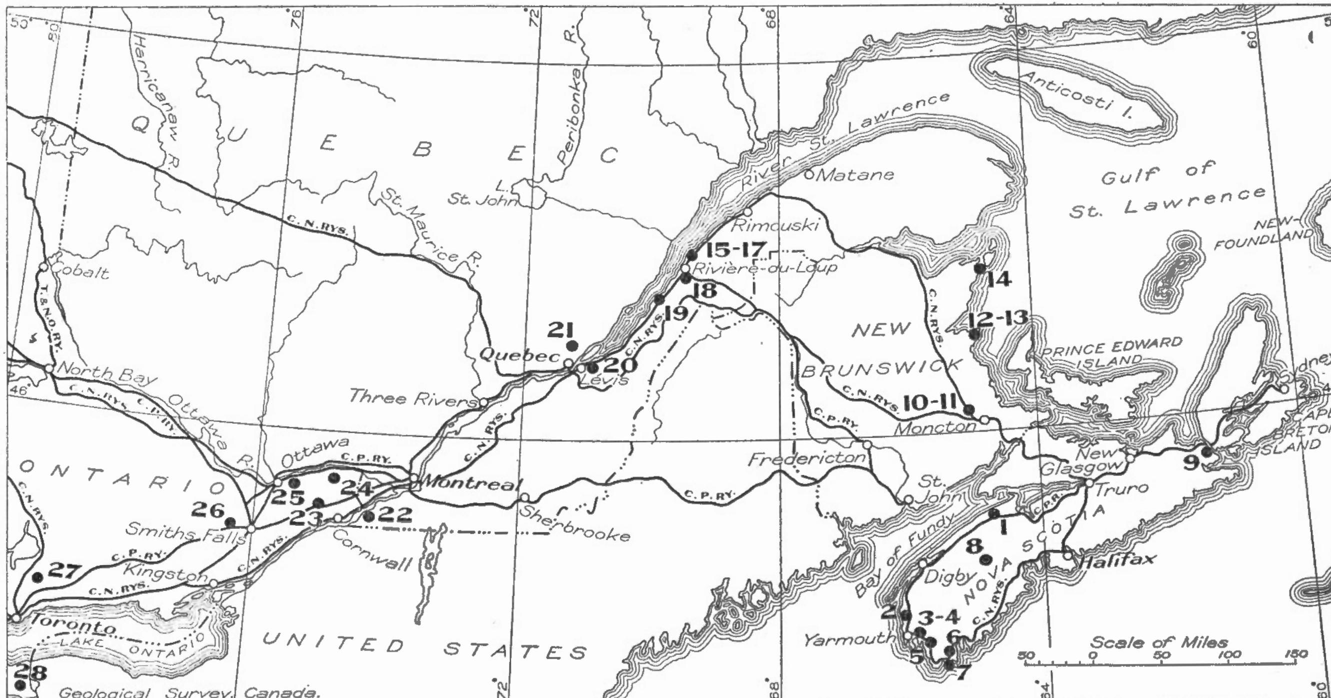

Figure 1. Index map of eastern Canada showing location of peat bogs. 1, Caribou; 2, Salmon River; 3, Tusket; 4, Makoke; 5, Heath; 6, Clyde River; 7, Latour; 8, Cherryfield; 9, Mulgrave; 10, Canaan; 11, Hicks; 12, Eel; 13, Escuminac; 14, Shippigan; 15, L'Ile-Verte; 16, St. Arsène; 17, Cacouna; 18, Rivière-du-Loup; 19, Rivière-Ouelle; 20, Clair; 21, Sagamité; 22, Large Tea Field; 23, Newington; 24, Alfred; 25, Mer Bleue; 26, Perth; 27, Marsh Hill; 28, Welland.

All determinable pollen particles in each microscopic preparation were counted. The number, as a rule, was between 200 and 300. If the number were less than 100, two or more preparations of the same sample were examined in order that the number of pollen particles determined in any one sample should not be less than 100. The results of the examinations of the preparations made from samples representing vertical sections of the peat bogs have been plotted on diagrams. Each diagram represents a vertical section of a bog, and on the diagram the abscissas are proportional to the logarithms of the percentage of each species of pollen and the ordinates are proportional to the depths, within the peat bog, of the samples in which the pollen particles were counted and determined. Owing to certain difficulties, some of the pollen species are not indicated in the diagrams.

A collection of recent pollen was made for comparative purposes and various species were determined with the aid of Dr. Erdtman of Stockholm, to whom, for this assistance, the writer is greatly indebted. The seeds obtained were submitted to Dr. W. L. McAtee, Bureau of Biological Survey, United States Department of Agriculture, and to him the writer is deeply indebted for the determination of the species represented. The author also owes sincere thanks, for aid received, to A. K. Cajander, Olli Heikinheimo, and Pentti Eskola.

The work was primarily made possible by financial aid granted by the International Education Board. While preparing this report, in Finland, the author was supported by the Finnish Academy of Sciences, by the Board of Alfred Kordelin's Fund for the Promotion of Enlightenment and Public Education, and by the Forest Research Institute.

Mr. Grant McDougal, of Winnipeg, acted most energetically as assistant during the course of the field work.

CONDITIONS AFFECTING THE GROWTH OF PEAT BOG VEGETATION

"Peat bog" is a general term applied to deposits of plant materials that accumulated in wet places, bogs, marshes, swamps, ponds, etc. The "peat" is the plant remains, exclusive of the cover of living plants. The peat, in most cases, represents successive generations of plants that grew on the site of the bog. The growth of the plant communities that form the successive layers, in a peat bog, and the plant varieties forming the successive layers, reflect the environmental conditions, such as the climate, and the topographical features of the peat bog. Changes of environmental conditions during the life of a peat bog cause changes in the growth and composition of the plant communities and, as a result, successive layers in a peat bog may be composed of the remains of different plant communities, and, therefore, have different characters. The uses to which a peat bog may be put manifestly depend on the nature of the peat and the structure of the bog. These features can be satisfactorily determined and evaluated only by deciphering the mode of origin and the history of the growth of the peat bog.

Climatic conditions in a large measure control the development of peat bogs. An adequate supply of surface water is necessary to promote the growth of the plants whose remains compose peat; an abundant supply of groundwater is necessary to prevent the decay of the accumulating plant remains. A generous rainfall, therefore, favours the formation of peat bogs, but it is the existence of depressions or other favouring topographic features that brings about the local growth of peat bogs. The establishment and growth of peat-forming plant communities constitute the process known as paludification and it may take place on dry lands, on flooded lands, and in bodies of water.

PALUDIFICATION OF DRY LANDS

In many places in southeastern Canada originally dry forest land has undergone, and is undergoing, paludification. Four main modes may be discriminated: (1) paludification of depressions, caused by surface waters; (2) paludification caused by the rise of the groundwater level; (3) paludification due to the spreading of peat bogs previously formed; and (4) paludification of lands caused by water flowing from peat bogs at higher levels. As a general rule all four modes of paludification, as well as various minor modes, operate together.

In the case of paludification of depressions by surface waters, it is evident that topographical features and the character of the soil are very important factors. If the soil is impermeable or but slightly permeable, water may gather in depressions and give rise to the development of peat-forming vegetation, and the further development is easily continued, especially if *Sphagnum* mosses have gained a footing. In such cases not only is the physical character of the soil an important factor but its chemical composition also. The poor soils of the morainic areas of southeastern Nova Scotia, for example, are subject to paludification on a much larger scale than the areas of fertile soil in the same province. The peat bogs that have originated on dry lands in the fertile areas consist mainly of a rich vegetation and, in most cases, have been caused by a rise of the groundwater level.

In the morainic area of southeastern Nova Scotia, the bottoms of small depressions in which peat-forming vegetation has become established consist, in many cases, of fine materials that have been washed into the depressions and have there diminished the permeability of the soil. In such depressions, *Polytrichum* and, later, *Sphagnum acutifolium*, start and quickly spread. Before long there appears a humid, *Sphagnum* spot which widens annually. The rate of widening accelerates as the area and, therefore, the water capacity, increases. Where the surface has little relief and many small depressions exist, the widening *Sphagnum* spots coalesce and a large peat bog results. In districts nearer the sea, a *Carex* peat has developed on the mineral soil of depressions and has formed an almost impermeable bottom layer. Over this a *Sphagnum* cover has gradually spread. Where tufts of *Carex* projected, trees have grown which afterwards were buried in *Sphagnum* peat when the *Sphagnum* cover became thick and continuous.

In central New Brunswick, in a dry midsummer, stagnant pools in small depressions were seen and along their borders *Sphagnum* was rapidly extending downwards to the pools and upwards over the dry land.

