CUTICLE IN ORGANIC TERRAIN AS APPLIED

TO COPETOWN BOG

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A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Master of Science

McMaster University

October 1960

MASTER OF SCIENCE (1960) (Biology)

McMASTER UNIVERSITY Hamilton, Ontario.

TITLE: Cuticle in Organic Terrain as Applied to Copetown Bog.

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NUMBER OF PAGES: 145.

SCOPE AND CONTENTS:

A technique of analysis is offered for the isolation of cuticle which was found in peat samples during the course of the preliminary investigation for this work. An identification of the isolated cuticle is developed. This is facilitated by comparative studies with known kinds of cuticle. Extracted cuticle is used in an attempt to interpret and explain the genesis of peat accumulations in the Copetown bog near Hamilton, Ontario.

ACKNOWLEDGMENTS

The author wishes to express his gratitude to Dr. N.W. Radforth, Chairman of the Department of Biology, McMaster University, for his encouragement and assistance in the execution of this investigation.

The award of a research scholarship by the Department of Biology, McMaster University is gratefully acknowledged.

The assistance extended by Miss Catie Kleerekoper and Mr. Kenneth Ashdown in the production of this thesis is greatly appreciated.

TABLE OF CONTENTS

PREFACE

During the last two centuries, many investigators have been attracted by the botanical and geological significance of plant fossils. These fragmentary remains of past floras have been used in accounting for the genesis and evolutionary history of present day vegetation. The great antiquity possessed by certain fossils is realised, when it is shown, that some have been isolated from Palaeozoic rocks of the Cambrian period. That many of them have survived the process of fossilization is attributed, in numerous instances, to the presence of a resistant outer cover known as cuticle.

Kinds of cuticle possess the property of retaining their identity while subject to chemical change and mechanical stress. This is attributed to the unique chemical and physical properties and morphological stability of the cuticular material. Thus its isolation from the surrounding matrix is a relatively easy matter; for all that is required in order to free the cuticular material is a chemical treatment sufficient to dissolve or loosen the adhering matrix.

Most of the work in palaeobotany has centred upon the fossil cuticles of pre-glacial deposits. Comparatively little attention has been focused on the cuticles of recently fossilized plants in post-glacial deposits. Peat is perhaps the best known example of a fossiliferous post-glacial deposit.

These deposits are familiar features of the landscape in temperate and sub-polar regions of the world. In Canada, the extent of such deposits has been estimated at approximately 435,000 sq miles or 11.8% of the total area (26). Until recently, the significance of these deposits on the economic development of Canada had not been fully realised. It was not until 1945 that the National Research Council decided to embark on a study of organic terrain (muskeg, as this terrain is known in Canada). The problem of what constitutes muskeg was given to Dr. N.W. Radforth of McMaster University who, in association with the Defence Research Board and the National Research Council, undertook this study.

Since then, Radforth and his associates (24, 34, 35, 36, 40, 41, 54) have been able to show and classify the natural organization present in muskeg from the botanical point of view. A classification system was expressed in qualitative terms by relating the variations inherent in muskeg to the microfossil frequency sequence in depth. The establishment of this system was followed by the recognition of relationship between the macrostructure and the natural organization of peat - the fossilized component of muskeg. His terms of reference for macrostructure, the predominance of fibrosity vs. amorphous and woodiness vs. non-woodiness, were based on qualitative assessment. A quantitative method of assessing the differences in peat constitution was advanced in a recent publication by Radforth and Eydt (40).

It is within this overall programme of research into the properties of muskeg currently being conducted at McMaster University, that the objectives of this present investigation are found. Thus, if these post-glacial deposits reveal the presence of kinds of cuticle sufficiently well-preserved and exhibiting diagnostic features, perhaps a new approach to the elucidation of the history of peat can be made.

INTRODUCTION

The study of post-glacial peat deposits has, in the course of time, been subdivided into two separate fields. The first involves the microfossils distributed throughout the peaty matrix and the second concerned the matrix itself, or the macrofossil element. Taken together, the fossil components form what is commonly called 'peat'.

Until fairly recently the major portion of research on peat has revolved around the microfossil element. The microfossils or fossil spores and pollen are regarded by specialists in this field as good indices of past floras. The features of these cuticular entities are of diagnostic value. Because Godwin (17, 18, 19) and others deal adequately with the topic of microfossil preservation in peat no more need be stated here.

The intense study devoted to the microfossil element during the last decade has perhaps led to its treatment as a separate entity, and to the neglect of other elements present in peat with similar diagnostic values. In recent years as a direct result of this interest a new expression, palynology, has entered the palaeobotanical literature. It is used partly to designate the study of fossil spores and pollen. Upon the isolation and identification of microfossils fro, a given peat sample, palynologists are able to construct histograms from which they determine the past floral succession of a given area. Climatologists also utilize these histograms for illustrating the subject of climatic rhythms of the past. The use of climatic rhythms in considering the status and history of pre-existing vegetation has been examined in great detail by von Post (52).

L. von Post of Sweden, one of the pioneers in palynology established methods of extracting and studying the microfossils. At first, he used the results of his analysis to explain forest successions and the climatic history of areas surrounding peat deposits. He also applied his findings along with those of Hansen (22), Erdtmann (12) and others, to interpreting the whole question of forest regeneration in areas once covered by glaciers.

Similarly Godwin and his associates (17, 18, 19) have investigated many peat areas throughout the British Isles. From the data collected in the course of investigations, they have constructed pollen histograms, which have enabled them to demonstrate in great detail the post-glacial floral and climatic history of Britain.

Today, most countries with peat deposits support, directly or indirectly, a programme of peat research; the results of which are usually made available to the rest of the world through publication in the appropriate scientific journals. In time, a complete record may be available showing past floral and climatical changes that have occurred widely since glacial times.

At the same time, new techniques are continually being investigated in attempts to ensure greater accuracy in the interpretation of histograms. One example of a new technique is the use of volcanic ash as a time marker. The thin stratifications of wind-borne volcanic ash present in certain peat profiles from the Pacific northwest, have been correlated with past volcanic eruptions (43). The times at which these eruptions took place have been established, resulting in a fairly accurate correlation between the volcanic ash stratification and the volcanic eruptions. Another fairly new technique is the use of carbon 14 datings. Such datings have been attempted with peat and should upon further refinements yield useful correlations between the palynological record and the geological time scale.

In applying the palynological methods of analysis to the muskeg of Canada, Radforth and his associates (24, 34, 35, 36, 41) used the results not only for the interpretation of past floral and climatical histories but also as a guide to:

> "permit a better understanding of the macroscopic ingredients from the point of view of both classification of properties and the appreciation of mechanical problems", (35).

