COMMENTATIONES
FORESTALES

1.

SOME FUTURE PROBLEMS OF PEAT
BOG INVESTIGATION IN
CANADA

BY

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Suomen Metsätieteellisen Seuran julkaisusarjat:

ACTA FORESTALIA FENNICA. Sisältää Suomen metsätaloutta ja sen perusteita käsitteleviä tieteellisiä tutkimuksia. Ilmestyvät epäsäännöllisin väliajoin niteinä, joista kukin yleensä käsittelee useampia tutkimuksia.

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ACTA FORESTALIA FENNICA. Innehåller vetenskapliga undersökningar rörande skogshushållningen i Finland och dess grunder. Banden, vilka icke utkomna periodiskt, omfatta i allmänhet flera avhandlingar.

SILVA FENNICA. Omfattar uppsatser av icke rent vetenskaplig natur rörande skogshushållningen i Finland. Utkommer icke periodiskt; varje uppsats som skilt band.

COMMENTATIONES FORESTALES. Innehåller undersökningar och andra uppsatser rörande skogshushållningen och i samband med denna stående frågor utom Finland. Utkommer icke periodiskt. I allmänhet ingår i varje band endast en avhandling.

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Contents

General points of view ........................................... 5
Investigations about the distribution of peat bogs ................. 8
Plant-topographic investigations .................................. 10
Investigation concerning the formation and development of peat bogs ... 17
The development of peat bogs .................................... 20
The peat soils .................................................... 22
Stratigraphic types ............................................... 24
The origin and development of the peat bogs in the light of the stratigraphy 24
The form of peat bogs ............................................ 25
The record of the peat bogs ...................................... 26
Practical peat bog investigations .................................. 29

Suomenkielinen selstus ........................................... 32

General points of view.

In the absence of a sufficient amount of scientific or practical peat bog investigation, that could give an idea even of the main characteristics of eventual possibilities of the Canadian peat bogs, it is difficult to draw up the outline for future investigations. It is true that a number of valuable investigations have been carried out, first and foremost among which should be mentioned those of Ganong and Nichols, but these have not exclusively dealt with peat bogs and their characteristics. In this connection I would also mention the short but elucidating reports of the Manitoban muskeg formations, recently published by Lewis and Dowding, as well as the fuel-peat investigations by Aas. From these and my own investigations, carried out in 1926, the distribution of peat bogs in Canada appears in larger features only. In the eastern parts of Canada being under the influence of the oceanic climate, the peat bogs are very abundant. So are they in the northern parts of Central Canada where the muskeg formations continue in a northerly direction, passing by gradual transitions over into tundras. It is also well known that there are plenty of peat bogs in the West of the Rocky Mountains resembling the sloping peat bogs of Europe. Considering that the Canadian peat bogs, according to the estimate of Chalmers, occupy an area of about 37,000 square miles, one is at once aware of the enormous importance of these areas, particularly as it is known that the peat bogs continue to spread even in our days.

In going to outline a program for the future investigations that should be carried out on the peat bogs in Canada, difficulties arise in the first place from the fact that my knowledge of Canada's peat bogs is limited to the southeastern part of the vast country. The points of view set forth below will thus only represent the conceptions and opinions of an individual scientist. I feel the task also to be so much more responsible as the scientific work in this rather untrodden field should from the
start be directed upon the right lines in order that future investigations should gain the best possible results. However, taking into consideration the similarities existing between North-European and Canadian conditions, I venture to suggest some broad outlines for peat bog investigations. I take for granted that these investigations should serve practical needs as well and lead to results that as early as possible may throw some light upon the so far little known peat bog formations of that vast country. This is of importance as Canada is one of the most important colonization countries in the world. The position of peat bogs, in comparison with other kinds of soil, ought therefore to be explained in the right way. As the population is spreading and growing, the bonituation 1 of the soil, particularly that of productive soil, should be made on such a basis that sales, buyings, taxation, etc., would throughout the whole country stand in the right proportion to one another. Consequently, one should make an effort to establish such a classification of the soil as, at least in its general features, could be extended over the whole of the country, or to as large regions as possible, showing the same regularities. For the colonization policy, a very great benefit might be derived from these principles, if they could be put into practice, as I, for my own part, am inclined to think.

Further, I consider it to be of great importance systematically to direct the investigations right from the start upon those theoretical problems whose solution might help to explain the laws and regularities applying to the development of the peat bogs and the conversion of dry lands or water-covered areas, into swamps, or paludification. When the validity and practical value of the results thus achieved become known in different parts of the country, then the regional basis for the knowledge of the Canadian peat bogs will be laid. I would particularly emphasize the fact that the best possible knowledge of the regional regularities will help to direct the use of the peat bogs as well as also the economic policy that should be followed in their exploitation to the right way.

As mentioned above, the European conditions may in many respects be compared to the Canadian. It is therefore very important that the Canadian peat bog investigators should make themselves as familiar as possible with experiences gained in Europe, and not only with the successful results, but also with the errors. I would emphasize this principally on account of the fact that the European investigations, before they have reached their present high level, have demanded a great amount of work. By an objective use of the European experiences it will in many cases be possible to apply in Canada a synthetic method, i.e., important and far-reaching results may right off be applied to the Canadian peat bogs. Now, European experiences, as will be shown later on, have already, and, as I think, even too one-sidedly, been applied in Canada. A synthetic method of this kind certainly demands great caution and criticism, but I would consider it to be strictly inevitable as many questions in Canada demand a speedy solution.

The nature and kind of the investigation depends above all on how the peat bogs and peat formations are generally treated. There are in many tracts thick peat deposits, on the top of which no kind of peat bog vegetation is found. There is thus the question of a geological deposit, a bog in a peat-geological sense. On the other hand, there are vast areas where one encounters a rapid extension growth of hygrophilic peat bog vegetation on a bare mineral ground without any kind of peat. In this case there is also the question of a bog, but in a plant-biological sense. Peat bogs in a biological sense are thus peat forming plant associations and, in a geological sense, natural peat deposits. But as the surface vegetation of peat bogs, at the same time as it is dependent on the subjacent peat substratum, also causes their growth, there is quite an intimate causal connection between these two things. Particularly is it difficult to give a correct interpretation to plant-topographical questions unless one knows exactly the earlier history of development of the peat bog just as it is impossible to understand the stratigraphy of peat bogs unless the changes that take place on their surface are well understood.

The above division is inevitable already on account of the fact that the practical-scientific classification of peat bogs depends primarily on the purpose for which peat bogs are used in each particular case. As is well known, peat bogs are used for fuel and litter, i.e. for industrial purposes, but they are perhaps still more used directly for agricultural purposes. In North-Europe, particularly in Finland and Sweden, moreover, very productive forest lands have been gained by the draining of peat bogs. Agriculture and industry are exploiting the peat of the peat bogs, and, with these usages in mind, the classification of peat bogs must be based on a peat-geological basis. On the other hand, the forestal classification is in the first place based upon the surface vegetation, as the forest in

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1) By bonituation is meant, in Northern Europe, a classification of land according to its economic value.
itself belongs to the vegetation and is subjected to the laws that govern the vegetation. On this account the forestial usage demands, in the first place, that the classification should be based on plant-topographic methods, especially as — with the exception of drainage which is done by means of ditches laying relatively far apart from one an other — the forestial economy does not apply any, at least not any considerable, improvement of the subjacent soil, but the habitats must be taken mainly as they are in nature, characterized by their vegetation.

**Investigations about the distribution of peat bogs.**

As is well known, the factors influencing the distribution of peat bogs are either of a climatic, topographic, or pedologic nature, but also the geologic age of the subjacent deposits has its influence upon the appearance of peat bogs.