Another process of paludification produced by surface waters acting in depressions was noted on the borders of the Clair bog southeast of Quebec city and also north of the city, near Sagamité lake. In the rich, beech tree forests of these places, the rank grass growing in the depressions forms, on the mineral soil, a nearly impermeable peat. In the depressions, *Mnium* and *Aulacomnion* with *Calliergon* and *Sphagnum,* gradually appear; this is a plant association characteristic of fertile soil. Presently *Sphagnum acutifolium* and *S. fuscum* appear with shrubby plants amongst which *Chamaedaphne* predominates. There thus results a poor type of growth in fertile surroundings. Though the surface water is rich in nourishment derived from the surrounding land, it has not affected the type of vegetation growing over the centres of the depressions.

Paludification of depressions, caused by a rise of the groundwater level, has been brought about in many cases in southeastern Canada, particularly near the sea, as a result of forest fires. Many investigations have established the fact that, in general, the groundwater level is higher in areas of naked soil than in areas covered by a forest growth where the consumption of water by trees causes a lower groundwater level. It is evident from these investigations that enormous quantities of water may be involved. The sudden disappearance of trees, or their dying, or the weakening of their vital power by fire, naturally causes great changes in the water economy of the soil. Unless evaporation is sufficient, the soil becomes water-soaked and paludification sets in. Fires also change the physical and chemical characters of the soil in such a way as to favour paludification. Thus, fine charcoal and tarry materials, formed by the fire, give rise to nearly impermeable strata. Also, the mineral particles of a soil, after a severe fire, are finer, and when washed into depressions form relatively impermeable layers. The rise of the groundwater level and the decreased permeability of the soil, bring about a moist condition in the depressions, and *Sphagnum* growths result.

Where, as in certain sections of Nova Scotia, the soil is sandy, surface water has little chance of stagnating in the depressions and, therefore, peat-forming plant assemblages develop only where the groundwater level has risen to the level of the depressions.

In exceptional cases, paludification results from water trickling down a slope. Water flowing in this way throughout the summer generally results in the production, on the slope, of vegetation of the *Amblystegium* type over which, as the peat grows in height, *Sphagnum* vegetation in many cases spreads. Examples of this manner of growth were seen on the hills near Mulgrave, Nova Scotia, where the *Amblystegium* type occurs in the path of the water and, lower down, the *Sphagnum* type has developed on *Amblystegium* peat.

Paludification which takes the form of the spreading of existing plant communities, depends on biological, edaphic, and topographical factors. Where a patch with a *Sphagnum* cover is surrounded by heathy land, as is commonly the case in coast districts, spreading of the peat-bog vegetation takes place on a large scale; where the surrounding land is covered by a peaty layer, spreading is less. In general, spreading is quicker over barren soil than elsewhere.

Peat bogs by growing upwards raise the surface of the groundwater and the peat-bog plants spread outwardly. For the same general reason peat bogs tend to spread most rapidly uphill against the direction of flow of the surface waters. Forest fires, by destroying the surface vegetation of a peat bog and thus preventing upward growth of the surface, may retard spreading, but in other cases fires may accelerate spreading.

The fourth general mode of paludification is due to water flowing from peat bogs to lower levels. The outflow of bog water may be caused by the growth in height of a peat bog whereby the water is enabled to flow out over a low part of the border of the basin. The slope down which the water flows, especially if it is rich ground, becomes covered with a bog-plant growth rich in grasses; lower down, where the water gathers, a rich *Sphagnum* growth speedily develops. The profiles of the Nova Scotia peat bogs indicate that this mode of development has been common there.

At the present time paludification of forest land is taking place most quickly in the eastern part of southeastern Canada, particularly in the barren districts close to the sea. In the east, groundwater is the most effective, whereas farther west, surface water is of most importance. Humidity of the air, due to nearness to the sea, aids paludification, and in Nova Scotia the damp climate promotes the spreading of *Sphagnum* and in many cases eclipses edaphic factors.

FILLING OF WATER BODIES

The filling, with peat, of ponds and lakes, takes place supra-aquatically, infra-aquatically, and by, so-called, mechanical filling.

Infra-aquatic filling takes place by peat-forming plants spreading from the shore outward on the bottom of the pond or lake. In southeastern Canada the chief noticeable differences in this process are due to the varying fertility of the ground; the filling flora in fertile districts is richer in species and more luxuriant than in less fertile districts. Variations are due also to the presence of more northern or more southern forms. Thus, in places, occur *Typha, Scirpus, Decodon*, etc., plants that are southern swamp forms.

Supra-aquatic filling takes place by the growth of a plant cover on the water surface. The floating cover, in most investigated cases, consists of submerged *Sphagnum cuspidatum* overgrown by *Carex, Menyanthes*, and shrubby plants such as *Chamaedaphne*. The growth, particularly its final phases, is vary rapid, as is evident, for instance, at Alfred peat bog, Ontario. A map of this bog, published in 1914, shows a lake that in 1926 was so overgrown that it was possible to walk on the *Sphagnum* peat cover.

Mechanical filling takes place by the transport of peat and its deposition in a pond or lake basin. This process was not observed to have taken place in southeastern Canada, but probably has done so. Examples were seen where the peat that formed the sides of a lake basin has been forced out into the basin and thus has greatly furthered the spreading of the plant growth.

ORIGIN OF PEAT BOGS ON FLOODED LANDS

Flooded lands along rivers turn, in places, into peat bogs and the amount of peat formed depends upon the condition of sedimentation. On flood-plains of large rivers where great quantities of sediment are transported in summer, moss vegetation cannot develop, and, therefore, *Sphagnum* peat bogs cannot form. Embankments produced by sedimentation occur along rivers, and behind them peat bogs begin to develop when the embankments have grown high enough to prevent overflow from the river, of water and transported sediment.

Formation of peat bogs is, however, taking place along stream banks in southeastern Canada, in many cases by a filling of the stream with vegetable matter. In some places the growth upwards on the stream banks is due to the fact that peat strata, forming lower down, dam back the water and cause an upward growth of peat. The seashores do not, in Canada, turn into peat bogs as, for example, in the area of upheaval in Pohjanmaa, Finland, where there are no tides that prevent the formation of peat reaching to the shoreline.

In delta areas on the coast where the actions of the sea and of the river join forces or are opposed, there is a great variety of land forms. Ponds of stagnant water form behind embankments and, when these are no longer reached by tide-water, they commence to fill with vegetable matter. On level areas, meadows form where *Juncus* and *Carex* plant associations spread without any kind of moss vegetation. *Sphagnum* begins to appear among the *Carex* and *Juncus* plants and by degrees forms a continuous covering. Brushy growths then appear and finally the areas become swampy.

GROWTH OF PEAT BOGS

Plant associations respectively adapted to different degrees of moisture occur in different places on the surface of a peat bog. The bogs are continuously undergoing development, either from a more humid to a drier condition—*progressive* development—or from a drier to a more humid state—*regressive* development, or, as it is now called, *regeneration*. The plant remains form peat year by year, and the surface of the bog rises above groundwater level and begins to dry. If, on the other hand, the flow of water to the bog increases, or if outflow decreases, the bog gradually becomes wetter. As the surface of a bog is not level, parts of it are at different heights above groundwater level and, therefore, the plant associations spread under the influence of different degrees of moisture, consequently the rate of growth varies from place to place and causes further differences in the humidity of the surface of the bog.

The filling of a pond or lake is an example of progressive development. When forest land turns into bog, regressive development takes place. In the *Sphagnum* cover of peat bogs there may be a struggle between damper and drier plant associations: *Sphagnum fuscum* may gradually change to a damper association even into a *Sphagnum cuspidatum* association; in some cases secondary ponds develop. Such a development is a mode of regeneration and the heterogeneous peat thus formed is called a regeneration peat.

The same laws of development hold in the case of brown moss associations. The damp *Amblystegium fluitans* association may develop progressively into *Paludella* associations, even into still drier associations, and be ultimately covered by a luxuriant tree vegetation.

A wet *Sphagnum* cover may gradually change to an association rich in brushy growths and, eventually, trees. The tree-growing area may become wet again, the trees may die and be buried in peat, and the whole plant cover may develop regressively until a progressive development again sets in. The final stage of a progressive development does not always result in a tree-growing association. Many *Sphagnum* peat bogs ultimately develop into a *Cladina* growing dry, mossless peat bog with a sparse, brushy vegetation.

The extensive *Sphagnum* peat bogs in southeastern Canada are, in many cases, quite dry and have no vegetation except shrubby growths, chiefly *Kalmia*. But here and there, *Sphagnum acutifolium* is spreading quite like it does on dry lands, so that the same series of developments is exhibited as in the case of paludification of forest land. This form of regressive development occurs especially on *Sphagnum* peat bogs near the sea and seems to be due to the moist, sea atmosphere.