They also recognised that the microfossils, contained within the muskeg, are identical to the pollen and spores of the surface vegetation. It appears then, that a relationship exists between the microfossil and macrofossil constituents, since both have a common origin and thereby contribute concurrently to the formation of peat but in different degrees.

A survey of the literature on the macrofossils has revealed that this important aspect of peat study is still relatively unexplored. This is perhaps unfortunate, since any comprehensive analysis of muskeg should include a study of both the microfossil and macrofossil elements. Apart from peat sequence, this is necessary for a better understanding of the relationship between the surface character of muskeg and sub-surface macrostructure.

Radforth was able to determine the relationship between surface and sub-surface organisation by first establishing the meaning of the term muskeg. He gave a comprehensive definition of muskeg when he stated that:

> "Muskeg has become the term designating organic terrain, the physical condition of which is governed by the structure of the peat it contains, and its related mineral sub-layer, considered in relation to topographic features and the surface vegetation with which peat co-exists." (34).

One is justified in abbreviating this definition to 'organic terrain' for the purposes of discussion.

One of the early contributions towards an understanding of the macrostructure of peat was made by Dachnowski (10). In this, he emphasized the stratigraphy of peat deposits. By this method, he was able to recognize and describe the different layers of peat as well as their number, thickness, and arrangement relative to one another. From his identification of layers and horizons in peat profiles, he separated 10 different categories of peat. To simplify this classification, since the variations of the 10 categories tended to confuse the system, he reorganized them into three main groups. These groups were based on the degree of woodiness, fibrosity and sediment in the peat. E.K. Soper (49), working on the peats of Minnesota, recognised the same qualitative differences. However, in his classification he considered the average quality of the peat in a given deposit, and not only recognised the three categories based on the degree of fibrosity, woodiness and sediment content, but also included a fourth which he called a "well decomposed structureless peat" (40). Soper did not consider this a practical classification system because he noted that the physical characteristics of peat change in the same deposit at different depths. Similarly Dachnowski realised that his classification system had limited value when he stated that:

> "for purposes of correlation it is desirable, however, to classify peat layers more definitely by actually noting the botanical identity of the plant remains present" (10).

More recently, Radforth (34, 35, 37) has attempted a classification system of peat character for reference purposes. While all three classification systems mentioned are based on the natural relationships of the macrostructure in peat, the Radforth system differs in that it places greater emphasis on the physical and morphological aspects of peat structure, whereas the systems of Dachnowski and Soper relate more directly to generic structures. However, all three classification systems were based on qualitative differences, and it was not until Radforth and Eydt (40) recognised the need for a quantitative assessment that an investigation into method was started. These authors also attempted to utilize the identifiable macrofossil fraction to explain the structural organization inherent in the macrostructure.

It would appear from these attempts that in order to ensure a greater identifiable macrofossil fraction a technique must be devised to identify plant species contributing directly to the macrostructure of peat. To undertake this task a structural reference entity is required that will not only resist the forces of decay but also possess specific diagnostic characteristics from which identification can be made. If cuticle can be shown to be present in peat, then perhaps it will fulfil this requirement.

Harris (23) and others have succeeded in isolating cuticle from the rocks of the Carboniferous and Jurassic periods. They have shown that taxonomic characteristics can be determined; for example, family characteristics can be shown by the arrangement of epidermal cells around stomatal openings, generic characteristics by the groupings of stomata in rows or at random, and specific characteristics by observing the cell outline to see if it possesses straight, wavy or thickly ridged features.

Thus in the light of what has been stated, the fulfilment of this investigation centres upon three basic questions:

1. Is cuticle present in peat and can a method be devised to reveal it ?
2. Is the isolated cuticle of conspicuous elements of the present vegetation identifiable with those from the macrofossil element of past floras ?
3. Can 1. and 2. be used to assess in palaeoecological terms the formation of peat ?

If these questions can be answered and cuticle can be used to represent the macrofossil constituents of the peat, then new knowledge will be brought to light not only about the macrostructure of peat but also about the dynamics of formation of organic terrain.

CHAPTER I

SOME PHYSIOGRAPHIC ASPECTS OF THE COPETOWN BOG

Before any start can be made towards the achievement of these objectives certain requirements have to be considered in the choice of location.

The first requirement is that organic terrain be present in sufficient quantities for study purposes. Extensive areas of organic terrain exist in the northern latitudes of Canada. For the present, it is impractical to carry out this investigation on these large areas and thus organic terrain of limited extent is required. A bog is a good example of organic terrain confined to a small area. While differences do occur between the processes involved in the formation of bogs and more extensive areas of muskeg, the principles underlying the origin of both are generally believed to be the same. Bogs are favoured by many investigators in this field of study, since not only are they of limited extent but they are also more readily accessible.

The second requirement is that the bog contain a suitable depth of peat, the deepest part of which is selected for study. This is necessary, as Potzgar and Coutemanche (32) point out in their work on the bogs of Quebec, to obtain as complete a record as possible of past floral succession.

The third requires that the present surface vegetation growing upon the bog be representative of the vegetal mantle found in the extensive areas of organic terrain.

In the fourth requirement the bog must not have been altered by human exploitation, thus ensuring the existence of a preserved natural record of past floral events.

Finally, practical considerations such as the limited time available and difficulties of transport makes it necessary to choose an area as near as possible to the muskeg laboratory at McMaster University.

The Copetown bog was selected as the site to test the validity of the present objectives. The bog is located approximately ½ mile south of the Copetown village in the county of Wentworth and is about eight miles by road from the muskeg laboratory at McMaster University. It covers an area of 28 acres and has a sufficient quantity of organic terrain. This bog has been mentioned by Radforth and Suguitan (41) who noted the similarity between its surface coverage and that of certain muskeg areas near Fort Churchill, Manitoba. The borings made at intervals along the transect across the Copetown bog, marked by the dotted line and symbols $X_1 - X_2$ on the map (Plate XL), reveals the profile and the corresponding depths of peat accumulations, the deepest part being 7.45 meters near the centre of the bog. It is in the immediate vicinity of this depth that the present study is made.

As far as could be ascertained the bog has not been altered by human exploitation and thus a complete record of past floral successions can be expected.

An oblique aerial photograph (Pl.1) shows that the bog is located in a depression surrounded by low lying hills, which are intensively cultivated. The elevations of the surrounding area are shown on the map (Pl.XI1). The approximate elevation of the bog can be estimated as a few feet below the spot elevation (783') near the junction of Highway 52 and the Toronto, Hamilton and Buffalo Railway. The same map shows the bog partially enclosed by the same railway and highway on its eastern and western boundaries. The southern portion is at the junction of railway and highway and the northern sector is enclosed by farmland (Pl.XLI).