As the formation of peat is dependent upon the degree in which the action of oxygen of air upon plant remains deposited on the land surface is prevented the determining factor in the formation of peat is water which is the general preserving agent. Either meteoric rain-water or terestric water running in the ground may come into question. The former causes a regional and the latter a local paludification.

Climatic conditions thus, in the first place, determine the distribution of peat bogs. Where the amount of rain is great in comparison with evaporation, there the regional appearance of peat bogs has big chances. This becomes evident also in Canada where the damp climate of the Ocean is the cause of intense peat formation in the Maritime provinces. It is not yet in all details clear in what degree climatic factors in the other parts of Canada have influence upon the general distribution of peat bogs, upon their vegetation types, the manner of their formation, upon their shapes and development, and upon their stratigraphy. In this respect I refer to my investigations in south-eastern Canada where many regular characters in the plant-topography as well as the geology of the peat bogs may be traced back to climatic causes. In what degree, among the climatic factors, the temperatures influence directly¹ the appearance of peat bogs remains an open question to science.

The general topography has a great influence particularly upon the dimensions of peat bogs. Where the valleys are narrow, cramped, and otherwise less favourable for the accumulation of peat, bogs are found very scantily, whereas wide, flat valley grounds give rise to the formation of extensive peat bogs. A system of several connected valleys results either in the formation of individual peat bogs or of networks of peat bogs joining each other.

At the same time as the general nature of topography is explained, attention should be drawn to the pedological factors, i.e., the characters of the soils. Among the pedological factors should above all be mentioned the physical and chemical characters of the soils which each in their own way influence upon the appearance, origin, and development of peat bogs. Soils, as poorly penetrated by water as, for instance, clay and glacial drift, are favourable to the formation of peat bogs, and it is also known that generally sterile lands are more apt to paludification than fertile regions. A careful and detailed study of the pedological factors would be welcome to complete the knowledge we have at present of the use of peat bogs, especially when there is a question of agriculture in its various forms.

As the various parts of Canada belong to different geological types, I would, in this connection, restrict myself to those areas that have been covered by the ice-sheet and thus naturally are most closely comparable with the corresponding areas on the old continent. As the investigations in Finland have so nicely shown, the appearance of peat bogs is in a very high degree influenced by the warping of the land crust and, in general, by changes in the boundaries between land and water. Peat formations have thus come earlier into existence on geologically older lands, i.e., on those areas that were first freed from the water cover, than on geologically younger lands. Hence it follows that thicker peat layers are to be found on geologically older areas, though, of course, thin, young peat formations may be found everywhere where peat forming processes on the whole are able to go on. The changes of niveau have, besides, caused changes in the inclination of the land and thus in the ground water surface. As shown by the investigations of Johnston, Goldthwait, and others, changes in the surface of the water have taken place in lakes, caused by the warping of the land, and at the same time as the water lines have altered in the lakes, the river beds have also changed. According to my investigations, moreover, many peat bogs have originated by following the coast line of the receding sea, and others have formed in the valleys when the river or lake water had disappeared.

We will once more return to these questions in connection with the peat-geological questions.

¹) Indirectly temperature acts by increasing or diminishing evaporation.
Plant-topographic investigations.

Types.

The plant-topography of peat bogs is thus concerned with the living part of peat bogs. Consequently it goes straight off to deal with the general principles used by plant-topography and plant-sociology. It is not my intention now to explain the comprehensive investigations carried out, especially during the last few years, on such a large scale in various European countries, but referring to the principles mentioned at the beginning of my paper, I will touch only upon a few important points in connection with the classification and use of peat bogs.

As is generally known, the plant cover shows more or less distinct regularities, caused by all the factors influencing upon each habitat, and revealing themselves as results of the fight between the plants. As the plant cover is chiefly dependent upon the habitat factors, it is thus in very many cases able directly to indicate the biological value of the habitat. The vegetation may thus also be the indicator of the bonity value of a certain land area. Indeed, everybody knows that richer plant associations with more pretentious species are as a rule more often found in fertile regions than in unfertile areas.

Extensive investigations have been carried out in Finland during the last years, dealing with the classification of forests and the whole forestal activity, scientific as well as practical, is at present based upon these investigations. In accordance with the above principles, A. K. Cajander prepared his theory about forest types, an English summary of which has recently been issued.1 Cajander divides the Finnish forests into types, the characters of which he defines in the following way: —

Consequently, all those stands are referred to the same forest type the vegetation of which at or near the time of maturity of the stands and provided the stands are normally stocked, is characterised by a more or less identical floristic composition and by an identical ecologic-biological nature, as well as all those stands the vegetation of which differs from that defined above only in those respects which — being expressions of differences due to age, fellings, etc. — have to be regarded as merely accidental and ephemeral or at any rate as only temporary. Permanent differences call forth a new forest type in cases where they are sufficiently

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THE SOCIETY OF FORESTRY IN SUOMI

has hitherto issued two separate series of publications: ACTA FORESTALIA FENNICA since 1913 and SILVA FENNICA since 1926. The former is intended for scientific treatises dealing with forestry in Suomi (Finland) and the latter for shorter essays that treat of the same subject, but are not in the nature of purely scientific research.

During recent years some members of the Society of Forestry in Suomi have carried out research work abroad which is not very suitable for inclusion in either of these series of publications, as it deals with conditions in foreign countries. For this reason the Society has decided to inaugurate the issue this year of a third series: COMMENTATIONES FORESTALES, intended for treatises connected with forestry in other countries than Suomi. This series, the first volume of which is now published, will be issued at irregular intervals. Each treatise will, in general, form a separate volume.

Helsinki, March, 1928.

Society of Forestry in Suomi.

DIE FORSTWISSENSCHAFTLICHE GESELLSCHAFT IN SUOMI

gab bisher zwei verschiedene Publikationsreihen heraus: Die ACTA FORESTALIA FENNICA mit dem Jahre 1913 beginnend und die Veröffentlichung SILVA FENNICA vom Jahre 1926 ab. Ersteres enthält wissenschaftliche Untersuchungen über die finnische Waldwirtschaft, letztere Aufsätze zur Waldwirtschaft Suomis (Finnlands) ohne den Charakter eigentlicher wissenschaftlicher Untersuchungen.


Helsinki, im März 1928.

Forstwissenschaftliche Gesellschaft in Suomi.

LA SOCIÉTÉ FORESTIÈRE DE SUOMI

a eu jusqu’ici deux séries différentes de publications: ACTA FORESTALIA FENNICA à partir de 1913 et SILVA FENNICA à partir de 1926. La première est destinée aux études scientifiques concernant l’économie forestière de Suomi (Finlande), et la seconde aux articles sur le même sujet, mais n’ayant pas le caractère d’études propresment dites.


Helsinki, mars 1928.

Société Forestière de Suomi.

Some future problems of peat bog investigation in Canada

well-marked, or a sub-type in cases where they are less essential, but, nevertheless, noticeable. In a forest type, therefore, as a rule, only those primary — climatic and edaphic — factors of the locality are reflected— which factors may be assumed to remain active, even when the locality is laid bare of all plants.

Forest types are thus distinguished on the basis of the vegetation. This has been done essentially from the surface vegetation, due to the fact that even in cultivated forests the surface vegetation quicker than the tree vegetation reaches at least a comparatively stationary condition, as it is composed of short-lived individuals and, consequently, is usually allowed to develop more naturally than the rest of the plants. Even the composition of the tree flora is not without importance, as, for instance in Finland, among barren forest types thrives only the pine forest, among medium types all the common tree species, and among the best types are found the hardwood. The floral composition, even of stands that have come under the influence of cultivation, characterizes the type in a high degree. But still more especially are the «ecologico-biological» nature of the trees, as of any other plants and, particularly, their growth relations and the development of stands very characteristic of each forest type. Hence the natural forest types, as they may be in any phyto-geographic province distinguished according to the views of C. JANDER, are the most suitable basis for a comparison of the productivity of forests, both with regard to forestial investigations and forest economy, i.e., for the bonitation and valuation of the forest.