PHYSICAL FEATURES OF PEAT BOGS DUE TO VARIATIONS IN DEGREE OF MOISTURE

Variations in humidity of the peat-bog surface cause special forms which in their minor details are due to local variations, and in their larger features to the geological development of the peat bog. Local variations of humidity give rise to many forms, such as hummocks, regular embankment systems, funnels, channels of running water, watery spots, and secondary ponds. Hummocks are small elevations on the surface of bogs where the drier plant associations grow. Thus we generally find on the *Sphagnum* peat bogs of Canada, hummocks rich in brushy growths and formed by *Sphagnum fuscum*. The usual mode of development of a hummock is as follows. Upon the wet surface of a peat bog, *Sphagnum papillosum* begins to grow; upon this, other, more xerophile species, such as *Sphagnum medium*, and finally *Sphagnum acutifolium* and *Sphagnum fuscum*. As a rule the hummocks are signs of a marked progressive development, particularly when they are very numerous. They may occur, however, at other stages of development. When regressive development is very marked, extensive areas become watery simultaneously and the highest parts remain as hummocks. Hummocks are in many cases formed, however, as a result of a combined progressive and regressive development.

Freezing-phenomena are very influential factors in southeastern Canada. Freezing and melting have a considerable effect even in the formation of hummocks. In early winter the wettest parts of a peat-bog surface freeze first and thus get a thicker ice-covering than the drier parts, which rise owing to the expansion of the ice. In spring the case is just the reverse. The ice melts first in the most watery parts and remains longer in the drier, higher parts, thus giving rise to a still more rapid progressive development, which causes the hummocks to widen in every direction. The effects of freezing-phenomena are more prominent in the north and in the continental climatic zone, than in the vicinity of the sea where the forms of peat bogs are almost exclusively due to natural development or to other factors, such as forest fires, rain, and wind.

The effect of fires is both direct and indirect. Uneven burning of the surface of a peat bog may cause the division of drier and damper places into hummocks, and fires may cause progressive or, more often, regressive development which in turn causes formation of hummocks. Local heavy rains and wind action on the surface of a dry peat bog may bring about a similar unevenness. Hummock formations are found in southeastern Canada on *Amblystegium* peat bogs as well as on *Sphagnum* bogs and are formed in the same way.

Large, parallel embankments, generally formed by rows of hummocks, occur on the peat bogs in southeastern Canada. They trend, as a rule, at right angles to the slope of the surface of the peat bog. In Europe these formations are northern and occur in Finland and Sweden as regional features following the course of low isotherms. They are *Sphagnum* embankments formed on *Carex* peat, but more to the south there are embankments on *Sphagnum* bottom similar to those found in southeastern Canada. The fact that they are at right angles to the general slope shows that they owe their origin in part to water flowing on the surface of the bogs. In some cases regelation has caused division of the surface into belts. In many cases the phenomenon is due to a gliding of the peat, which happens particularly in spring when the surface layer pushed by the melting water slides along the frozen ground. On the peat bogs in Canada, moreover, an important factor is the pressing up of the water out of the interior of a convex peat bog causing a breaking of the surface and the formation of embankments on the borders. These embankments occur, as a rule, on the borders of level areas in the midst of the convex surface of *Sphagnum* peat bogs, and surround the peat bog in a step-like manner.

The watery places on the surface of peat bogs may be classified according to Sernander's method. He distinguishes that formed by the effect of shade; those caused by algae, epiphytic liver-mosses, and certain lichens, such as *Lecanora;* and those caused by fire and other factors which damage the surface of the bogs. In southeastern Canada all these modes of origin occur. Stagnation in the growth of peat caused by lichens, the effects of fire, and regelation are the chief factors. Regelation causes unevenness in the surface by irregular melting and freezing and is one of the most important causes of many forms of watery spots. Especially in spring, when the snow has just melted, the surface easily moves on the frozen ground below and the consequence of such a movement is unevenness in the surface of the peat bog.

Another cause of movement of the surface peat is fairly well illustrated in the Clair peat bog. The raw *Sphagnum* peat layer on the surface is gliding on a very decayed *Sphagnum* layer underneath and this causes division of the peat bog surface into sharply defined wet and dry areas. In most cases the watery areas develop into secondary lakes and ponds and the drier areas between them are, in the steeper places, like embankments and, in more even spaces, form irregular networks of ridges overgrown with low spruce and brushwood. The watery places are the result of a regressive development; the drier parts are relics of a former continuous peat bog. The regressive development causes a gradual change in places to damper bog plant associations and in other places it may be seen that the most even part of the surfaces has quite suddenly, without any transitional stage whatever, become very wet.

A remarkable fact is that in places where there is a direct change into watery spots, depressions are formed whose surfaces are compact and dry, until they sink down to the level of the groundwater, when spreading secondary ponds at once form. The spreading is chiefly due to the influence of regelation, as is to be found also in Finland in analogous cases, and leads to the formation of larger ponds of irregular pattern on the steeper slopes at right angles to the direction of the course of water.

Secondary ponds, formed as the final result of continuous regressive development, occur on certain peat bogs in southeastern Canada so abundantly that the whole peat bog is a complex of lakes. As a rule, the secondary ponds concentrate in groups in places where the water of the peat bog can in some way remain stationary, on level areas and in the depressions, but also on the steep edge slopes of peat bogs, where water runs over the peat bog or underneath its surface. They are found more abundantly in the vicinity of the ocean.

Some cases worthy of mention were noted on the Rivière-du-Loup peat bog. In the southern part of the bog the water streams from the more elevated parts of the peat bog in channels underneath the surface, and comes up again to the surface in lower places to form secondary watery spots. But as the lakes are drained by the outflow of water there is a rapid filling by the growth of plants. Upon the submerged *Sphagnum cuspidatum* the more xerophile *Sphagnum cuspidatum* associations gradually spread, until at last the spruce-growing type wholly covers the former pond.

Other surface forms of peat bogs are the so-called *funnels* which are found very rarely on the peat bogs in southeastern Canada. A really typical funnel formation has been found only on the St. Arsène peat bog. In European literature the nature and origin of these formations have often been touched upon, but as the funnel formation of St. Arsène in some respects differs from those in Europe a few words may be said concerning it.

The position of the funnel beside a broad and gently sloping channel suggests that there has been a change in the course of the channel and that the depression in the surface of the peat bog was caused by the earlier stream. The funnel has an upper broad and a lower narrow conical part. The peat beneath it is undisturbed and its surface is quite dry in spite of the depth being about 2 metres. There is no growth of moss and the peat is somewhat decayed. The water-level is below the bottom of the depression although 10 feet from it the peat bog is so wet that the water flows to lower parts. It seems probable that there is a subterranean channel which carries away the water during the time of thawing of the ground and by which water sometimes flows during the summer. This theory is supported by the fact that the peat on the downstream side of the funnel is appreciably looser than elsewhere.

The rivers and creeks flowing on the surface of peat bogs are, in most cases, primary creeks that have had the same course since the bog was formed, though they may have somewhat changed their courses. There are also rivulets originated directly by changes of surface; for example, a channel may be formed between the parts of the bog that have become higher than other parts. In southeastern Canada the conditions prevent the formation of typical "Rullen" which are so characteristic of the European peat bogs. The Canadian peat bogs are more homogeneous in structure and the peat is rawer and looser, so that the water can more easily run underneath the surface of the bog. Such underground channels of water cause the borders of the bog to break up, and give rise to many forms. The burning off of the moss covering may cause the surface of the peat bog to be so permeable that the water from heavy rains breaks through in many places and flows away as rapid rivulets. Where burning has formed deep holes in a bog, water may pour into them and eventually cause channels. A more decayed and less permeable layer beneath the surface layer may have an appreciable effect upon the surface features. Where development of the peat bog has led to a dry, mossless lichen type, rainfall causes great changes in the surface of the bog by breaking it up.

ORIGIN AND DEVELOPMENT OF PEAT BOGS

The materials composing the peat bogs investigated may be classified according to origin and composition, in eight divisions named and described in the following paragraphs.

INORGANIC OOZE

A blue or grey, in some cases brownish or yellowish, amorphous, tough substance which, in some instances, is distinguished with difficulty from underlying clay. The ooze formed on the bottoms of ponds and lakes is limnetic, and the layers are seldom thick. It may be largely clay. The upper part of a layer may hold plankton remains.

ORGANIC OOZE (LIMNETIC)

This consists chiefly of organic remains: Diatomaceae, pollen particles, plankton. The colour varies but is commonly brown-tinged green. Classed with the organic ooze and, like it, a deposit formed in ponds and lakes, is *detrital ooze* consisting of remains of *Ceratophyllum*, *Myriophyllum*, *Naias*, *Potamogeton*, *Nymphaea*, and other water plants.

LIMY OOZE (LIMNETIC)

This type of ooze contains remains of mollusc skulls. It was found in Newington, Mer Bleue, Perth, and Marsh Hill peat bogs. It also was deposited in ponds or lakes.