No investigation into the properties of organic terrain can be complete without consideration of the mineral sublayer upon which the peat accumulates. Gorham (20) in an excellent survey of the development of peatlands stresses the geological factor, when he states at the beginning:

> "Geology conditions bog development both physically through its effects upon the permeability and erodability of the soil, and hence upon water relations, and chemically, by its effects upon nutrient supply." (20).

Chapman and Putnam (6), who have written on the physiography of southern Ontario, also emphasize the necessity of a fundamental knowledge of geology before seeking to understand the distribution of soils in Ontario. In particular they stress a working knowledge of the glacial history of the area.

The effects of past glacial action on the distribution and formation of many bogs has been studied by numerous investigators. The uneven topography, resulting from the unequal deposition of glacial materials usually contains numerous depressions, many of which now contain bogs. The depression in which the Copetown bog lies is a result of a glacial action. The mineral sublayer, revealed by the soundings taken on the transect (Pl.XL) and by borings made by the Department of Highways of Ontario, is composed of such materials as fine sand, silt and clay.

The Copetown area forms only a small part of the morainic complex, that extends from just south of the Dundas Valley to near the southerly tip of the Niagara escarpment. The particular area around Copetown and Ancaster has been described by Chapman and Putnam as a region of kames and outwash and consisting of:

> "a knobby surface with undrained depressions of irregular shape between the knobs." (6).

Such a condition exists in the study area where two undrained depressions lie to the northeast of the bog (Pl. XLI). All three depressions appear to have been formed in the same abandoned glacial drainage channel typical of morainic terrain.

The origin of the water supply in the bog is not definitely known. However, it would appear from the configurations in the underlying and surrounding mineral strata that the inflow and outflow of water in the bog is complex. No visible streams enter it. The main source of water is believed to be directly connected with the surrounding water table. The extent to which rainfall contributes to its hydrology is unknown. The contribution of rainfall, while important, is not critical for the development of this type of bog. Rainfall tends to be critical, however, for bogs not formed in depressions and thus applies more to the "blanket and raised bog" types, where the significant climatical index is the ratio of precipitation to evaporation (28).

The large pools of brownish water dispersed throughout the bog are a striking feature of the surface topography. With the exception of the central pool, all the others are located near the northern and southern periphery. The central pool is of particular interest since it is over 45 feet or 14 meters deep and is used by some of the local inhabitants for agricultural purposes. This continuous source of water has given rise to the popular belief that the pool is spring fed.

In the Spring and early Summer the region between mineral and organic terrain is filled with water to such an extent that the bog is delineated by a continuous moat. This moat is referred to by Conway (7) as "the marginal fen" and as the "lagg" by such Scandinavian workers as Sjors (47). It is the narrow transition region between the plant communities of mineral soils and those of organic terrain. The bog forms a natural catchment area for run-off water from the surrounding higher ground. The erosion channels in the fill of the road-bed and the drainage culverts under the railway bed testify to this. The luxuriant growth of vegetation in the lagg suggests that the run-off water is rich in undissolved minerals.

To prevent localised flooding near the dwellings on the southern embankment of the bog, a shallow drainage ditch has been constructed that diverts excess water from the lagg into a culvert beneath the road-bed. This is thought to restore the drainage condition that existed prior to the construction of the road.

CHAPTER II

DESCRIPTION OF SURFACE VEGETATION.

Bog habitats are unique in that they tend to support a rather specialized vegetation. In this ecological niche are found certain plants that have completely adjusted to growth on a peaty medium, e.g. *Sphagnum* spp., and *Sarracenia purpurea* L., while others with wider tolerances to varying environmental conditions grow successfully both on the bog as well as on other types of terrain, e.g. *Salix* spp., and *Iris versicolor* L.

Possible reasons for the specialized vegetation on bogs have intrigued a number of investigators. Some, such as Transeau, (51), Soper (49), and Rigg (42), have believed that the acidity produced by the irreversible fixation of mineral ions in the decay resistant tissues of *Sphagnum* spp., is the most likely reason for such selective growth. Other workers like Gillespie (16), advocated that it is the presence of toxic substances released by plant tissues in a reduced condition, rather than acidity, that is responsible for the specialized surface vegetation. Similarly Wilde (55) has been able to show that a very low negative redox potential can be correlated with the presence of large quantities of toxic reduced substances, which in turn leads to a deterioration of root structure and resulting poor growth particularly in the trees. A number of plants, exogenous to bogs, e.g. species of *Acer* and *Quercus*, germinate on the bog's surface but they rarely, if ever, reach maturity. These plants from mineral environments appear to be a result of random seed dispersal.

A knowledge of the surface vegetation is important in any bog study since it imparts to the upper layers of peat definite morphological features brought about by the selective growth induced by the environment (55). It is on this basis that the constitution of the present surface vegetation growing on the Copetown bog must be examined in order to gain an understanding of the underlying peat.

From the phytogeographical point of view the location of this bog is interesting for it lies in the transition between the Carolinian zone of Ontario and the Boreal Forest of the north (15). Braun in his work on the deciduous forests of N.E. America considers the bogs of this region to be of ecological interest in that they represent islands of the more northern coniferous forests in the Beech-Maple forest region (5). In other words Braun refers to bogs, at present surrounded by deciduous trees, such as the Copetown bog, as relics of the past coniferous forests which at one time covered much of southern Canada and the northern U.S.A. This controversial view has been questioned by a number of investigators who regard the specialized vegetation of bogs as a result of both the inhibitory properties of peat and appropriate climatic conditions(47,55).

Perhaps one of the most fruitful concepts used by ecologists for interpreting vegetation is that of succession. This concept was first advocated by Cooper in 1926 (8), who realised that vegetation is dynamic and characterized by constant change. According to this concept, pioneer communities of vegetation are replaced by others as the environment changes. This process continues until a more stable vegetation, which is more or less self-sustaining succeeds in establishing itself as a climax. Soper (49), has emphasized this particular concept in interpreting bog formation and lists six successional stages through which bogs develop in the Great Lakes region. These are listed as follows:

"(1)	the stonewort-water weed stage	(Chara-Philotna Associes)
(2)	the pond weed-water lily stage	(Potamogeton-Nymphaea Associes)
(3)	the rush-wild rice stage	(Scirpus-Zizania Associes)
(4)	the bog-meadow stage	(Carex Associes)
(5)	the sphagnum-bog heath stage	(Andromeda-Ledum Associes)
(6)	the tamarack-spruce stage	(Larix-Picea Associes)"

For the meaning of associes a brief reference must be made to the climax theory proposed by Weaver and Clements (53). In this theory plant communities have their dominants defined as the controlling species with the same life form, for instance, grasses in prairies and trees in forests. The major unit of the theory is the formation which is regarded as a product of climate and is in turn said to consist of several associations, which are defined as plant communities with:

> "homogenous physiognomy, ecological structure, and floristic composition" (31).