From the same points of view C. JANDER has divided the Finnish peat bogs into types. The question arises as to how far the peat bog type investigations, and, generally, type classifications may be used as a basis for the classification of peat bogs.

C. JANDER’s peat bog types are already fairly much used as a basis for forestorial peat bog investigations in Finland. Thus it has already been proved that a peat bog type, as a result of ditching, turns into a definite forest type whose bonity value may, under the most favourable conditions, match that of the best forest types. It has also been proved that better peat bog types are more frequently found in fertile areas than in barren regions. In their relationship to one another the Finnish peat bog types appear as definite groups or complex types. The results disclosed by the investigations of the writer are among the strongest supports of the type theory. I succeeded in proving that in areas of definite plant-topographic complex types, the boundaries of which,
moreover, are regionally very regular may be found peat-geological types characteristic for each area. The plant-topographic regional classification according to these principles, may thus indicate the occurrence of different kinds of peat turf strata. Therefore nowadays in Finland during the orientating investigation work in the search for regional regularities, bog types are used also in peat-geological studies.

The above principles may perhaps demand still closer arguments.

From the fact that the bogs, biologically defined, are at the same time peat-forming plant-associations and that the more pretentious bog plant-associations, appearing on better land, as a rule form better peat than a less pretentious one, it follows that the quality of the ground-soil influences even upon a later development of the peat bog, as CAJANDER has observed. Good and fertile peat bogs therefore arise on areas providing an abundant and flourishing water-vegetation, e.g. in the shape of rush and horsetail vegetation and huge sedge stands. Areas of this kind are as a rule fertile. A large part of Canada's peat bogs have, however, formed on dry land, and the first peat-forming vegetation has got all its mineral nourishment from the mineral soil upon which it grows. The more abundant the nourishment available, the more amply the plants can take it and the larger quantities of nutritive substances are found in the roots and stalks of the plants forming peat. As the peat strata grow thicker, the uppermost layer always receives its mineral nourishment from the subjacent layer, and the more provision the latter contains, the more does the former receive. As the uppermost layer is never able wholly to exhaust the lower layers, the peat layers, unless they can receive nourishment from outside sources, must become so much poorer the higher the peat bog grows. Even in fertile regions the surface peat in thick parts of the bogs may thus be very poor, but it is evident that the same degree of poorness is attained much earlier in such places where the ground-soil is meager than where it is fertile, i.e., bogs of poor peat are in poorer regions more abundant.

This development, however, is not proceeding without disturbances, as the peat bogs are generally located in such a way that they receive water from the surroundings areas, and, depending upon the development of the surrounding lands, the amount and composition of this water may change considerably.

It is clear from the above-named facts that the investigation of the surface vegetation alone is not by any means sufficient in the peat bog study. Then, as we have seen, the peat layers turn more meagre from the bottom upwards even during an undisturbed development of the peat bogs, and the waters flowing from surrounding lands cause considerable alterations and changes in the development of the peat bogs. Still, more do so the climatic changes during geological periods. Peat bogs of a similar type may at different stages of development have represented very different — more xerophile and more hygrophile, more pretentious and less pretentious — types. In forestry, when peat bogs are only ditched, but no other improvements of the land are undertaken, the present peat bog type with its characteristic surface peat often suffice to give an idea as to the afforestation possibilities of the peat bog. In agriculture, on the other hand, where the tillage of the soil and, perhaps, the removal of the surface peat have to be added, more attention must be paid also to the biological value of the deeper peat layers by means of manuring and fertilisers, etc., a poorer peat may be rendered more productive, but even in this case the bog type may not be without importance in giving indications as to the value of the peat. Finally, when there is a question of using peat bogs for technical purposes, the entirety of the peat strata is of much greater importance than the surface peat and its plant cover.

As to the general qualifications of the type doctrine and its possible application to other countries, CAJANDER says, among other things, the following concerning the forest types:

> Within the range of similar climate types characterized by various forest types and within the range of the same degree of quality of locality, as indicated by the forest types, it therefore appears to be possible to place forestry everywhere on a common foundation and to treat it from an international point of view. On such a basis it further seems to be possible to generalize as common international methods of procedure, all those sylvicultural methods which have been developed or are being developed in the various local districts, and which have led or are leading to satisfactory results. At the same time it should, however, be noted that the market conditions of the different regions will always furnish forestry with local features, since these conditions are vitally important in deciding which of the methods of treatment possible from the biological point of view, are economically advantageous, and how near it is possible to approach to the sylviculturally and biologically most productive method of treatment after first taking the economic point of view into account.

The above statements hold good not only in forestry, but clearly also in plant cultivation in general, as well as, more or less indirectly,
in those industries which are founded on plant cultivation or depend upon it. Whilst agriculture in the southern half of Finland — to give one example — consists mainly in growing crops, in North Finland, where the areas under the plough are relatively small, as well as in corresponding districts elsewhere, for instance at corresponding altitudes in the Central European mountains, agriculture consists for the most part in the cultivation of meadows. In the Central European hardwood forest regions, where the proportion of land suitable for cultivation is incomparably greater than in the southern half of Finland, wheat-growing takes precedence over the growing of other crops.

Bearing in mind the above points of view, the question naturally arises whether it is possible to find for the Canadian bogs such a plant-topographical classification, according to which the scientific-practical investigation work could be guided according to similar principles.

Anybody who has travelled in any part of southeastern Canada has noticed extensive, open Sphagnum-covered bogs growing sometimes a thicker, sometimes a thinner, twig vegetation (Kalmia, Cassandra, Empetrum, etc.). At many places one finds other moss species, of the Aamblystegium group. Especially on the peat bogs of the river banks these form a continuous moss-cover, growing a very rich sedge and grass vegetation. A similar floral composition is also found in the bogs formed on the lakeshores by filling up of part of the lakes with peat almost anywhere in this area. Quite common are also the tree-growing bog plant associations, and especially Picea mariana and Larix americana are in some places together forming even very extensive forests on the bogs: Especially on marginal parts of bogs and on the bottom of small depressions there may be found wooded bogs growing maple besides spruce. Any of these kinds of plant associations are found on wide areas, and, as it further has become evident that each of them is the result of the development of the surface vegetation of a definite bog, I would call them Canadian bog types. From a plant-topographical point of view I would thus distinguish between the following type-groups:

1) **White-moors**, i.e., open bogs, whose moss-vegetation principally consists of Sphagnum. The brushwood is often very scarce. Tufts do not occur or are but low.

2) **Brown-moors**, i.e., mostly wet peat bogs without any tufts, the moss-vegetation principally consisting of so-called brown-moss (Amblystegium, Paludella, Meesia, etc.). There may be some Sphagnum, and in that case usually of more pretentious kinds. The grass and hay vegetation is richer than on the white moors.

3) **Dwarf-shrub Moors**, i.e., generally dry bogs with plenty of brushwood, with or without hummocks, and the moss vegetation principally consisting of Sphagnum. They almost always grow forest, the most usual trees being Picea mariana and Larix.

4) **Marshes**, i.e., forest-growing bogs whose tree vegetation consists of spruce, pine, and hardwood, particularly maple. The moss vegetation usually consists of more or less pretentious Sphagnums, but occasionally one also comes across other kinds of moss, as, for instance, Polytrichum and other leaf moss species.