JELLY-LIKE OOZE (LIMNETIC)

This also occurs in Newington, Mer Bleue, Perth, and Marsh Hill peat bogs and in part rests directly on the limy ooze. It was also deposited in ponds or lakes. The ooze is jelly-like. The substance is brown or, in some cases, particularly in the Newington peat bog, light brown and semi-transparent. Since shells occur in the underlying limy ooze, humus acids cannot be present. In the Newington bog this variety of ooze varies from dark and solid to light coloured and soft. The soft variety occurs in the centre of the bog, extends upwards close to the surface, and was the last deposit of a recently filled lake.

The foregoing limnetic types form bottom layers of the peat bogs, but also occur at higher horizons, even above terrestrial layers. In some cases, the oozes hold remains of *Carex*, *Cladium*, *Typha*, and *Equisetum*. On the bottoms of ponds on peat bogs, especially in Nova Scotia, muds occur with intermixed humus, or plankton, or comminuted remains of *Carex*, *Sphagnum*, and *Amblystegium*.

CAREX PEAT

This has developed on wet grounds (telmatic peat). In some bogs *Carex* peat forms a lower, thin layer, in other bogs, such as the Alfred and the Large Tea Field, it forms nearly the whole bog. The Carex peat may be quite pure, but in many cases is intermixed with *Amblystegium* or other plants. In the Alfred peat bog there is, in the Carex peat, a distinct stratum holding intermixed *Amblystegium*. In the Large Tea Field bog, the top and bottom of the Carex peat layer are decayed, but the interior is rawer. Carex peat, in many cases, occurs above limnetic layers and is overlain by *Sphagnum* peat (semi-terrestrial).

AMBLYSTEGIUM PEAT (TELMATIC)

This is rather scarce and occurs mostly intermixed with certain kinds of forest peat.

SPHAGNUM PEAT

This variety, developed in dryer situations (semi-terrestrial) than the *Carex* peat, is the most important in southeastern Canada. It forms thick bodies whose plant composition is exceptionally pure and homogeneous. The mosses are chiefly *Sphagnum cymbifolium* and *S. acutifolium*. The peat in most cases is quite raw, but decayed layers occur, and decayed *Sphagnum* may form the entire bog except for the bottom layers. Stumps occur scattered through the *Sphagnum* peat layers or may be concentrated in certain horizons.

GRASS-HERB-FOREST PEAT (TERRESTRIAL)

Two main kinds of terrestrial peat occur. One kind consists of tree stumps in *Sphagnum* peat. The second kind consists of decayed, brushy material in grass-herb-forest peat; it is a very rich peat particularly if it contains much *Amblystegium;* and it occurs mostly on the bottom or borders of the peat bogs.

The peat bogs mainly composed of *Sphagnum* peat occur in the extreme east, comparatively close to the Atlantic. To the west, inland, *Sphagnum* peat forms only a thin surface layer or is wanting, whereas *Carex* peat forms thick deposits, and pure terrestrial peats increase in importance.

The profiles of the peat bogs accompanying this report show that lake and pond (limnetic) deposits occupy a comparatively small part of the areas of the bottoms of the peat bogs, and that the peat bogs largely developed by the paludification of dry land. At the contact of the peat with the mineral soil of what was dry land, remains of trees, brushy growths, and of, in general, such plants as are the pioneers in the paludifying of forest land, are generally found. In most cases, it is evident that paludification commenced on or about ancient ponds and lakes and spread from them. As the peat accumulations grew upwards, the bog water of the higher sites overflowed and accelerated paludification on the slopes leading to the lower sites. In some cases paludification commenced in small depressions, not ponds or lakes. In general, paludification appears to have set in and continued in the same ways as are now operative.

As the accompanying profiles show, the peat layers resting on mineral soil are, in most cases, *Carex* peat and this is so even where the profile of the bottom is convex. Tree stumps were seldom found in the basal part of the *Carex* peat, thus proving the general absence of trees. *Sphagnum* peat seldom rests on mineral soil except in the case of younger, overlapping strata. It is evident, therefore, that in earlier times, dry lands turned into peat bogs chiefly by the spread of *Carex* plant associations and not until later, by the spreading of *Sphagnum*. In a number of cases where *Sphagnum* peat rests on mineral soil, much charcoal lies below the peat, showing that forest growths then existed and also indicating the importance of forest fires as a cause of paludification.

The *Carex* peat of some of the peat bogs rests on clay. In several bogs near the sea, the underlying clay was found to hold marine *Diatomacea* thus suggesting that these bogs, at least, developed as the sea receded. It is certain, however, that the *Carex* peat of many of the peat bogs developed on soils of non-marine origin. On the other hand, the surfaces of the *Carex* peat layers regularly bear tree stumps representing the remains of dwarf shrub plant assemblages much as nowadays thin layers of decayed *Carex* peat near the seashore bear a tree-growing vegetation transitional in character to that which affords *Sphagnum* peat.

The manner of filling the ponds and lakes about which the peat bogs originated is indicated on the accompanying profiles. The bottom is usually covered with inorganic ooze overlain by various types of organic ooze. The water basins in most cases have been filled by *Carex* vegetation and, at later stages, by *Sphagnum*. The *Carex* vegetation grew from the shores inwards as is apparent in various instances by the surface of the limnetic deposits rising towards the centre of the pond; the limnetic deposits continued to grow as the *Carex* vegetation gradually encroached over the pond basin. Occasionally, later ponds developed, as indicated by limnetic layers in peat, and were subsequently filled in.

The oozes filling the original ponds and lakes in the east are characterized by their comparatively great humus content. The limnetic deposits of the peat bogs farther west, in Ontario, are distinguished by layers of limy ooze and jelly-like ooze and by the greater abundance of detrital plant material and plankton remains. The vegetation which overgrew the original ponds and lakes was richer in species and more luxuriant than the plant cover of today. The water bodies were bordered by *Typha, Cladium, Scirpus, Decodon,* and other forms, and in the waters grew a rich vegetation characterized by *Naias, Ceratophyllum, Myriophyllum,* etc.

If the original ponds or lakes were small, ponds tended to develop at a later date over the same sites. If the lakes were large and, therefore, were not filled in and overgrown at a comparatively early date, they, at a later date, tended to expand so that limnetic deposits overlap peat.

The concentrations of stumps in layers in the peat bogs indicate, in many cases, events of merely local significance, such as a drying up of the surface of the peat bog because of its increased height. Decayed peat layers, in many cases, have a similar significance.

The surfaces of the younger peat bogs (most of these are *Carex* bogs) conform, in shape, in a general way, to the topography of the surfaces on which the bogs grew. The *Carex* bogs of the western, inland district show no such relation. The *Sphagnum* bogs of the eastern, maritime district, have convex surfaces.

EVIDENCES OF CLIMATIC CHANGES

The manner in which peat bogs originate and grow tends to produce in every bog the same stratigraphical structure. In general the plant content, etc., of successive layers indicate a change to drier conditions, but this and other changes do not necessarily reflect changes of climate. On the other hand, since peat-forming vegetation so greatly reflects in its character, variations in moisture, and since general changes in the degree of moisture are largely caused by changes of climate, it is evident that climatic changes should be manifested by the general stratigraphical succession in the peat bogs of a given region.

Some of the differences in the composition or character of successive layers that might indicate changes of climate are as follows. If *Carex* peat is overlain by a mossless or an *Amblystegium* type, a change to moister conditions is indicated. A *Sphagnum* peat, by its floral composition, may indicate changes to dryer or wetter conditions; the presence of decayed layers indicates a lack of moisture. A peat composed of swampy growths may give indications of a change to still wetter conditions by, for instance, becoming richer in sedges; or it may indicate a progressive change to drier conditions by a change upwards into more terrestrial-like, fairly well decayed peat. The limnetic strata and their relations to the overlying peat may indicate a shrinkage of the water basin or an expansion, and these changes in the water bodies may be due to climatic changes. But all such changes may be seen to be taking place on the present surfaces of the peat bogs and are not due to climatic changes. This being so, stratigraphical structures of the peat bogs of southeastern Canada should not be interpreted as indicative of climatic changes unless it can be proved that a certain stratigraphical succession characterizes the individual peat bogs of a region and was simultaneously developed in them.

As stated on a previous page, the flora, which bordered and overgrew the lakes and ponds about which most of the peat bogs originated, was richer in species and more luxuriant than that of the present plant covers. This condition may indicate that a milder climate prevailed in the beginning. It is noticeable that during the early stages of the peat bogs, either the primary ponds and lakes grew in area or, if they were overgrown at an early date, secondary ponds formed shortly thereafter. Further, where peat bogs formed by the paludification of dry land, secondary lakes appeared at a comparatively early date. Evidences of a change to drier conditions at a later date are indicated by the existence of layers of decayed peat, or by the presence of stumps, or, in bogs where the lakes still persisted, by a peat layer resulting from a rapid overgrowing of the water body. The characters of higher layers indicate a return to moister conditions. The present surfaces, especially in the western districts of southeastern Canada, point to drier conditions. The above-mentioned successive changes indicated by the peat bog layers are in evidence in the peat bogs of the whole region and everywhere took place in the same order. They cannot be due to local causes and, therefore, are presumed to have been caused by climatic changes.