A good example of this is the Tundra formation made up of at least three associations, the most common of which is the Carex-Poa association. Where the association has not reached the climax a condition exists that has been called an associes.

From Soper's interpretation (49) of bog formation it would appear that the Copetown bog is at the Tamarack-Spruce stage (Larix-Picea Associes). Whether or not it has passed through the five successional stages during the course of formation remains to be determined.

In the summer of 1959 a collection was made of the outstanding plants growing on the bog. This collection was necessary for two reasons:

(a) to identify the conspicuous elements in the surface vegetation; and

(b) to use the leaf cuticles of the identified plants as a reference source.

The identities of these plants from the bog are considered important for assessing the factors contributing to peat formation. The identification of genera and species was aided by using Gray's Manual (14), Crout (21), Bodenberg (3), Braithwaite (4), and the McMaster Herbarium as reference sources.

A map of the surface vegetation on the bog has been constructed from the data collected on field trips carried out during the summer of 1959 and 1960 (Plate XIII). On this map, the major plant groups containing the various combinations of 18 species and genera have been indicated and the approximate boundaries shown by a thin black continuous line. These boundaries were determined by oblique aerial photos taken during the summer of 1958 and then verified by following the boundaries on foot. It must be emphasized here that the use of these groups only attempts to show visible predominance of particular genera and species. No attempt is made to explain the number of plants, for example, Sarracenia purpurea L. and Drosera rotundifolia L., apparently scattered at random, that occur throughout the bog regardless of groupings.

The plants found in each group are represented on the map by symbols. There are 18 genera and species listed on this map from which the symbols have been derived. The symbols for a species consist of the first two letters of the binomial with the first letter of the generic name capitalized. Where only the generic name is known, a single capitalized letter is used. The symbols are used not only for convenience, but also for neatness in representation. The symbols representing plants in a group are together called a formula. The order in which the symbols are placed in the formula is estimated visually on the basis of apparent abundance.

A brief account is offered of the vegetation surrounding the bog. The depression in which the bog is situated is enclosed by wooded slopes and open meadow. The majority of the trees on the wooded slopes are deciduous and consist chiefly of *Quercus alba* L., *Quercus Rubra* L., *Salix* spp., *Fagus grandifolia* Ehrh., *Corylus Cornuta* Marsh., *Acer saccharum* Marsh., *Acer rubrum* L., *Betula* spp., *Populus deltoides* Marsh., *Populus tremuloides* Michx., *Crategus* spp., *Prunus virginiana* L., etc. A number of shrubs form a dense undergrowth and consist mostly of *Cornus stolonifera* Michx., *Salix* spp., *Echinocystis lobata* (Michx.) T.&G., *Rubus* spp., *Rosa* spp., etc. The open meadows bordering the bog are used for grazing cattle and are covered with numerous unidentified grasses.

The region between the surrounding slopes of mineral soil and the bog proper has been called the lagg. It is designated by a thick black line on the map (Plate XLll). A dense and varied assortment of plants is found growing in this region. A cross-section of the lagg shows that the trees and shrubs appear to be thicker towards the outer limits, that is, close to the mineral soil, and thinner towards the inner limits or organic terrain. The only tree that is successful in the outer limits has been tentatively identified as *Salix nigra* Marsh. Shrubs are more successful, and such species as *Cornus stolonifera* Michx., *Salix* spp., and *Ilex verticillata* (L) Gray. predominate. The inner limit of this region is occupied mainly by such trees as Larix laricina (Du Roi) K. Koch., Picea mariana (Mill.) B.S.P. and occasionally Pinus Strobus L.. The under-growth consists mostly of Chamaedaphne calyculata (L) Moench, growing among Sphagnum spp. Localized patches of Ledum groenlandicum Oeder., Woodwardia virginica (L.) Smith., Onoclea sensibilis L., Calla palustris L., Iris versicolor L., Maianthemum canadense Desf., etc., also occur scattered throughout the region.

In general, the four most prominent plants growing on the bog are Larix laricina (Du Roi.) K. Koch, Picea mariana (Mill.) B.S.P., Chamaedaphne calyculata (L.) Moench, and Sphagnum spp. . When all four species are included under the same formula, they represent the largest estimated coverage of any group on the bog.

The most abundant of all plants growing on the bog are the mosses, in particular the bog mosses or Sphagna. They form a dense layer through which all other plants must penetrate in order to survive. On the Copetown bog there exists a number of species of which only a few have been identified. The species identified are found in most localities, but a tendency is noted for them to be concentrated in particular areas. For instance, Sphagnum palustre L. tends to be confined to areas where trees are present in the immediate vicinity. Sphagnum capillaceum var. tenellum Schimp. Andrews. and Sphagnum teres Schimp. Angstre. are found growing in localized patches in open areas with ericaceous plants. Sphagnum acutifolium Ehrh. generally prefers the wetter areas of the bog and is found in the depressions between hummocks and near pools of water.

The Sphagna are not the only mosses present. Polytrichum spp. occuring on the hummocks are usually surrounded by Sphagnum capillaceum var. tenellum Schimp. Andrews. and Sphagnum teres Schimp. Angstre. In general, the Polytrichum spp. are to be found growing on the drier upper portions of the hummocks. No continuous mats of Polytrichum spp. are observed as occurs with the Sphagna. Other mosses are present but their distribution over the surface is not extensive. In particular Pohlia spp. and Aulacomium spp. were identified. They appear to be confined under the trees on the drier or more consolidated parts of the bog.

In addition to the mosses, the most widespread group of plants are members of the Ericaceae of which Chamaedaphne calyculata (L) Moench, is the most prolific. With their "wiry" branches extending above the Sphagnum mat they are present in most localities of the bog. Another prolific member, though not quite as evident as Chamaedaphne calyculata (L) Moench, is Vaccinium Oxycoccos L. with its small, slender, creeping stems growing on the surface of the Sphagnum substratum. Ledum groenlandicum L. grows in scattered patches throughout the bog and only one small concentration of this species has been noted on the western portion of the map (Plate XLll).

A number of large bushes of Vaccinium corymbosum L. grow on the northern portion of the bog where they are found amongst Picea mariana (Mill.) B.S.P. (Plate XLll). One of the rarest representative of this family on this particular bog is Andromeda glaucophylla Link. Only a few specimens of this plant occur and those are found towards the centre of the bog.