As a close examination of the plant cover of the peat bogs, did not belong to my investigations which were restricted chiefly to their structure, all more detailed botanical classifications were left to other investigators. In that more comprehensive report which I hope soon to be able to submit to the Geological Survey of Canada, I have tried to characterize some of the most characteristic types. It may thus be stated that a plant-topographical classification of the peat bogs of Canada, will show the same regularities as in Finland. As far as I have had the opportunity of investigating the general forms of development of the plant associations of Canada's bogs, I would say that they also change according to regular laws. The brown-moors have thus by draining changed into excellent forest lands resembling grass-herb forests, whereas less good white-moor types have by draining changed only into poor Larix-Picea forests. As soon as the forest types in Canada are definitely fixed and their yielding capacity accurately determined by forestial investigations, the forest value of a certain bog can be calculated, if its type and development is known.

From the point of view of forestry it is also necessary to win experience about the demands of different bogs with regard to the ditching technic, as to the direction, depth, and frequency of the ditches, as well as the changes of the peat as a result of ditching, the durability of the ditches under different conditions etc. These important results may be arrived at by experiments and by a comparative study of earlier ditchings.

Many of the cases which I have investigated show, however, that a classification merely based on the plant cover is not sufficient even for the forest valuation, but that the character of the peat must also be taken into consideration. As an example might be mentioned, for instance, the big Alfred peat bog in Ontario, near Ottawa. Being in a very good
forest-growing condition, its eastern and southeastern parts are of a better type than what the unbroken Sphagnum-cover, extending itself on the surface, would suggest. The investigations carried out on this peat bog show, however, that there is a good Amblystegium-Carex peat under the thin Sphagnum surface layer.

The bog types that have been put up in Finland, appear, as already stated, as definite combinations or complex types. Judging from the literature and my own investigations, analogous regional complex types exist in Canada as well, and their exposition would be of the greatest importance already because each complex type has its peculiar mode of origin and development, as well as other characters of its own. It seems to me that different complex types may be distinguished at least in the following areas: in Nova Scotia where the northern and southern parts, moreover, in some respects differ from one another. In the area extending from the mouth of the St. Lawrence river towards the interior of the country I found a different complex which I would call a continental form, and between the two above mentioned areas there is a complex apparently intermediate between the oceanic and continental forms. Further special continental groups probably exist in Manitoba, and likewise in northern Quebec, not to speak of the wide areas of northern Canada in general, as well as of eastern Canada, where numerous and regular areas of complex types no doubt may be found. It would be interesting to investigate in what degree these regular variations coincide with the floral areas set up by Macoun and Malte.

In analogy to the different forest and bog types one could also distinguish meadow, tundra, and other types.

The regional boundaries of the vegetation types are not by any means always sharp nor very regular. The geological development of Canada, principally during post-Glacial periods, has in a very notable way affected the distribution of the vegetation. Northern forms may be found in isolated spots within the areas of the southern type regions, and southern forms in more northern areas than those of their regular distribution. The vegetation has, after the ice age, spread from South to North, but climatic variations in post-Glacial times have caused new transfers in a north-southerly direction as well as in an east-westerly direction, this particularly on the boundaries between the oceanic and continental climatic zones. For instance, in southern Quebec and New Brunswick I have traced a distinct northern influence, and in Nova Scotia there are a.o. purely southern forms. I am convinced that in Canada where the regions are huge and regular, a closer investigation of the relict occurrence of whole types as well as of more individual floral elements would give most interesting scientific results, showing the mode and ways of the oscillations that possibly have taken place in the vegetation, and perhaps in the whole type regions.

The classification based upon the type principle has, with very few exceptions, been recognised and accepted all over the world.

The fact that the whole forest economy of Finland as well as all the forestal measures and investigations, not to speak of the very comprehensive investigations in the sphere of botany and forestry, are at present entirely based on the type system, gives anyhow some kind of guarantees for its being useful as a practical-scientific method. Of course, there is nothing to prevent, and it would be even highly desirable, to try also other investigation methods in Canada. For I am convinced that in such an extensive country as Canada a suitable basis also for other methods and classification principles may be found, but I am just as sure that, correctly applied, this theory is leading to positive results all over the whole of Canada.

Investigation concerning the formation and development of peat bogs.

The plant-topographic investigation work concerning the peat bogs must not stop at the exposition of the types, but it should, on the basis of the points of view and systematics explained above, also include the phenomena of paludification and the development of the peat bogs.

As is well known, peat bogs are formed in many different ways, among which may be mentioned: the filling up of water areas, the paludification of dry lands, of flooded lands, and of sea shores, etc.

Peat bogs are formed to-day, among other ways, so that small lakes and ponds are filled up by water vegetation into coherent peat bogs. This depends, of course, upon the kind of the lake as well as upon the kind of the vegetation that performs the filling up. Here I would particularly point out that the filling up vegetation on fertile areas, as well

1) Among the latter, an oozv Typha swamp form deserves particularly to be mentioned. This is a term for a combination of the growth-place and the plant-cover, and, consequently, must not offhand be compared with the above plant-topographic forms.
as the way in which the filling takes place, differs considerably from the filling up vegetation in lakes of barren lands. This question is very comprehensive; geomorphological phenomena like this differ in many ways in the different parts of an extensive country. Examination of sediments of lakes that have been, or are being, filled up, leads into a close touch with the modern limnological methods, and in this respect I would particularly refer to the results published by the International Limnological Society. By examining the profiles and sediment types of the lakes of Canada, many important scientific and practical results would certainly be arrived at. By applying the classifications used by limnology, among other things, the distinction between more fertile and more barren lands would appear clearly. An investigation of this kind should also offer great opportunities to fish-culture and, indirectly, also to the colonization problem.

Further, by a study of the filling up of rivers and of paludification phenomena on riversides generally, as well as of the development stages of secondary peat bog ponds and lakes, new points of view with regard to these geobotanically so interesting phenomena could certainly be established.

The paludification of forest land, or dry land in general, is, however, the principal method of the formation of peat bogs, as shown by the investigations in northern Europe. As far as I have been able to prove this is also the case in Canada. Many places which within the memory of man had consisted of dry lands have turned into extensive peat bogs. In the area covered by my investigations dry land turns into peat bog more intensely in the sphere of influence of the oceanic climate, as in Nova Scotia. This phenomenon is greatly weakening inland, and, as alleged by Lewis and Dowding, the inner parts of Canada are directly drying up, signs of which I myself was able to prove in the western parts of the area where I did my work. The intensity of paludification is thus, evidently, variable in different parts of Canada, being greatest along the coasts where peat may be found directly stratified on convex rock surfaces, this being due to the influence of the moist ocean climate. How far the extension growth of peat bogs in the inner parts of Canada, has entirely ceased, remains to be established by future investigations, for at least to me it seems that forest lands in the northern parts of inner Canada still continue to turn into peat bogs on a considerable scale, though perhaps not as much as during the earlier post-Glacial periods. This is also indicated by the conditions in the northern parts of United States, as in Minnesota.

A regional exposition of the degree of the intensity by which dry land or forest land turns into peat bog in the different parts of Canada would, also from an economical point of view, be of the greatest importance. For the investigations, especially in Nova Scotia, have proved that the national dangers of Canada, the forest fires, is of a very great importance to the present formation and spreading of peat bogs. I have found wide areas where, under the influence of forest fires, peat bogs have, in a few decades, began rapidly to form. This is chiefly due to the fact that, after the forest has been destroyed, the surface of the ground-water rises. There are also other reasons why the burned area becomes water-soaked and leaves a suitable ground for the spreading of Sphagnum. As such a great attention is being paid in Canada to the effects of forest fires as well as to measures for their prevention, attention will also, sooner or later, be paid to the importance of peat bog formation due to forest fires. In Europe, these effects cannot be proved so clearly as in Canada where the importance of forest fires is much bigger than what a stranger ever could imagine.