The pollen content of the successive layers of the individual peat bogs is a direct indication of the comparative abundance of the different kinds of trees growing as the peat layers formed. As shown by the accompanying diagram of the pollen content certain changes took place in the same order. These, too, may indicate climatic changes. *Picea* pollen is most abundant in the oldest layers, decreases in amount in higher layers, in certain cases disappears, and in the highest layers increases in amount. The *Abies* pollen behaves like the *Picea* pollen. Pine pollen is very abundant in the older layers and gradually decreases in amount upwards; in one instance the decrease is exceptionally rapid. Pollen of deciduous trees occurs abundantly in those layers in which *Picea* pollen is in minimum quantity. The variations in amounts of pollen of *Tsuga* and of deciduous trees are in many cases much alike.

Though, as briefly stated in the preceding paragraphs, various stratigraphical features of the peat bogs seem to indicate climatic changes, the evidence should not be regarded as being conclusive until it is proved that the stratigraphical features were synchronous. As yet, the only available method of correlating the strata of the different peat bogs is by means of their pollen content, a method that has been found to be applicable in Europe. In the case of the peat bogs of southeastern Canada, even this method is difficult to apply because it has been found, for instance, that the pollen content of neighbouring peat bogs may differ considerably. In attempting to correlate, by means of pollen content, the strata of different peat bogs, the most significant feature is the first appearance of a species, but as plants spread more rapidly in some districts than in others, even this feature is strictly applicable only to small areas. Possibly, some or many of the difficulties in interpreting the meaning of the pollen content of Canadian peat bogs may have been caused by not sampling closely enough.

Pollen of *Picea* and *Abies* is, in general, at a maximum in the bottom layers of the peat bogs. Since this is true of the eastern peat bogs where the ocean must always have tended to cause a moist climate, it probably means that the climate was warmer. The early maximum of *Picea* and *Abies* is true of all the peat bogs in which *Carex* peat overgrew the early lakes and took part in the paludification of dry land, and is thought to indicate that these peat bogs originated at about the same time.

In those peat bogs where the original lakes persisted into the secondary lake stage, *Picea* and *Abies* pollen decreases greatly in amount in the strata of this stage, whereas certain foliage trees and other more pretentious plant species began to increase. The maximum of *Tsuga* is in the upper part of the sediments of the secondary lake stage. The pollen diagrams seem to indicate that the strata of the secondary lake stage are synchronous and that the strata of the next stage, when the lakes were filled, also were of one age. The pollen contents also support the view that the strata of the succeeding damper period were likewise synchronous.

The pollen content thus indicates that the alternating drier and wetter periods were synchronous and supports the view that the alternating periods were due to climatic changes, for the reason that the synchronism applies to so wide a stretch of country.

In making the comparisons from which the above deductions were drawn, the Caribou peat bog may be chosen as a standard. In the primary lake deposits of this peat bog which, it is thought, formed during the early warm and, apparently, dry stage, *Picea* pollen has its maximum. This is true, also, of the primary lake deposits of Clyde River, Makoke, Heath, Cherryfield, and Cacouna peat bogs, all situated in the maritime district, and it is concluded, therefore, that these primary lake deposits are of the same age. Farther west, remote from the sea, this stage is represented in the Newington peat bog by a low-water stage when the limy ooze formed; in the Perth peat bog by a low-water stage when limy ooze accumulated on one shore and *Carex* peat was advancing from the other; in the Alfred peat bog by a terrestrial peat that grew on a clay bottom; and in the Mer Bleue peat bog by an Amblystegium peat cover and a terrestrial peat border to the primary lake.

In the Caribou bog, deposits of a secondary lake lie on the *Carex* peat overgrowth of the original lake. With this secondary lake stage is correlated—in the Clyde River bog, the transgression of *Carex* peat over *Sphagnum* peat; in the Makoke bog, the appearance of a secondary lake; and in the Cacouna bog, a secondary lake whose deposits lie between two layers of *Amblystegium* peat. This stage is represented in the Newington bog by a spreading of jelly-like ooze over the limy ooze that took place during an extension of the water body; in the Perth bog by organic ooze which, because of an enlarging of the lake, spread over *Carex* peat and limy ooze; in the Mer Bleue bog by the secondary lake deposits that lie between *Carex* peat resting on terrestrial peat; in the Alfred bog by at least the lowest part of the *Amblystegium* peat layer and pond deposits in this layer; in the Welland bog by the small, secondary pond deposits resting on terrestrial peat.

In the deposits of this secondary lake stage, *Picea* pollen decreases, pollen of deciduous trees increases, and that of *Tsuga* increases considerably, attaining its maximum in the upper part of the deposits or at a slightly higher horizon. The presence of *Tsuga* is indicative of a moist condition. That the secondary lake stage was short is apparent in the comparative thinness of the deposits, the vertical distribution of *Tsuga* being contributory evidence since the climatic conditions brought about the appearance of *Tsuga*, though this did not reach its maximum until after the favouring climatic conditions had given place to others.

The deposits of the following stage give evidence of dryness. In the Caribou bog was formed a thick, lens-like body of decayed peat holding many stumps, indicating that a forest extended over the peat bog. Cherryfield, Cacouna, and Clair bogs also hold decayed layers and in most of the bogs stumps are common in the deposits of this stage. In the Newington bog, at this stage, the *Carex* peat rapidly advanced over the enlarged lake; in the Perth bog the lake, after having widened, was rapidly overgrown by a thin *Carex* peat layer and on one side by a terrestrial peat—at the end of the stage trees grew over the peat bog; in the Mer Bleue bog *Carex* peat overgrew the lake deposits and trees, as indicated by the stumps, grew on the *Carex* peat layer; in the Alfred and Welland bogs the stage is marked by horizon characterized by stumps.

During the stage of dryness, deciduous trees, as indicated by their pollen, were very abundant. Thereafter the deciduous trees decreased and *Picea* rapidly increased, indicating a change to a wetter climate which is also indicated by the raw nature of the peat of this stage, by the wider spreading of *Sphagnum*, and by the appearance of secondary lakes.

The peat bogs of southeastern Canada thus seem to indicate that the lower layers formed during a warm, dry period; that this was followed by a moist period which, judging by the presence of deciduous trees, was also probably warm; that this was succeeded by a dry, warm period, and this in turn by a moist period which possibly was comparatively cool as deciduous trees decreased in quantity. The climatic changes correspond in a general way, at least, to those that affected Europe in post-Glacial time. The early dry, warm period corresponds with the Boreal period; the next, the moist, probably warm period, with the Atlantic period; the third, the dry, warm period with the sub-Boreal period; and the last, the moist, probably cool period, with the sub-Atlantic period.

SEEDS FROM PEAT BOGS IN SOUTHEASTERN CANADA

Determined by W. L. McAtee

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CARIBOU PEAT BOG

1.	*Potamogeton zosterifolius* Schum.	(4)
	Naias flexilis Rostk. and Schmidt	(10)
	Cladium mariscoides Torr.	(2)
	Scirpus americanus Pers.	(1)
	Castalia odorata Ait.	(6)
2.	*Nymphaea advena* Sol.	(3)
	Brasenia schreberi Gmel.	(1)
	Castalia odorata Ait.	(10)
	Potamogeton pusillus L.	(4)
	Naias flexilis Rostk. and Schmidt	(about 11)
3.	*Brasenia schreberi* Gmel.	(1)
	Castalia odorata Ait.	(6)
	Potamogeton pusillus L.	(5)
	" *zosterifolius* Schum.	(5)
	Nais flexilis Rostk. and Schmidt	(about 33)
4.	*Brasenia schreberi* Gmel.	(2)
	Castalia odorata Ait.	(4)
	Potamogeton sp.	(2)
	Cladium mariscoides Torr.	(4)
	Naias flexilis Rostk. and Schmidt	(1)
	Unidentified	(2)
5.	*Potamogeton zosterifolius* Schum.	(1)
	" sp. immature	(1)
	Castalia odorate Ait.	(1)
	Naias flexilis Rostk. and Schmidt	(1)
	Cladium mariscoides Torr.	(1)
	Scirpus sp.	(1)
6.	*Nymphaea advena* Sol.	(5)
	Sparganium sp.	(1)
	Potamogeton sp.	(1)
	Carex sp.	(1)
7.	*Brasenia schreberi* Gmel.	(1)
	Nymphaea advena Sol.	(3)
	Potamogeton pusillus	(6)
	" *zosterifolius* Schum.	(3)
	Naias flexilis Rostk. and Schmidt	(5)

8. *Naias flexilis* Rostk. and Schmidt	(3)
Potamogeton puillus L.	(37)
Immature sedge	(1)
Unidentified	(1)