Sedge-like plants are next in order of abundance. As a rule they tend to grow in greater numbers on the wetter portions of the bog. However, they are also found thinly scattered throughout in isolated groups. Only the more conspicuous members of this group can be shown on the map (Plate XLll) as space is lacking to show all.

The most abundant of the Sedge-like plants are the true sedges or members of the Cyperaceae, several genera of which are known to exist on the bog. Of these the most widespread are members of *Carex* and *Scirpus* that have not been identified to species. The species of *Carex* and *Scirpus* were concentrated together on the wetter portions, namely the western and southern sectors of the bog. (PlateXIll). These members are also found in the wet depressions between the hummocks on the more consolidated or drier parts of the bog. In close association with *Carex* spp. and *Scirpus* spp. in the northern part are two other members of the Cyperaceae. They are *Cyperus* spp. and *Rhynchospora* spp. On the drier portions among the trees and open parts of the central area, isolated patches of *Eleocharis* spp., *Eriophorum* spp. are particularly prevalent. *Eleocharis* spp. where it occurs is confined mostly to the tops of hummocks in close association with ericaceous plants and mosses. *Eriophorum* spp. were especially noticeable with their white fruiting structures. They congregate in the wider depressions between hummocks in the central and southern portions of the bog. One common *Eriophorum* species was identified as *Eriophorum angustifolium* Honckeny. *Dulichium arundinaceum* (L.) Britt. was concentrated on the eastern portion of the central pond (PlateXIll), and was not found anywhere else on the bog.

A prominent Sedge-like member of the wetter parts is *Juncus canadensis* J. Gray. found in close association with *Carex* and *Scirpus*.

Perhaps the most striking of the Sedge-like plants is *Typha latifolia* L. It is very prevalent in the areas submerged under water during the Spring and early Summer. As a result, large numbers of this plant are to be found in the southern half of the bog and occasionally in parts of the lagg. Two small areas with Typha latifolia L. are found in both the eastern and western side of the central pond (Plate XL11). In these small areas their spatial distribution is not as concentrated as in the southern part. The southern portion is interesting as far as Typha latifolia L. is concerned for in close association with it are found the following plants: Carex spp., Scirpus spp., Juncus spp., Cyperus spp., Rhynchospora spp., Calla palustris L., Alisma triviale Pursh., Equisetum spp., Onoclea sensibilis L. Chamaedaphne calyculata (L.) Moench, etc. An occasional tree of Larix laricina (Du Roi.) K. Koch grows in the area. All these plants are loosely embedded in the sodden substratum of Sphagna.

Just east of the central pond among the smaller ponds a few clones of Iris versicolor L. grow surrounded by the Sphagna.

The trees are not as numerically abundant as the other groups, but they are more noticeable on account of their size. Generally, trees are confined to the more consolidated or drier parts of the bog. However there are exceptions such as Larix laricina (Du Roi.) K. Koch which occasionally can be seen growing in the wetter areas surrounded by sedge-like plants.

The two trees with the greatest distribution on the bog are Larix laricina (Du Roi.) K. Koch and Picea mariana (Mill) B.S.P. While no pure stands of either are found, Larix laricina (Du Roi.) K. Koch is more noticeable on the fringes of the bog where it grows taller than its counterpart near the centre. Picea mariana (Mill) B.S.P. is more concentrated around the central pond and the central portion of the bog (Plate XL11). An area exists between the fringes and central portions of the bog that tends to be sparse with regard to tree distribution. A few examples of

CUTICLE IN ORGANIC TERRAIN AS APPLIED TO COPETOWN BOG

Pinus Strobus L. exist but their growth on the whole is poor.

In addition to the above mentioned categories of plants, there are those which have no persistent woody stems above ground and are classified as herbs. These herbaceous plants either occur in great profusion in small areas or else they are spread thinly across the surface of the bog in isolated pockets. The majority of them found in local concentrations are near the periphery of the bog. This is realised when the distribution of such plants as Woodwardia virginica L. Calla palustris L. and Maianthemum canadense Desf. are examined on the map (PlateXLll), where they are found along the western fringe of the bog. However, Calla palustris L. is also found thinly scattered throughout the bog where it is mostly confined to the wetter portions between hummocks. The fern Onoclea sensibilis L. is found in the southern portion of the bog where it grows in great profusion amongst Typha latifolia L.

Confined almost exclusively to the more consolidated or drier portions is Sarracenia purpurea L. It appears to grow better in the depressions between hummocks in the open areas. Another member of the same order, Drosera rotundifolia L. grows best on the hummocks, where it is mostly confined to the slopes and because of its small size often escapes detection.

Before a site on the bog was selected for the extraction of a core sample, a number of requirements concerning the surface vegetation were fulfilled. In the first place, the site was selected in an area with the most frequently occurring cover formula. That is to say, the area was well represented by the following species, Larix laricina (Du Roi.) K.Koch., Picea mariana (Mill) B.S.P., Chamaedaphne calyculata (L.) Moench., and

Sphagnum. Secondly, the selected area overlay the deepest part of the bog, and finally the area was untouched so that a natural record of plant distribution existed.

This area was located near the centre of the bog (Plate XLII). The composition of the surface vegetation is illustrated by photographs and three quadrats. The latter consists first of a one meter quadrat that shows the distribution of all the identified species and genera in the immediate vicinity of the core (Plate XXXVII). The second is the five meter quadrat, revealing the relative positions of hummocks and depressions (Plate XXXVIII). The third is a ten meter quadrat illustrating the spatial distribution of *Larix laricina* (Du Roi.) K. Koch and *Picea mariana* (Mill) B.S.P. in relation to the core site (Plate XXXIX). From the photographs of the one meter quadrat it is seen that a natural record of plant distribution in the area exists (Plate II); also it is observed that the site overlies the deepest part of the transect (Plate XL).

CHAPTER III

DEVELOPMENT OF METHOD FOR PEAT INVESTIGATION

A peat core sample, measuring 7.1 meters, was extracted from the selected area. The core site lies in a depression between the hummocks that vary from three inches to nine inches in height (Plate XXXVII). The core was extracted by means of a Hiller borer (17, 18, 19, 32) on September 30, 1959, at a time when most of the small visible pools of water in the depression had disappeared below the surface mat of *Sphagna*.

No peat samples could be extracted with the Hiller borer from the first 35 cm. on account of the high percentage of water in the peat. Thus the actual record for the peat samples starts at 35 cm. below the surface and extends to a depth of 7.45 meters.