Paludification of dry land takes mainly place in the following ways: 1) A peat bog spreads to the neighbouring heath, or transgresses. 2) Water from the higher situated peat bog pours into the lower areas which, as a result, are turned into peat bogs. 3) Primary peat bogs are also formed by the stagnation of the surface water on land which consists of soils poorly penetrated by water, thus causing the formation of peat bogs in the depressions, from which they extend until they join one other and form more extensive bogs. The same is also the case with the fourth way of peat bog formation: 4) when the surface of ground-water, from some reason or other, rises, and causes the appearance of new peat bog sources in the depressions. A closer exposition of these different forms of paludification, using the plant-topographic methods, would lead in Canada to far-reaching and economically important results, and, in connection with these investigations, other regional factors, such as pedologic and climatic influencing the distribution of peat bogs, should also be taken into consideration.

An investigation of the attitude of Canada's numerous tree species to the different ways of paludification would be of great importance to forestry and would suggest methods of protecting the forest from paludification. The draining experiments, ditching, etc., together with calculatons concerning the profitableness of the same, would complete those calculations which I suggested to be exposed in connection with the afforestation of peat bogs.
As already mentioned, the intensity of paludification has no doubt changed during the epochs of the post-Glacial period. This becomes apparent from the investigations I have carried out in southeastern Canada. A comparative investigation on the intensity and forms of peat bog formation in different parts of Canada at the present time, as well as at different stages of the post-Glacial period would thus lead to many important scientific results, and would serve as a basis for the regional investigation of Canada's peat bogs. In this as well as in many other questions, past and present time should be dealt with alongside.

Flooded lands turn into peat bogs. This takes place when peat bogs grow on riversides and sea-shores, a matter which generally has been very little dealt with from a scientific point of view. The paludification of riversides is, of course, of great practical importance, considering that the rivers in wide areas of Canada still continue to serve as transport ways and as channels for the spreading of settlement. It should be necessary to expose the nature and the possibilities of these peat bogs, and, besides, the scientific-theoretical investigations would yield interesting results.

**The development of peat bogs.**

At the same time as the peat bogs form and spread over dry land, a development is also taking place on their surface either in such a direction that more damp plant associations change into more dry ones, i.e., progression, or, vice versa, regression. The former thus means that the surface of a peat bog is, in one way or other, drying up, the latter that it is getting wet. Each peat bog type has its own characteristic forms of development, successions, which may be alternating from a more damp into a more dry condition, and vice versa. As the Amblystegium as well as Sphagnum bogs have their own stages of development, and each locality has its special features, their different habits and their regional distribution all over the whole of Canada can be exposed with the aid of botanic methods. The changes in humidity appear from the stratigraphic structure. Thus, thin stripes in the Sphagnum surface layer indicate a struggle between the more damp and the more dry moss species; the product thus formed is called regeneration peat. Regeneration means a development from a more dry into a more damp direction. The regressive peat bog forms in Europe become more general towards the north; a somewhat similar rule should also apply to Canada. It is thus most suitable to examine the humidity factors of the peat bogs in northern Canada, as well as the surface-forms due to same, the pronounced features of which are still promoted by the freezing phenomena whose intensity increases in a northerly direction. Regressive and regeneration forms are also found on southern peat bogs, especially on big Sphagnum bogs. In the investigation of these relations the methods used by OSVALD in Sweden could be recommended. He is able to distinguish different morphological complexes during the development of the peat bog surface. Secondary lakes, ponds, channels, embankments, and funnel formations, appearing on the surface of the peat bogs, would thus be systematically treated.

But just as the southern peat bogs may show signs of development characteristic of northern peat bogs, so one comes also in the North across forms indicating a southern influence, i.e., forms mainly showing a progressive development. Consequently, one is entitled to expect that forms of each development may appear alongside each other in the boundary areas of the regional zones.

When, as a direct result of drought, the Sphagnum cover of peat bogs starts to disappear it is called a retrogressive development. According to the investigations of Lewis and DOWDING this would be quite a usual feature, at least with regard to the peat bogs in some of the Manitoba areas. As far as I can judge by their published investigations and pictures the question should remain to some extent open at least in one case, because it seems clearly as if there were a question of the parallel appearance of a pro- and regressive development and influence of forest-fires, each being very strongly represented.

Many morphological and plant-physionomic features indicate the general, natural development of the peat bogs. The different growth and growth speed of the peat bog surface at its different stages, causes definite alterations in the surface of the bog, though this is based upon their general stratigraphic development with which we are going to deal later on.

In this connection it is so much more important to draw particular attention to the variations in humidity which appear on the peat bogs sometimes from a revival of the forest, and sometimes from drying out of the trees which then remain standing as dead stumps.

It has indeed become evident from my investigations that a reforestation of peat bogs is possible at a certain stage of their development, irrespective of climatic factors. This is illustrated on many peat bogs on sea shores where a woody peat bog type forms upon a thin Carex peat layer at the same time as Sphagnum peat commences to stratify on it. The same phenomenon is also recorded in the stratigraphic structure of
the peat bogs where the bottom regularly consists of Carex peat, on the
top of which there is a Sphagnum layer starting with a stub-layer as a
remnant of an ancient forest. On the surface of the peat bogs one often
comes across local development of forest, a detailed explanation of which
must be left over to future investigations.

It is, on the other hand, just as important to explain the causes of
the occurrence of dead pine forests, often very extensive, whose white
dead trees leave a peculiar seal on those peat bog landscapes. Among
other things, it would be important also to try to find out in what way
the extension growth of peat bogs, freezing phenomena, insect damages,
and other factors, cause the wholesale dying out of trees on peat bogs
or on their edges. The expiring of trees is, in many cases, also on heath
lands caused by the upward growth of an adjacent peat bog which calls
forth a general rise of the water surface. And in the same way as the
forest revives on the surface of peat bogs from which the water flows
down to the lower lands, so the more slowly situated peat bogs become
moist, and the forest that may grow there, eventually dies out. System
analyses of the trees and by careful floristic investigations of the humidity
changes of different plant associations it is possible to explain this question
and in general to elucidate the problem of paludification of forests. The
investigations in Finland have proved that the progressive development,
due to the drainage of peat bogs, proceeds as a rule gradually into a
definite forest type, and that, when a drained peat bog becomes wet
anew, the development can proceed in an opposite direction, in a definite
succession of types. Consequently, taking the great practical importance
of this fact into consideration, careful investigations should be carried
out in Canada, particularly in the light of the pro- and regressive
development. An investigation of this kind is so much more important as,
under different circumstances, the same peat bog types reach different final
stages in each course of development. For instance, the final stage of a wet
peat bog which has run dry is not always a forest-growing type, but a
moosless type, often growing a lichen-covered, low twig vegetation.

The peat soils.

The changes, taking place in the living part of peat bogs, thus give
rise to the formation and distribution of different peat soils.
Consequently, the first task of a peat-geological investigation is a
systematic exposition of all the characters of a peat bog, an exposition
based on all the knowledge which is available at the present time. Diff-
erent methods can be followed; among them the following two should
be mentioned in the first place: 1) The peat soils are defined on the basis
of their physical characteristics, or 2) they are classified according to a
system, based on the original biological type of each kind of peat. Should
a most careful application of each method meet with great difficulties,
then one must be satisfied with definitions which are a combination of
both of them.

As no systematic classification of peat bogs has so far been made in
Canada, I propose that the genetic system, generally used in Europe,
should be taken into use. According to this system, the peats are divided
into 1) limnic, 2) telmatic, 3) semiterrestrial, and 4) terrestrial kinds.

1) The limnic group comprises all matters deposited in water, for
instance, different kinds of ooze, mud, detritus, shore and inundation
peat, Equisetum, Scirpus, and similar peats stratified below the water.

2) The telmatic group comprises the Carex peats as well as those
belonging to the Amblystegium and Sphagnum cuspidatum group.