TUSKET PEAT BOG

9. *Naias flexilis* Rostk. and Schmidt	(30)
Castalia odorata Ait.	(2)
10. *Potamogeton pusillus* L.	(35)
Naias flexilis Rostk. and Schmidt	(1)
Batrachium trichophyllum Chaix	(1)

MAKOKE PEAT BOG

11. *Castalia odorata* Ait.	(5)
Brasenia schreberi Gmel.	(2)
Naias flexilis Rostk. and Schmidt	(3)

CLYDE RIVER PEAT BOG

12. *Potamogeton pusillus* L.	(10)
" *spirillus* Tuck.	(3)
Brasenia schreberi Gmel.	(1)
Betula sp.	(1)
Menyanthes trifoliata L.	(1)
Unidentified	(1)
13. *Brasenia schreberi* Gmel.	(11)
Potamogeton spirillus Tuck.	(4)
" sp.	(5)
14. *Brasenia schreberi* Gmel.	(11)
Castalia odorata Ait.	(3)
Nymphaea advena Sol.	(1)
Rhynchospora sp.	(1)
Unidentified	(2)

CHERRYFIELD PEAT BOG

15. *Castalia odorata* Ait.	(7)
Brasenia schreberi Gmel.	(2)
Naias flexilis Rostk. and Schmidt	(1)
Potamogeton sp.	(1)
Unidentified	(1)
16. *Naias flexilis* Rostk. and Schmidt	(5)
Potamogeton pusillus L.	(9)

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17.	*Nymphaea advena* Sol.	(4)
	Brasenia schreberi Gmel.	(3)
	Castalia odorata Ait.	(12)
	Potamogeton spirillus Tuck.	(1)
	" sp.	(1)
	Naias flexilis Rostk. and Schmidt	(1)
	Rynchospora sp.	(1)
	Betula sp.	(1)
	Cladium mariscoides Torr.	(2)
	Gaultheria procumbens L.	(1)
18.	*Castalia odorata* Ait.	(6)
	Brasenia schreberi Gmel.	(1)
	Carex sp.	(2)
	Unidentified	(1)
19.	*Castalia odorata* Ait.	(7)
	Naias flexilis Rostk. and Schmidt	(4)

MULGRAVE PEAT BOG

20.	*Nymphaea advena* Sol.	(1)
	Batrachium trichophyllum Chaix	(4)
	Potamogeton spirillus Tuck.	(1)
	" sp.	(3)
	Carex sp.	(1)
	Unidentified	(1) + (1) + (1)
21.	*Nymphaea advena* Sol.	(4)
	Carex sp.	(1)
	Eleocharis sp.	(1)
	Potamogeton spirillus Tuck.	(1)
	" *pusillus* L.	(1)
	Naias flexilis Rostk. and Schmidt	(1)
22.	*Nymphaea advena* Sol.	(1)
	Castalia odorata Ait.	(1)
	Naias flexilis Rostk. and Schmidt	(4)
	Potamogeton spirillus Tuck.	(3)
	" *foliosus* Raf.	(1)

HICKS PEAT BOG

23.	*Potamogeton pusillus* L.	(13)
24.	*Nymphaea advena* Sol.	(2)
	Eleocharis sp.	(10)
	Carex sp.	(1)
	Sedge	(1)
	Myriophyllum near *scabratum*	(1)
	Naias flexilis Rostk. and Schmidt	(3)
	Potamogeton sp.	(2)

CANAAN PEAT BOG

25.	*Ceratophyllum demersum* L.	(1)
	Rhus sp.	(2) + (1)
26.	*Nymphaea advena* Sol.	(1)
	Cladium mariscoides Torrey	(3)
	Naias flexilis Rostk. and Schmidt	(4)
	Potamogeton sp.	(3)
	Brasenia schreberi Gmel.	(1)
27.	*Brasenia schreberi* Gmel.	(1)
	Potamogeton sp.	(2)
	Myriophyllum near *scabratum*	(3)
	Carex sp.	(1)
	Eleocharis sp.	(12)
	Scirpus sp.	(1)

SAGAMITÉ PEAT BOG

28.	*Betula* sp.	(15)
	Picea sp.	(1)
	Carex sp.	(1)
29.	*Naias flexilis* Rostk. and Schmidt	(1)
	Betula sp.	(3)
30.	*Rhynchospora* sp.	(2)
	Scirpus sp.	(1)
	Carex sp.	(1)
	Eleocharis sp.	(12)
	Brasenia schreberi Gmel.	(3)
	Sagittaria latifolia Willd.	(1)
	Alnus sp.	(1)
31.	*Sagittaria latifolia* Willd.	(5)
	Naias flexilis Rostk. and Schmidt	(1)
	Brasenia schreberi Gmel.	(1)
	Carex sp.	(3)
	Eleocharis obtusa Schultes	(17)
	" sp. immature..............................	(2)
	Scirpus americanus Pers.	(1)
32.	*Betula* sp.	(3)
	Naias flexilis Rostk. and Schmidt	(1)
	Potamogeton sp.	(1)
33.	*Betula* sp.	(2)
	Naias flexilis	(1)
	Unidentified	(2)

ALFRED PEAT BOG

34.	*Menyanthes trifoliata* L.	(2)
	Scirpus sp.	(25)
	Eleocharis sp.	(about 70)
35.	*Scirpus* sp.	(1)
36.	*Cladium mariscoides* Torr.	(1)
	Scirpus sp.	(16±)
	Immature sedge seeds..............................	(80±)
	Menyanthes trifoliata L.	(3)
37.	*Naias flexilis* Rostk. and Schmidt	(several)
	Scirpus americanus Pers.	(1)
38.	*Naias flexilis* Rostk. and Schmidt	(11)
	Myriophyllum sp.	(1)
39.	*Naias flexilis* Rostk. and Schmidt	(12)
	Potamogeton sp.	(1)
	Unidentified	(1)
40.	*Naias flexilis* Rostk. and Schmidt	(8)
	Potamogeton sp.	(1 frg.)
41.	*Naias flexilis* Rostk. and Schmidt	(12)
	Potamogeton sp.	(1)
	Brasenia schreberi Gmel.	(1)
	Castalia odorata Ait.	(1)
	Carex sp.	(6)
	Unidentified	(2)

NEWINGTON PEAT BOG

42.	*Naias flexilis* Rostk. and Schmidt	(6)
	Potamogeton sp.	(frg.)
	Carex sp.	(4)
	Scirpus sp.	(8)
	Rhynchospora sp.	(1)
	Unidentified	(2)
43.	*Naias flexilis* Rostk. and Schmidt	(1)
	Potamogeton sp.	(1)
44.	*Cladium mariscoides* Torr.	(1)
	Potamogeton sp.	(1)
	Unidentified	(2)
45.	*Naias flexilis* Rostk. and Schmidt	(many)
	Betula sp.	(2)
46.	*Naias flexilis* Rostk. and Schmidt	(12)

47.	*Cornus amonum* Mill.	(1 split)
	Cornus circinata L'Her.	(1 more spherical)
48.	*Castalia odorata* Ait.	(2)
	Carex sp.	(2)
	Eleocharis sp.	(5)
	Scirpus sp.	(3)
	Boehmeria cylindrica (L.) Sw.	(6)
	Sagittaria latifolia Willd.	(1)
	Naias flexilis Rostk. and Schmidt	(16)
49.	*Naias flexilis* Rostk. and Schmidt	(28)
50.	*Nymphaea advena* Sol.	(1)
	Carex sp.	(1) + (2)
	Rhynchospora sp.	(2)
	Scirpus sp.	(10)
	Bidens sp.	(2)
	Betula sp.	(1)
	Sagittaria latifolia Willd.	(1)
	Unidentified	(1)
	Eleocharis sp.	(2)
	Naias flexilis Rostk. and Schmidt	(10)
51.	*Boehmeria cylindrica* (L.) Sw.	(1)
	Castalia odorata Ait.	(1)
	Scirpus lacustris L.	(4)
	Carex sp.	(1)
	Naias flexilis Rostk. and Schmidt	(11)
52.	*Eleocharis* sp.	(6)
	Scirpus lacustris L.	(13)
	Potamogeton pusillus L.	(3)
	Naias flexilis Rostk. and Schmidt	(9)
	Bidens sp.	(2)
53.	*Impatiens* sp.	(1)
	Boehmeria cylindrica (L.) Sw.	(1)
	Scirpus sp.	(4)
	Carex sp.	(2)
	Proserpinaca palustris L.	(1)
	Decodon verticillatus L.	(1)
	Cyperus sp.	(1)
	Unidentified	(1) + (4) + (3)
	Potentilla sp.	(3)
	Scrophulariaceae	(3)
	Naias flexilis Rostk. and Schmidt	(about 45)
54.	Carex sp.	(4)