The peat was extracted in 50 cm. increments. To minimize the danger of error being introduced by overlapping increments, the 50 cm. depth markings on the borer were always aligned with the surface of the visible water-table. The chamber of the borer holding the 50 cm. increment of peat is 2.54 cm. or 1 inch in diameter and has markings every 10 cm.. Each 10 cm. of peat was extracted and wrapped in absorbent paper with the depth in relation to the surface marked on the paper. The samples were gathered together in one meter lots and taken to the laboratory for analysis.

In conjunction with the extraction of the core, a collection was made of the conspicuous plants on the bog. This collection was considered necessary in order to have standard cuticle reference during the analysis of the peat samples.

To separate the cuticles from peat in which cuticles proved to be present, a method is required that is sufficient to dissolve away the adhering matrix, yet not strong enough to alter the cuticular material.

Such a method is possible when concentrated nitric acid and potassium chlorate are used along with ammonia. This macerating agent has been used by Harris (23) and others for the separation of cuticular material from fossiliferous rocks. As far as is known, it has not been applied to peat or post-glacial fossiliferous deposits with the intention of isolating the cuticular material.

Preceding the maceration of the peat core samples, was a number of trials that determined the duration of treatments and quantities of concentrated nitric acid, potassium chlorate and ammonia to be used. It was found that approximately 0.5 gm. of peat with a pinch of potassium chlorate and 5 ml. of concentrated nitric acid required three hours of treatment in the fume cupboard at room temperature with occasional stirring. After three hours the treated peat was washed twice with water and then 5 ml. of ammonia was added for five minutes. The following procedure was used throughout the investigation for the extraction of cuticular material.

Each 10 cm. sample was unwrapped and the direction and depth from the surface noted. The sample was then weighed and its length and breadth measured. This was necessary as shrinkage had occurred and the measurements gave an approximate idea of the extent of contraction.
Each sample was divided into four equal parts, representing 2.5 cm. of the original material. Each quarter was weighed and its sides shaven until a

central core of uncontaminated peat varying from 0.1 to 0.9 gm. remained. The leaves of the conspicuous plants of the bog needed no preliminary preparation unless they were too large to be subjected to the above treatment. When this was the case, for example, with Typha and the sedges, 1 cm. portions of the leaves were cut and prepared for treatment.

The prepared samples were placed in appropriately marked test-tubes to which was added a pinch of potassium chlorate and 5 ml. concentrated nitric acid.

The test tubes were then placed in a fume cupboard for three hours. Occasional stirring was required as it tended to prevent the accumulation of the peaty material in the foam resulting from the reaction. It also ensured that the material was continually exposed to the reactive chemicals.

After three hours the solution was removed from the fume cupboard and diluted with distilled water. The solution was placed in centrifuge tubes, which were balanced and then centrifuged for approximately five minutes. Following this, the residue was retained and washed with water made slightly alkaline with ammonia to reduce the washing period and shorten the procedure; after which, the solution was centrifuged.

To the residue was added approximately 5 ml. concentrated ammonia. Upon stirring a black gelatinous solution resulted which was left to settle for approximately five minutes. Water was then added to dilute the solution and at the same time balance the tube for centrifugation. The resultant residue was washed first with slightly acidified water to hasten the return to neutrality, and then with distilled water. The residue was retained in both cases after centrifugation. After the second washing, distilled water was added and the contents shaken by hand. The test-tube was then placed in a test-tube rack and the suspension allowed to settle overnight.

After the residue had settled the liquid portion was discarded. The cuticular material was placed in a flat-bottomed glass dish (18 cm. diam.) and examined under a low-power binocular microscope (30X).

At this point, the cuticle from the conspicuous plants on the bog were placed on a clean glass slide (3" x 1"), properly labelled and allowed to dry on a slide warmer at 37°C.

The prominent cuticles from the treated peat samples, were separated manually and placed upon a slide with approximately 1 ml. of the small cuticular debris selected at random with an eye dropper. The slide was then labelled with the depth and date marked upon it and placed on the slide warmer at 37°C. Each slide when dry was placed in a slide cabinet for storage until use.

Very little preparation was required for the leaves of the standard reference sources before they were subjected to chemical treatment. As noted the only preparation was the cutting of leaves too large for the test-tube into 1 cm^2. In the following list of the 23 species used as standards, those species whose leaves were cut into 1 cm^2. are listed separately.

Leaves cut into 1cm^2

1. *Salix* spp.
2. *Typha latifolia* L.
3. *Ilex verticillata* (L.) Gray.
4. *Cornus stolonifera* Michx.
5. *Chamaedaphne calyculata* (L.) Moench.
6. *Ledum groenlandicum* L.

7. *Vaccinium corymbosum* L.

8. *Andromeda glaucophylla* Link.

9. *Carex,* spp.

10. *Scirpus* spp.

11. *Eriophorum angustifolium* Honckeny.

12. *Dulichium arundinaceum* (L.) Britt.

13. *Juncus canadensis* J. Gray.

14. *Iris versicolor* L.

15. *Woodwardia virginica* L.

16. *Sarracenia purpurea* L.

17. *Calla palustris* L.

Leaves untouched.

18. *Picea mariana* (Mill.) B.S.P.

19. *Larix laricina* (Du Roi.) K. Koch.

20. *Pinus Strobus* L.

21. *Vaccinium Oxycoccos* L.

22. *Drosera rotundifolia* L.

23. *Sphagnum palustre* L.

The 23 slides containing the standard reference cuticles were examined under a binocular microscope with a 10X ocular, using transmitted and reflected light. With transmitted light, a 10x objective was used for observation and photomicrography. For reflected light, 10x and 22x Zeiss Ultrapak objectives were used together with the same 10x ocular for observation and some photomicrography.

A precursory examination of the 23 slides revealed that distinctive morphological differences exist between the cuticles. However despite these differences it was noticed that groups of cuticles had certain features in common, and by listing them it was possible to organize the 23 cuticles into a number of groups. The four different features and the various combinations of them helped to differentiate each group from the other. These four features are now discussed in detail.

The outline of the underlying epidermal cells, patterned on the cuticle, was the first outstanding feature observed under the microscope. It should be emphasised at this point that where mention is made to such features as cell outline, cell shape, and cell wall, reference is really being made to the impression of such features upon the cuticle by the underlying epidermal cells. This pattern was classified as being either regular or irregular. If regular, the individual cell outlines are in even rows with each cell approximately the same size, and in addition the spatial arrangement of the cells in the rows regularly alternate with one another. For irregular, no organized pattern exists. In other words, the cells are joined or in contact with each other in random assortment. The individual cell outlines are also noted under this feature, where they are classified as either rectangular, polygonal, circular or contorted. However, there are exceptions to these group outlines; for instance, the cell outline of Larix laricina (Du Roi.) K. Koch.is almost rectangular in shape, but has tapering ends.(Plate 111Fig. 2). There are also a few cuticles whose cell outline patterns if any, are hard to distinguish. This is particularly evident in the cuticles of Drosera rotundifolia L. (PlateX111Fig. 2) and Calla palustris L. (Plate XV Fig. 2).