3) The semiterrestrial group comprises Eriophorum, Sphagnum, and
some leaffree forest peats, grown near the water surface and in moist
conditions, such as Alnus peat whose equivalent in Canada has not yet
been stated with certainty, but which seems to be some grass-herb forest
peat.

4) The terrestrial group comprises peats of various forest peat bog
types, the essential part of which consists of remnants of trees.

This investigation work must, of course, be founded on a regional
basis, particularly in view of the fact that the application of peat bogs
to agriculture and industry is based explicitly on peats. This investigation
will then give an idea of the resources of different peats in Canada, where-
on and in connection with which the physical and chemical investiga-
tions on the characters of the peats are carried out. For defining the actual
value of the peats, the physical and chemical investigations should thus
be as many sided as possible, with due attention to all possible applications
of the peat bogs.

As at least the main kinds of peat are the same in Canada as in Europe,
I will in this connection only advise the peat bog investigators of Canada
to acquaint themselves well with the European investigations, this already
because the former country would be able to save a good deal of money
by making use of the best and most successful results.
Where the question explicitly deals with the application of peat to agriculture, there the geological structure of the surrounding countries lands must of course be taken into consideration. Canada possesses in fact wide areas containing plenty of clay and other soils, suitable for agriculture, which together with the peat, in a considerable degree, increase the agricultural value of the land.

**Stratigraphic types.**

The peat bogs rarely consist of only one kind of peat, but are mostly composed of different layers. It is therefore evident that the sequence and reciprocal relations of the different peat layers, i.e., the stratigraphy of the peat bogs, demands a detailed and accurate exposition. At the same time as this investigation should aim at the establishment of definite stratigraphic types, it follows that the regional occurrence of these types is among the most important tasks of the peat-geological investigation.

From the investigations carried out in southeastern Canada, some stratigraphic types may already be distinguished such as those in which Sphagnum peat and those in which Carex peat forms the thickest layers, the former representing the oceanic area and the latter the more continental area. There is a transition type between the two areas. Besides, grass-herb forest peat bogs are also found in the area of the continental type. The Carex peat bog of southern and southeastern Canada should, however, be distinguished from the Carex peat bog of northern Canada. It is probable that Amblystegium peat bogs can be found in western Canada and, locally, at places where the rock substratum contains limestone. As these types evidently have their distinct regions, their distribution should be determined at the same time as the possible appearance of new types is described.

**The origin and development of the peat bogs in the light of the stratigraphy.**

Alongside with the more or less practical investigations outlined above attention should be paid to many scientific problems of the greatest value. The most important are those that deal with the origin and development of the peat bogs in the light of stratigraphy, or, in other words, dry to read the record written by nature in the series of peat strata. The peat-geologic investigations are thus intended to expose the reciprocal relation of the different modes of formation of peat bogs. The attention is first drawn to the structure of those layers that lay under the peat bog, and also to the reciprocal relation of ancient lakes and the dry land which forms the bottom of the peat bog layers. Investigations in southeastern Canada have already proved that the filling up of water bodies has been of much greater importance in the area of the continental type than in the oceanic area where the paludification of forest lands has all the time been the prevailing feature.

From these comparative investigations the research is naturally directed upon the nature of paludification which appears from the different sediments of the ancient lakes and the vegetable accumulations that fill them up as well as from the general structure of the bottom layers of the peat bogs.

In this respect I beg to refer to my own results which prove, for instance, distinct differences in the mode of formation of peat bogs in the earlier post-Glacial periods and the present time, as well as to the fact that the greater part of the peat bogs investigated have been formed close to the shore line of the receding sea. This fact is of a special importance to investigations concerning the elevation of land and the chronology of the post-Glacial period.

**The form of peat bogs.**

As a result of their general stratigraphic development, the peat bogs have obtained a definite form, the exposition of which, in connection with that of the humidity changes on the surface of the peat bog, is inevitable for practical reasons.

In my investigations I have distinguished between some main forms among which, particularly, those of the Sphagnum peat bogs in the area of the oceanic type deserve to be mentioned. Their surface is generally convex, but very big variations can be found due to the manner of the natural growth as well as to mechanic-morphological factors influencing the surface form of the peat bog. The convexity of the peat bog surfaces, increasing during their development causes various changes in the inclination, and these changes in their turn, with the assistance of moss growth, shape different forms, most difficult to explain. Without, in this connection, entering upon a detailed account of individual cases, I only refer to the profiles published in my main report. The many-sidedness and importance of this question is fully apparent from these.
The record of the peat bogs.

My investigations in southeastern Canada have proved that the regional regularities largely comply with the climatic factors. This being the case, there is, of course, reason to suppose that the climatic changes that have occurred during the post-Glacial period have put their mark on the structure of individual peat bogs in the shape of various layers, and, also, as transfers of their regional areas. The peat bogs, being archives where the records of the development of the vegetation during the course of thousands of years have been preserved, are the most important objects of study for an exposition of the nature of the post-Glacial times.

My investigations have, in this respect, led to some very profitable results, because the stratigraphic development of the peat bogs has shown distinct regularities throughout the whole area investigated, and the regularities have proved to be contemporaneous. According to my investigations, the changes of climate in Canada clearly show the same periods as in Europe. Consequently, in my opinion, it is justifiable to apply also to Canada the whole comprehensive investigation method used in Europe, of course, altered in accordance with the Canadian conditions. Secondly, this result is of importance also in so far as it gives a chronologic base for the investigations concerning the geographical history of the post-Glacial period. The peat-geological investigation is thus, to my mind, in a chronologic respect more important than the investigations based upon the ancient shores, which have lead to very different conclusions. Besides, the archeologic investigation in Canada cannot offer such a good chronological foundation as the European archeological chronology.

It ought to be possible to combine the geochronological investigations based upon various kinds of sediments, as varve clays, moraines etc. and the peat-geological investigations so that they would arrive at a definite continuous chronologic series, and thus establish a consistent basis for all future investigations concerning the history of the Quaternary period.

Before going to deal with further investigations concerning the various phases of the post-Glacial period, there is reason shortly to expose the method by which the chronologic development of peat bogs can be explained. I have myself used this method in connection with the investigations in Canada.

By microscopically examining the layers of the peat bogs one can follow, in the same series, and from bottom to surface, the buried pollen particles of the plant species. The examination of the occurrence of pollen is made quantitatively, i.e. all the determinable pollen particles in slides of a definite size are counted, and the results are expressed by diagrams where the different depths in a section through a peat bog are plotted on the ordinate, and the relative number of pollen of each species, expressed percent of the total number of pollen particles counted on the abscissa. The points for each tree species are joined by lines, and thus are obtained abundance curves which represent the variation of the relative amount of pollen of each tree species in different layers of the peat bog. These curves show practically the same regularities in different sections, not only for one and the same peat bog, but also for peat bogs far away from one other. These curves thus enable the investigator to connect synchronous layers in different peat bogs. In case the pollen of a certain tree species, shows a nether limit below which it is not at all found in the series of peat layers, then this limit indicates a time when the said tree migrated to the area investigated. The peat bog investigations in southeastern Canada have proved that the regular variations in the development of the peat bogs, according to this method of comparison, are of the same age. If, as has now been proved, the same climatic changes have taken place in Canada as in Europe, where these changes have already been fixed in a complete chronological system, then it is possible to establish an absolute time scale for the different epochs of the post-Glacial period in Canada as well. In such areas where climatic changes cannot be seen, one is, by the application of this method, in any case able to find the synchronous horizons for different peat bogs. By connecting these diagrams from southeastern Canada to other parts it is further possible to extend the chronology all over the country.