MER BLEUE PEAT BOG

55.	*Naias flexilis* Rostk. and Schmidt	(18)
	Scirpus sp.	(3)
	Betula sp.	(1)
	Tsuga canadensis L.	(1)
56.	*Cladium mariscoides* Torr.	(6)
	Scirpus lacustris L.	(2)
	Carex sp.	(3)
	Polygonum lapathifolium L.	(1)
	" sp. immature	(1)
	Naias flexilis Rostk. and Schmidt	(7)
	Alnus incana Willd.	(3)
	Tsuga canadensis Carr.	(1)
	Unidentified	(1)
57.	*Scirpus americanus* Pers.	(3)
	Sedge, immature	(3)
	Naias flexilis Rostk. and Schmidt	(1)
	Umbelliferae (*Cicula*)	(1)
	Compositae	(1)

MARSH HILL PEAT BOG

58.	*Naias flexilis* Rostk. and Schmidt	(4)
	Cornus sp.	(1 frg.)
59.	*Naias flexilis* Rostk. and Schmidt	(12)
60.	*Cladium mariscoides* Torr.	(8)
	Scirpus americanus Pers.	(1)
	Carex sp.	(1)
	Rosa sp.	(1)
	Unidentified	(4)
	Naias flexilis Rostk. and Schmidt	(3)
61.	*Cladium mariscoides* Torr.	(17)
	Carex sp.	(1)
	Scirpus lacustris L.	(6)
	" *americanus* Pers.	(1)
	Asclepias sp.	(1)
	Decodon verticillatus L.	(1)
	Alnus incana L.	(2)
	Betula sp.	(1)
	Potamogeton sp.	(1)
	Naias flexilis Rostk. and Schmidt	(12)
	Boehmeria cylindrica (L.) Sw.	(2)
	Unidentified	(3)

62.	*Cladium mariscoides* Torr.	(5)
	Carex sp.	(8)
	Decodon verticillatus L.	(2)
	Polygonum lapathifolium L.	(1)
	Potamogeton sp.	(1)
	Scirpus sp.	(1)
	Saxifragaceae ?	(9)
	This same thing commonly listed as unidentified, these the most perfect specimens seen.	
	Brasenia schreberi Gmel.	(1)
	Rosa sp.	(1)
	Alnus incana L.	(1)
	Boehmeria cylindrica (L.) Sw.	(1)
	Naias flexilis Rostk. and Schmidt	(12)
63.	Carex sp.	(11)
	Cyperus sp.	(6)
	Scirpus sp.	(1)
	Cladium mariscoides Torr.	(1)
	Betula sp.	(2)
	Alnus incana L.	(7)
	Decodon verticillatus L.	(7)
	Boehmeria cylindrica (L.) Sw.	(6)
	Picea sp.	(1)
	Potamogeton spirillus Tuck.	(1)
	Polygonum lapathifolium L.	(1)
	Naias flexilis Rostk. and Schmidt	(1)
	Bidens sp.	(1)
	Asclepias sp.	(1)
	Sagittaria latifolia Willd.	(1)
64.	*Boehmeria cylindrica* (L.) Sw.	(3)
	Lycopus americanus Gr.	(2)
	Cladium mariscoides Torr.	(6)
	Carex sp.	(8)
	Scirpus lacustris L.	(8)
	Naias flexilis Rostk. and Schmidt	(11)
65.	*Naias flexilis* Rostk. and Schmidt	(3)
	Cladium mariscoides Torr.	(10)
	Decodon verticillatum L.	(5)
	Alnus incana Willd.	(1)
	Carex sp.	(1)
	Adicea pumila L.	(1)
	Quercus sp.	(fragment)
	Scirpus sp.	(1)
66.	*Cladium mariscoides* Torr.	(11)
	Decodon verticillatum L.	(6)
	Betula sp.	(3)

	Alnus incana Willd.	(1)
	Polygonum lapathifolium L.	(1)
	Scirpus americanus Pers.	(1)
	Carex sp.	(9)
	Unidentified	(6) + (1) + (2)
	Boehmeria cylindrica (L.) Sw.	(2)
	Potamogeton sp.	(1)
	Lycopus sp.	(2)
	Naias flexilis Rostk. and Schmidt	(10)
	Sagittaria latifolia Willd.	(1)
67.	*Cladium mariscoides* Torr.	(9)
	Cornus stolonifera Michx.	(1)
	Scirpus sp.	(2)
	Carex sp.	(4)
	Eleocharis sp.	(2)
	Unidentified	(2)
	Asclepias sp.	(1)
	Naias flexilis Rostk. and Schmidt	(16)
	Sagittaria latifolia Willd.	(4)
	Lycopus americanus Gray	(6)
	Boehmeria cylindrica (L.) Sw.	(3)
	Betula sp.	(2)
	Alnus incana Willd.	(2)
	Decodon verticillatus L.	(1)
	Potamogeton sp.	(1)
68.	*Naias flexilis* Rostk. and Schmidt	(7)
	Cladium mariscoides Torr.	(7)
	Scirpus lacustris L.	(1)
	" sp. immature	(2)
	Carex sp.	(8)
	Boehmeria cylindrica (L.) Sw.	(5)
	Alnus incana Willd.	(2)
	Lycopus americanus Gr.	(1)
	Cyperus sp.	(1)
	Rosa sp.	(2)
	Vaccinium sp.	(1)
	Umbelliferae	(1)
	Unidentified	(10 of three species)
69.	*Cladium mariscoides* Torr.	(11)
	Scirpus americanus Pers.	(2)
	Carex sp.	(4)
	Naias flexilis Rostk. and Schmidt	(6)
	Potamogeton sp.	(1)
	Polygonum lapathifolium L.	(1)
	Alnus incana Willd.	(1)
	Unidentified	(3)

70. *Naias flexilis* Rostk. and Schmidt	(7)
Cladium mariscoides Torr.	(10)
Castalia odorata Ait.	(1)
Scirpus lacustris L.	(5)
Carex sp.	(2)
Polygonum lapathifolium L.	(1)
Potamogeton amplifolius Tuck.	(1)
Lycopus americanus Gray	(2)
Unidentified	(2)
71. *Naias flexilis* Rostk. and Schmidt	(several)
Cladium mariscoides Torr.	(5)
Potamogeton sp.	(1)
Scirpus americanus Pers.	(3)
Rhynchospora sp.	(1)
Alnus sp.	(1)
Unidentified	(1)
72. *Naias flexilis* Rostk. and Schmidt	(7)
Potamogeton sp.	(1)
Cladium mariscoides Torr.	(4)
Scirpus americanus Pers.	(2)
" *lacustris* L.	(8)
Carex sp.	(1)
Immature sedge seeds	(3)
Tsuga canadensis Carr.	(1)
Cornus stolonifera Michx.	(1)
Boehmeria cylindrica (L.) Sw.	(2)
73. *Cladium mariscoides* Torr.	(9)
Brasenia schreberi Gmel.	(1)
Carex sp.	(4)
Rhynchospora sp.	(1)
Scirpus lacustris L.	(2)
Boehmeria cylindrica (L.) Sw.	(5)
Decodon verticillatus L.	(3)
Polygonum lapathifolium L.	(1)
Naias flexilis Rostk. and Schmidt	(13)
Compositae	(1)
74. *Scirpus americanus* Pers.	(2)
" sp.	(2)
Carex sp.	(1)
Cladium mariscoides Torr.	(5)
Polygonum sp. immature	(2)
Adicea pumila L.	(2)
Decodon verticillatus L.	(1)
Unidentified	(3) + (1)
Naias flexilis Rostk. and Schmidt	(8)

75.	*Cladium mariscoides* Torr.	(9)
	Carex sp.	(3)
	Cephalanthus occidentalis L.	(1)
	Alnus sp.	(1)
	Betula sp.	(2)
	Bidens sp.	(1)
	Naias flexilis Rostk. and Schmidt	(8)
	Picea sp.	(1)

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76.	*Ceratophyllum demersum* L.	(2)
	Brasenia schreberi Gmel.	(1)
	Potamogeton zosterifolius Schum.	(3)
	Sparganium sp.	(3)
	Carex sp.	(2)
	Scirpus sp.	(3)
	Polygonum hydropiperoides Mx.	(9)
	Sagittaria latifolia Willd.	(15)
	Naias flexilis Rostk. and Schmidt	(1)
	Chenopodium sp.	(1)
77.	*Naias flexilis* Rostk. and Schmidt	(8)
	Cladium mariscoides Torr.	(4)
	Scirpus americanus Pers.	(2)
	" *lacustris* L.	(2)
	Cornus sp. immature	(1)
	Unidentified	(1)
78.	*Ceratophyllum demersum* L.	(1)
	Brasenia schreberi Gmel.	(1)
	Sparganium sp.	(2)
	Decodon verticillatus L.	(5)
	Cephalanthus occidentalis L.	(6)
	Polygonum hydropiperoides Mx.	(1)
	Carex sp.	(1)
	Cornus sp. fragment	(1)
	Sagittaria latifolia Willd.	(7)
	Betula sp.	(5)
	Rhynchospora sp.	(1)
	Polygonum sp. immature	(1)
	Potamogeton sp.	(1) + (1)
	Naias sp. immature	(2)
	Unidentified	(1)
79.	*Sparganium* sp.	(11)
	Cephalanthus occidentalis L.	(3)
	Ceratophyllum demersum L.	(1)
	Decodon verticillatus L.	(12)
	Scirpus sp.	(8)
	Rhynchospora sp.	(1)