Further study of the cell outline pattern revealed the second feature, which was the form or shape of the individual cell wall.

The most noticeable of all the cell wall configurations impressed upon the cuticle are those that possess a distinct ripple or wave-like shape (Plate XV Fig. 1) However, the majority of cell walls observed exist as straight lines between two corners of the cell (Plate X, Xl, Xlll). In other cell outlines, the cell walls are neither wavy nor straight but circular (Plate IV Fig. 2).

The third feature is based on the variety of positions that the stomata can assume. When present they may be in a single row or a number of rows side by side. They can also be scattered throughout the cuticle at random. Sometimes a loosely organized state is found where a row or series of rows may have the stomata separated from each other by a varying number of intervening cells. In certain species no stomata have been observed in the cuticles, (Plate lll Fig. 2 PlateXVl Fig. 1) However this appears to be rather exceptional. It should be mentioned at this point that the distribution of stomata in the majority of cases is usually confined to the cuticles from the lower epidermis of the leaf. This can be illustrated with reference to the cuticles of the upper and lower epidermis of Vaccinium Oxycoccos L. (Plate Vlll Fig.2) Thus, where stomatal features are concerned it is mostly the cuticle from the lower epidermis that is involved.

Perhaps the most fruitful criteria for diagnosis are those inherent characteristics of the cuticle that occur in addition to the above mentioned features. Examples are to be found in protrusions on the surfaces of cuticles from Chamaedaphne calyculata (L.) Moench (Plate Vll Fig. 1) and Sarracenia purpurea L. (PlateXlV Fig.1), Other peculiarities such as the presence of trichomes in the lower epidermal cuticle (Plate VIII Fig. 1), the spacing of the rows of stomata (Plate X Fig. 2), the striations and pitting in the cell outline (Plate XIII Fig. 1 Plate XIII Fig. 1), are all diagnostic features that aid in the identification of the cuticle.

The grouping of the isolated cuticles from the peat in some semblance of order by utilizing the features just mentioned, involved some difficulty in interpretation. For, if the diagnostic features are used alone, then the exceptions that occur in each group tend to confuse the system. To overcome this difficulty it was decided to combine the diagnostic features with the life-form of the individual plants. Thus by this method, the plants are grouped together by similarities of life-form but described according to the morphological features of the cuticles. This resulted in six groupings from the 23 genera and species involved.

The first group is the Conifers. They are characterized by regularly alternating, rectangular cell shapes with wavy cell wall outlines. The overall cuticle is thick. The exception to this group is Larix laricina (Du Roi.) K. Koch. with an irregular pattern composed of modified rectangular cells with tapering ends and possessing cell walls that are straight or slightly curved. No stomatal openings have been observed on the isolated cuticles (Plate III Fig. 2).

The second group is composed mostly of shrubs. It is characterized by cuticles with an irregular cell outline pattern; the cells of which vary in shape being either polygonal, circular or contorted. The stomata are dispersed at random, mostly throughout the lower epidermis. There are two peculiarities of this group that should be mentioned, since they are of diagnostic value. One peculiarity is found in Cornus stolonifera Michx. where the cell walls have noticeable swellings

(Plate V Fig. 1). The other is found in the leaves of Vaccinium corymbosum L. which have a clearly defined midrib of irregular rectangular shaped cells, the remainder being polygonal (Plate VI Fig. 1). Vaccinium corymbosum L. is a member of the Ericaceae and should be placed in the Ericoid group, but because of its shrub-like stature it is included under the shrubs.

All members of the third group belong to the Ericaceae. The cuticles are characterized by having an irregular cell outline pattern with the individual cells having a circular outline. All the cell walls possess a distinct rippling or wave-like shape (Plate VII, VIII). The stomata are distributed at random and such peculiarities as a granular appearance, pitting in the cell outline, and the distribution of trichomes upon the lower epidermal cuticle help differentiate the group.

Most of the members of the fourth group belong to the Cyperaceae or True Sedges. The cuticles from the Cyperaceae when examined, appear to possess a regular alternating cell pattern composed of rectangular-shaped cells. The cell walls at first glance appear to be straight but upon further examination a slight ripple is observed. The stomata occur in loosely assorted rows with the individual stoma separated from each other by a varying number of epidermal cells. The distance between rows appears to be diagnostic for certain genera. Included in the group are two plants that agree with the Cyperaceae only in life-form. They are sedge-like in appearance but differ in the cell pattern and stomatal arrangement. The cuticle of Typha latifolia L. has two types of cells; one type is circular and the other polygonal (Plate XIII Fig.2), the cell wall outline being either round or straight. The stomata are distributed at random only throughout the polygonal shaped cells; none being found amongst the circular. The second plant is *Iris versicolor* L. with an irregular cell pattern composed of modified rectangular cells. Peculiar to these cells are striations that are perpendicular to the long axis of the cell (Plate XIII, Fig. 1).

The fifth group consists of a varied assortment of herbs and herb-like plants. They all possess an irregular cell pattern. The individual cell shapes have no regular geometric form, although in those cells with wavy cell walls, the cell outline does tend to be circular. Similarly the cell walls are either wavy or indistinct. Stomata, where they do occur, are distributed at random. Peculiarities help to distonguish this group. In *Woodwardia virginica* L. two peculiarities have been noted; the wavy cell wall outlines are thickly ridged (Plate XV, Fig. 1) and peculiar openings are found in the cuticle surrounded by cells with straight cell walls. In another cuticle with wave-like cell walls - *Sarracenia purpurea* L., small knobs of cuticular material are dotted across the cuticle surface (Plate XIV). In *Calla palustris* L. numerous cracks and disc-shaped protrusions of cuticular materials can be observed (Plate XV, Fig. 2). With *Drosera rotundifolia* L. the cuticles from the gland bearing bristles set it apart from the others. (Plate XIII, Fig. 2).

The sixth or last group is composed of Mosses. The predominant mosses on the Copetown bog are the Sphagnaceae. The particular species that is suspected of being predominant in the central portion of the Copetown bog is *Sphagnum palustre* L. (Plate XVI, Fig. 1). (The structure of their leaves differs from that of the other mosses). The size and shape of the leaves without midribs tend to set the mosses apart from the other groups. The two kinds of leaves present in *Sphagnum* are the branch and stem leaves. Both have the same type of cell structure consisting of very large:

> "hyaline rhomboidal or elliptical cells with the walls spirally thickened and often perforated by round pores, and the true chlorophyllose cells, which are narrow and elongated and lie between the other." (21).