In connection with this investigation area very big tasks are opened for future geological investigations in Canada. Firstly, in each area to which this method is applied all possible sources of error should be exposed. Such sources are, occasionally encountered, and they must be eliminated. To this end it is, among other things, necessary to examine the surface of the peat bogs, to find out in what way the present composition of the tree flora appears in the pollen percentages of that layer that is now being stratified on the peat bog.

At the same time as this method is at present most important to the chronology of the post-Glacial times, it is also able to expose the history of the vegetation during the same period. The pollen limits indicate the epochs when different tree species have arrived at a certain locality.
In this respect extensive investigations should be carried out in Canada in straight lines from South to North, and from East to West. Thus would be found out in what amount, in what way, and when the boundaries and zones, characterized by different trees, have changed during the course of the times. So much may be said at present that, at least in a north-southern direction, besides the ordinary progress of the migration of the vegetation, there have occurred also other movements in closest connection with climatic factors.

I would at least like to draw the attention to the following regularity in southeastern Canada. In the bottom layer of the peat bogs, Picea and Abies pollen appear in abundance whereupon their curve, a little higher up, rapidly drops to a minimum, when the pollen amounts of the hardwood reach their highest value. In the surface parts the pollen amount of spruce trees again increases while that of hardwood is decreasing. Particularly noticeable is, i.a., the absence of Tsuga in the oldest bottom layers.

The application of this method may, besides, give a particularly clear picture of the flora of the interglacial periods, as proved by my investigations on the peat layers found in the southwestern parts of Hudson Bay.

This method may also be used to compare the relative age of different parts of one and the same peat bog, and thus to follow, geologically, the nature and intensity of the different kinds of paludification. Besides, this method may be used in many cases as an indicator of critical peat varieties, and, also, in exposing the thickness growth of the peat.

As proved by the meritorious investigations of Canadian geologists, the unequal upheaval of land, still continuing in Canada, has in many tracts the effect that the shore lines of the lakes move, either in a positive or negative sense with regard to the centre of upheaval depending on position of the outflow of the water. Peat-geological investigation methods may therefore be applied on peat bogs on lake shores where changes of the water-level appear from the characters of the peat, according to the genetic system set forth above. By this method the rate of the niveau changes may be successfully established on a chronological basis, as the investigations in Finland and Scandinavia have demonstrated in such a beautiful way.

Besides these microscopical plant-paleontological investigations, megascopical investigations should also be carried out for the purpose of determining fossil plant and animal remains, especially in the sediments of ancient lakes. As the investigations in southeastern Canada in this respect have given good results, I feel confident that it would answer the purpose to apply this method also to the whole of Canada, so much more as it would complete the microscopic method, at the same time as it is in some respects more reliable than the latter.

The points of view set forth above do not claim to be anything more than some single outlines, based upon a comparatively limited knowledge of the Canadian peat bogs. I have chosen these by comparing the peat bogs of Canada and Europe with one another, and using the experiences gained on the old Continent as an analogy. Experiences gained in other countries are of course worth of being taken into a careful consideration, but no investigation work is in the long run more profitable than that which is based upon an independent system of methods.

Practical peat bog investigations.

In the sketch of the theoretical investigation methods given on the previous pages I have tried to draw the attention particularly to those questions that are absolutely indispensable to practice. This program might thus well be regarded as intended to serve practice just as much as science. At the special request of the Director of the Geological Survey of Canada I am now going to deal quite shortly with some purely practical questions in connection with the peat bogs of Canada, and touching upon the investigations earlier carried out by the Geological Survey. I am willing to do this in view of the fact that the results I have arrived at in southeastern Canada somewhat differ, from a practical point of view, from the results of those investigations that the Geological Survey has carried out, during the last 10 years or a little more, with the use of fuel-peat in mind. As many of the peat bogs that I investigated had formerly been explored by the peat specialist of the Geological Survey, A. Ankep, I have had a fairly large material at my disposal, enabling me to study the way in which fuel-peat investigations were formerly carried out.

Taking into consideration the extensiveness of the said investigations as well as the accounts and maps containing large amounts of quantitative data, published by the Geological Survey in its publication series, I can testify to the creditable amount of labor and time that have been devoted to these investigations. I would, however, like to touch upon some observations which, although they in no way are intended to shake the present system of investigation, yet to my mind, if they were followed,
might complete the Canadian investigation activity and, in any cause, would make it correspond to the latest demands.

First of all, the exposition of the peat bogs should during the investigations be as many-sided as possible. Even the European peat bog specialists have to deal, besides with theoretical questions, also with numerous branches of practical activity, and they have to apply the results of theoretical work to practice. Such an extensive and broadly developing country as Canada requires investigation work of this kind more than any other country where the distribution and characteristics of the peat bogs are generally known from earlier times. With this I mean that the Canadian peat bog investigations should deal with the use of peat bogs, on a theoretic and scientific basis, with an eye on all the different possibilities of practical application. An investigation method of this kind can, of course, not be fully practicable unless the classification and bonitation methods for various practical uses have been fully exposed in Canada, but the peat bog investigation can give an exact analysis of the structure of the peat bogs, the ways of paludification, as well as of their development, and all this is in the first place necessary, when the most appropriate and profitable form of application shall be found out. The more circumstantial special methods, suitable for the special kinds of application, can only be chosen on the basis of the first general results.

The investigations so far carried out by the State have only dealt with the application of peat bogs for fuel-peat and litter, and they have been limited to East Canada only. Most of the investigated peat bogs are, according to the results obtained, suitable for fuel-peat industry, and a part of them for the peat-litter industry. The deviating opinion of the writer of these lines is, however, that out of some 30 cases which I have been in a position to check, the peat bogs have but in a very few cases been profitable to the fuel-peat industry. And even in these cases the greatest caution should, to my mind, be observed with regard to the adaption of this application form. Among peat bogs of this kind the following might be mentioned: Large Tea Field, Alfred, Newington, and Perth. Considering that some enterprises even on these peat bogs have ended with big failure, it is doubtful in what degree the other ones may at all come into question. It appears from the profiles which will be published in my investigations that Sphagnum peat, which forms the predominating layer in most of these peat bogs, is so raw that it is more or less unsuitable for use in the fuel-peat industry. And even in the few instances when the degree of moldering of the peat would somewhat correspond to the demands that can be put on fuel-peat, the mechanical extrication of peat from the peat bog encounters so many difficulties on account of the numerous stub layers and other obstacles that the establishment of a fuel-peat factory in their vicinity would certainly mean money thrown away. For a distinction must be made between the suitableness of the material for a certain use and the profitableness of that use. In the possibly profitable cases mentioned above, this estimation refers mainly to Carex peat.

I am convinced that the practical investigation in Canada has started too boldly from the assumption that the structure of the peat bogs over there is the same as in Europe. However, not in a single case have I been able to find any type that would correspond to the European Hochmoor which, under the raw Sphagnum layer, contain an older highly moldered Sphagnum layer, and, underneath the same, a forest peat layer usually containing plenty of Alnus. The fuel-peat value of these moldered layers is in Europe a very big one. Neither with regard to their physical nor chemical qualities do the moldered Sphagnum layers of eastern Canada in a single case stand a comparison with European ones. It might still be added that the comparatively rare forest peat in Canada is of a different nature than the corresponding variety in Europe. By the investigations carried out in Canada one is not, however, in a position to judge the value of this Canadian forest peat. In this respect the weakness of the investigations carried out in Canada lies in the fact that the different peat varieties, have not been studied systematically but the investigations have principally been based on the degree of decay. Though quite a big number of analyses have been made, it is very difficult or almost impossible to get a clear idea of the chemical characters of the Canadian peats. This is due not only to the fact that the systematics of the peats has not been cleared up beforehand, but also to the inappropriate sampling, a whole profile of a peat bog having been combined in one and the same sample, and, consequently, chemical analyses have been made also of samples containing up to five peat kinds, each having its peculiar character and composition. The biggest mistakes have, however, been avoided in cases where the layers of the peat bogs have been homogenous. Consequently, analyses ought absolutely to be made systematically of definite peat varieties, and if the distribution of these varieties were known, much time, trouble, and money would be saved. The characters of fuel-peat ought also to be exposed according to the newest methods used in Europe.
I would still like to add a few observations about the general mapping methods. During my investigation work, while using maps drawn up of the peat bogs, I have noticed even big inaccuracies. For instance, the Sagamite peat bog is only a small bog on the shore of the lake with the same name, and does not extend to the lake above, as the map indicates, for from there the water is falling into the Sagamite lake down waterfall which is some tens of feet high. Mapping is, of course, only then of any practical use when it is done minutely and accurately, so that the indicated quantities of the different peat varieties are absolutely reliable. In many cases the mapping is on the whole quite first-rate, but in my opinion it has been unnecessary to waste work on such bogs for which there can in no case have been any question of using them for the fuel-peat industry. Detailed mappings in different forms ought, to my mind, be carried out only when the value and form of use of the peat bogs first has been fixed, each one then demanding its own method of mapping.