Polygonum hydropiperoides Michx.	(2)
Potamogeton sp.	(1) + (2)
Naias flexilis Rostk. and Schmidt	(3)
Sagittaria latifolia Willd.	(15)
Betula sp.	(3)
80. *Cephalanthus occidentalis* L.	(12)
Decodon verticillatus L.	(5)
Rhynchospora sp.	(1)
Carex sp.	(1)
Eleocharis sp.	
Scirpus fluviatilis Torr.	(1)
" *microcarpus* Presl.	(1)
Polygonum hydropiperoides Michx.	(1)
Rubus sp.	(1)
Brasenia schreberi Gmel.	(3)
Betula sp.	(6)
Boehmeria cylindrica (L.) Sw.	(2)
Alnus incana L.	(1)
Naias flexilis Rostk. and Schmidt	(1)
Polygonum lapathifolium L.	(1)
Sagittaria latifolia Willd.	(1)
81. *Sparganium* sp.	(5)
Some have been passed over as "galls" in previously examined numbers.	
Rubus sp.	(2)
Viola sp.	(2)
Sagittaria latifolia Willd.	(1)
Ranunculus delphinifolius Torr.	(1)
82. *Sparganium* sp.	(3)
Ceratophyllum demersum L.	(1)
Polygonum hydropiperoides Michx.	(9)
Scirpus lacustris L.	(13)
Carex sp.	(2)
Eleocharis sp.	(1)
Sagittaria latifolia	(19)
Cephalanthus occidentalis L.	(1)
Decodon verticillatus L.	(1)
83. *Cephalanthus occidentalis* L.	(10)
Sagittaria latifolia Willd.	(2)
Carex sp.	(2)
Scirpus sp.	(1)
Alnus sp.	(3)
Polygonum hydropiperoides Michx.	(3)
Cornus amonum Mill.	(1)
Decodon verticillatus L.	(35)

One or two of these seeds are present in several of the previously examined samples, but were not recognized at the time.

84.	*Ceratophyllum demersum* L.	(2)
	Boehmeria cylindrica (L.) Sw.	(3)
	Decodon verticillatus L.	(6)
	Cephalanthus occidentalis L.	(3)
	Sagittaria latifolia Willd.	(5)
	Potamogeton spirillus Tuck.	(1)
	Potamogeton pusillus L.	(1)
	Polygonum hydropiperoides Mx.	(1)
	Cyperus sp.	(1)
85.	*Ceratophyllum demersum* L.	(1)
	Sparganium sp.	(3)
	Cephalanthus occidentalis L.	(3)
	Polygonum hydropiperoides Mx.	(6)
	Scirpus sp.	(4)
	Eleocharis sp.	(1)
	Rhynchospora sp.	(1)
	Umbelliferae	(1)
	Sagittaria latifolia Willd.	(11)
	Unidentified	(1)
86.	*Ceratophyllum demersum* L.	(1)
	Cornus sp. (fragment)	
	Cephalanthus occidentalis L.	(7)
	Decodon verticillatus L.	(11)
	Carex sp.	(1)
	Sagittaria latifolia Willd.	(6)
	Boehmeria cylindrica (L.) Sw.	(3)
	Menyanthes trifoliata L.	(1)
	Cyperus sp.	(1)
	Umbelliferae	(1)
87.	*Ceratophyllum demersum* L.	(1)
	Sparganium sp.	(8)
	Castalia odorata Ait.	(1)
	Viola sp.	(1)
	Polygonum hydropiperoides Mx.	(4)
	Sagittaria latifolia Willd.	(11)
	Umbelliferae	(1)
88.	*Naias flexilis* Rostk. and Schmidt	(18)
	Betula sp.	(1)
	Carex sp.	(1)

LIST OF PLANTS FOUND IN THE PEAT OF PEAT BOGS IN SOUTHEASTERN CANADA

Adicea pumila L.: Marsh Hill
Alnus sp.: Sagamité, Marsh Hill, Welland
Alnus incana Willd.: Marsh Hill, Welland
Asclepias sp.: Marsh Hill
Batrachium trichophyllum Chaix.: Tusket, Mulgrave
Betula sp.: Clyde River, Cherryfield, Sagamité, Newington, Perth, Mer Bleue, Marsh Hill, Welland
Bidens sp.: Perth, Marsh Hill
Boehmeria cylindrica (L.) Sw.: Perth, Marsh Hill, Welland
Brasenia schreberi Gmel.: Caribou, Makoke, Clyde River, Cherryfield, Canaan, Sagamité, Alfred, Marsh Hill, Welland
Carex sp.: common
Castalia odorata Ait.: Caribou, Tusket, Makoke, Clyde River, Cherryfield, Mulgrave, Alfred, Perth, Marsh Hill, Welland
Cephalanthus occidentalis L.: Marsh Hill, Welland
Ceratophyllum demersum L.: Canaan, Welland Leaf-thorns, Caribou, Tusket, Makoke, Cherryfield, Mulgrave, Sagamité, Marsh Hill, Welland
Chenopodium sp.: Welland
Cladium mariscoides Torr.: Caribou, Cherryfield, Canaan, Alfred, Newington, Marsh Hill, Welland
Compositae (*Cicula*): Mer Bleue
Cornus amonum Mill.: Perth, Welland
Cornus circinata L' Her.: Perth
Cornus stolonifera Michx.: Marsh Hill
Cyperus sp.: Welland
Decodon verticillatus L.: Perth, Marsh Hill, Welland
Eleocharis obtusa Schultes.: Sagamité
Eleocharis sp.: Mulgrave, Hicks, Canaan, Sagamité, Alfred, Perth, Marsh Hill, Welland
Gaultheria procumbens L.: Cherryfield
Impatiens sp.: Perth
Lycopus sp.: Marsh Hill
Lycopus americanus Gr.: Canaan, Marsh Hill
Menyanthes trifoliata L.: Clyde River, Alfred, Welland
Myriophyllum sp.: Alfred
Myriophyllum near *scabratum* Michx.: Canaan, Hicks
Naias flexilis Rostk. and Schmidt.: Caribou, Tusket, Makoke, Cherryfield, Mulgrave, Hicks, Canaan, Sagamité, Alfred, Newington, Perth, Mer Bleue, Marsh Hill, Welland
Nymphaea advena Sol.: Caribou, Clyde River, Cherryfield, Mulgrave, Canaan, Hicks, Perth
Picea sp.: Sagamité, Marsh Hill, Welland
Polygonum hydropiperoides Mx.: Welland
Polygonum lapathifolium L.: Marsh Hill
Potamogeton amplifolius Tuck.: Marsh Hill

Potamogeton foliosus Raf.: Mulgrave
Potamogeton spirillus Tuck.: Clyde River, Cherryfield, Mulgrave, Marsh Hill, Welland
Potamogeton zosterifolius Schum: Caribou, Welland
Potamogeton sp.: Caribou, Clyde River, Cherryfield, Mulgrave, Hicks, Canaan, Sagamité, Alfred, Newington, Marsh Hill, Welland
Potamogeton pusillus L.: Caribou, Tusket, Clyde River, Cherryfield, Mulgrave, Hicks, Perth, Welland
Potentilla sp.: Perth
Proserpinaca palustris L.: Perth
Quercus sp.: Marsh Hill
Ranunculus delphinifolius Torr.: Welland
Rhynchospora sp.: Clyde River, Cherryfield, Sagamité, Newington, Perth, Marsh Hill, Welland
Rhus sp.: Canaan
Rosa sp.: Marsh Hill
Saxifragaceae: Marsh Hill
Rubus sp.: Welland
Scirpus fluviatilis Torr.: Welland
Scirpus sp.: Caribou, Canaan, Sagamité, Alfred, Newington, Perth, Mer Bleue, Marsh Hill, Welland
Scirpus microcarpus Presl.: Welland
Scirpus lacustris L.: Perth, Marsh Hill, Welland
Scirpus americanus Pers.: Caribou, Sagamité, Alfred, Mer Bleue, Marsh Hill, Welland
Sagittaria latifolia Willd.: Sagamité, Perth, Marsh Hill, Welland
Scrophulariaceae: Perth
Sparganium sp.: Caribou, Welland
Tsuga canadensis L.: Mer Bleue, Marsh Hill
Umbelliferae: Mer Bleue, Marsh Hill, Welland
Vaccinium sp.: Marsh Hill
Viola sp.: Welland