My diverging results, however, do not imply that there would be small chances for fuel-peat industry in Canada. They show rather that the investigation method of the peat bogs could have been more to the purpose, and that peat bogs have been investigated in areas where the fuel-peat industry generally has rather small chances, due among other things to the fact that in the sphere of the damp sea climate difficulties are met with at once when raw peat material should be used for the preparation of fuel-peat. Regional investigations into the structure of peat bogs would have shown where fuel-peat bogs of a suitable structure generally are to be found. I am in any case of the opinion that the fuel-peat industry, at least in eastern Canada, and principally due to the structure of the peat bogs, has not as good possibilities as in Europe. I doubt, besides, at least for the present, if mechanically treated peat can compete with coal. Consequently, the attention should be paid chiefly to the needs of private settlements and smaller settlement centres.

The above conception of the chances of the fuel-peat industry is, to my mind, by no means hopeless as to the uses of peat bogs generally, considering that the Canadian peat bog investigation is hereby entitled to a more comprehensive warrant to pay attention also to other useful branches. And it seems to me that the principal uses to which the peat bogs of eastern Canada can be put are the moss litter industry and the afforestation. Many chances are offered to agriculture, at least on the borders of peat bogs, and the peat material derived from the peat bogs may, particularly on clay soil, yield good results. The substantial report of the Canadian Peat Committee, published in 1926, deserves special attention also in so far as attention is drawn also to other than the fuel-peat chances. But as long as nature supplies a sufficient amount of fertile arable land, the use of peat bogs for agriculture will, of course, have to wait for future times. Even in that case is the classification and valuation of the peat bogs as well as a valuation of their future possibilities absolutely necessary.

Before I finish with this report, I would once more like to emphasize that even when there is a question of a purely practical aims, the peat bog investigation should be, theoretically as well as systematically, as many-sided as possible, and pay a comparative attention to all the forms of use to which peat bogs can be put. The detailed investigations are thereafter to be adapted according to the most profitable form of use. In this respect I beg to refer to those schemes of peat bog investigation methods which I prepared, at the request of the Geological Survey, in the autumn of 1926, and according to which, particularly with regard to fuel-peat, the investigation of peat bogs should be done in straight lines along the railway lines.

Canada is a settlement and home colonization country; the settlement-political importance of the peat bogs is therefore great, at least in such districts where there is plenty of peat bogs. By observing the above outlined classification principles, the regional valuation of peat bogs may thus show the extension chances of colonization. And as the colonization activity in Canada is at present guided in a model way, i.e., by first developing the communication possibilities, an accurate knowledge of the peat bogs might thus give a clear indication as to how the new railways and high roads should be built so as to enable the colonization to concentrate in the right way and according to the possibilities. In this activity attention will, of course, be paid also to all the other productive possibilities of nature whose importance might, directly as well as indirectly, be influenced by the peat formations.
Eräittä vastaisia tehtäviä suotutkimuksen alalla Kanadassa.

Selostus.

Kun tieteellisiä suotutkimuksia Kanadassa ei ole aikaisemmin suoritettu, oli tekijällä erinomainen tilaisuus selvittää sekä pintamorfologiset että turvegeologiset perusteet, joiden mukaan tulevia tutkimusmateriaaleja olisi suoritettava. Koska suomalainen tutkimusmetodikka osoittautui erinomaisen hyvin soveltuvan Kanadassaakin käytettäväksi, perustuikin esitys vastaisista tutkimuksista etupäässä meikäläisten metodikon soveltukseen.


Kerrossarjoista suoritettu siltepöytötutkimus osoittavat, että kerrosten kosteus- vaihtelut ovat alueellisia ja samankaltaisia ja vastaavat samoja vaiheita kuin Eurooppasakin, joten Pohjois-Amerikassa ovat vallinneet jääkauden jälkeen samat ilmaston vaihtelut kuin vanhallakin manterella. Muinaisen kasviston historia, joka myös selvitettii, viittaa monessa suhteessa samoihin säännöllisyyskiin kuin Eurooppasakin.

Kanadan soiden käytännölliset suotutkimukset ovat monessa suhteessa aikaansa jäljessä, ja on tekijä jättänyt Kanadan valtiolle suunnitelmien näiden tutkimusten uusimisesta. Tämän kirjoituksen loppussa selvitellään päätirteissä näitä suunnitelmia ja ehdotuksia.

Publications of the Society of Forestry in Suomi:

ACTA FORESTALIA FENNICA. Contains scientific treatises dealing with forestry in Suomi (Finland) and its foundations. The volumes, which appear at irregular intervals, generally contain several treatises.

SILVA FENNICA. Contains essays dealing with forestry in Suomi, which are not in the nature of purely scientific research. Published at irregular intervals. Each essay appears as a separate volume.

COMMENTATIONES FORESTALES. Contains investigations and other essays regarding forestry and other spheres connected with it in other countries than Suomi. Published at irregular intervals. Each volume generally contains only one treatise.

Die Veröffentlichungsreihen der Forstwissenschaftlichen Gesellschaft in Suomi:

ACTA FORESTALIA FENNICA. Enthalten wissenschaftliche Untersuchungen über die finnische Waldwirtschaft und ihre Grundlagen. Sie erscheinen in unregelmässigen Abständen in Bänden, von denen jeder im allgemeinen mehrere Unter- suchungen enthält.

SILVA FENNICA. Diese Veröffentlichungsreihe enthält Aufsätze zur Waldwirts- schaft Suomis (Finlands), ohne den Charakter eigentlicher wissenschaftlicher Unter- suchungen. Sie erscheint in unregelmässigen Abständen. Jeder Aufsatz er- scheint als besonderer Band.

COMMENTATIONES FORESTALES. Enthalten Untersuchungen und Beiträge zur Waldwirtschaft und damit zusammenhängenden Fragen für andere Länder als Suomi. Sie erscheinen in unregelmässigen Abständen. Jeder Band enthält im allgemeinen nur eine Untersuchung.

Publications de la Société forestière de Suomi:

ACTA FORESTALIA FENNICA. Contient des études scientifiques sur l'économie forestière en Suomi (Finlande) et sur ses bases. Paralt à intervalles irréguliers en volumes dont chacun contient en général plusieurs études.

SILVA FENNICA. Contient des articles de caractère non purement scientifique sur l'économie forestière de Suomi. Paralt à intervalles irréguliers. Chaque article constitue habituellement un volume.

COMMENTATIONES FORESTALES. Contient des études et des articles sur l'écono- mie forestière et les branches connexes dans les pays autres que Suomi. Paralt à intervalles irréguliers. En général, chaque volume ne contient qu'une étude.