However both the stem and branch leaves differ in their overall shape, and for a detailed distinction between the two, reference should be made to Bodenberg's book Moss Identification (3).

Typical of most of the Sphagnaceae are the cortical cells of which all except the Cymbifolia group have spiral fibrils.

The above mentioned groups with their combinations of features are summarized in Table I.

The details involved in the preparation of the core samples for chemical analysis have been mentioned previously. The recording of data from this preparation was considered necessary since it shows the amount of shrinkage of samples that occurred during storage as well as the actual weight of peat subjected to maceration.

The data are summarized in Table 2.

The prepared slides of cuticular material were examined using transmitted and reflected light. Photomicrographs were taken using the transmitted light and occasionally with reflected light. The interpretation of cuticular material posed some difficulties. These were mainly overcome by deciding to count all the individual cuticular material on the slides. The counting of the recognizable cuticles was distributed amongst the six different groups obtained from the examination of standard cuticles. In addition two more groups were added to bring the total to eight groups. In the first group were placed such things as seeds, fragments of wood, stems, etc. and in the other any unknown cuticular object. Thus, the cuticular material from the prepared slides is divided amongst the eight groups listed below in Table 3.

TABLE 1.

GROUPS DERIVED FROM STANDARD CUTICULAR FEATURES

Species or Genera	Group	Cell Outline Pattern	Shape of Cell-wall	Arrangement of Stomata	Individual Characteristics
Picea mariana	Conifer	Regular, Rectang.	Wavy	4 rows, close.	Thick, granular.
Pinus Strobus	Conifer	Regular, Rectang.	Slightly Wavy.	1 row, close.	Thick, granular.
Larix laricina	Conifer	Irregular, Rectang.	Straight	None observed.	Thin, clear.
Salix spp.	Shrub	Irregular, Polygonal.	Straight.	Random.	Medium thick.
Ilex verticillata	Shrub	Irregular, Circular.	Circular.	Random.	Medium thick.
Cornus stolonifera	Shrub	Irregular Contorted.	Indistinct.	Random.	Swellings on cell-wall.
Vaccinium corymbosum	Shrub	Irregular, Polygonal.	Straight.	Random.	Upper cuticle granular. Lower clear.
Chamaedaphne calyculata	Ericoid	Irregular, Contorted.	Wavy.	Random.	Granular protrusions from cuticle.
Ledum groenlandicum	Ericoid	Irregular, Contorted.	Indistinct.	Random.	Pitting upper cuticle, Trichomes lower cuticle.
Vaccinium Oxycoccos	Ericoid	Irregular, Contorted.	Wavy.	Random.	Stomata numerous in lower cuticle.
Andromeda glaucophylla	Ericoid	Irregular, Contorted.	Wavy.	Random.	Few trichomes attached mid-rib.
Carex spp.	Sedge-like	Regular, Rectang.	Wavy.	Single rows far apart.	Spacing between Stomata and Cells Irregular.
Scirpus spp.	Sedge-like	Regular, Rectang.	Wavy.	6 rows, close.	Approx. 6 rows cells between banks stomata.

TABLE 1 (continued)

Species or Genera	Group	Cell Outline Pattern	Shape of Cell-wall	Arrange-ment of Stomata	Individual Characteristics
Eriophorum angustifolium	Sedge-like	Regular, Rectang.	Wavy.	3 rows, Irregular.	Spacing Irregular.
Juncus canadensis	Sedge-like	Regular, Rectang.	Wavy.	Indistinct rows.	Stomata separated well-defined ribs.
Dulichium arundinaceum	Sedge-like	Regular, Rectang.	Wavy.	3 rows Irregular.	Spacing Irregular
Typha latifolia	Sedge-like	Irregular, Polygonal.	Circular & straight.	Random.	Ribs composed of of circular cells.
Iris versicolor	Sedge-like	Irregular, Rectang.	Elongated.	Random.	Perpendicular striations in cell outline.
Woodwardia virginica	Herb	Irregular, Contorted.	Wavy.	-	Thickly ridged cells.
Sarracenia purpurea	Herb	Irregular, Contorted.	Wavy.	Random.	Pecular protrusions.
Drosera rotundifolia	Herb	Irregular, Contorted.	Indistinct.	Random.	Terminal glandular bristles.
Calla palustris	Herb	Irregular, Contorted.	Indistinct.	Random.	Cracks in cuticle.
Sphagnum palustre	Moss	Regular, Contorted.	Wavy	-	Strands across cell outline.

TABLE 2.

PHYSICAL DATA OF SAMPLES BEFORE TREATMENT

Number of slide	Depth m.	Measurements of 10 cm. sample: Weight gm.	Length cm.	Breadth cm.	Weight of ½ section: Untreated gm.	to be treated gm.	Weight retained gm.
1	0.35-0.375	4	6	2	1.2	0.6	0.6
2	0.375-0.40	4	6	2	1.2	0.9	0.3
3	0.4-0.425	4	5.5	2	0.7	0.2	0.5
4	0.425-0.450	4	5.5	2	0.9	0.5	0.4
5	0.45-0.475	4	5.5	2	1.5	0.6	0.9
6	0.475-0.5	4	5.5	2	0.9	0.5	0.4
7	0.5-0.525	4	5.5	1.5	0.9	0.5	0.4
8	0.525-0.55	4	5.5	1.5	0.7	0.4	0.3
9	0.55-0.575	4	5.5	1.5	1.2	0.7	0.5
10	0.575-0.6	4	5.5	1.5	1	1.0	-
11	0.6-0.625	2	5	2	0.4	0.2	0.2
12	0.625-0.65	2	5	2	0.7	0.4	0.3
13	0.65-0.675	2	5	2	0.6	0.4	0.2
14	0.675-0.7	2	5	2	0.4	0.2	0.2
15	0.7-0.725	1	10	1.5	0.2	0.1	0.1
16	0.725-0.75	1	10	1.5	0.2	0.1	0.1
17	0.75-0.775	1	10	1.5	0.3	0.1	0.2
18	0.775-0.8	1	10	1.5	0.3	0.1	0.2
19	0.8-0.825	1.7	8	3	0.5	0.3	0.2
20	.825-0.850	1.7	8	3	0.4	0.2	0.2

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm. sample Weight gm.	Length cm.	Breadth cm.	Weight of ½ section Untreated gm.	to be treated gm.	Weight retained gm.
21	.850-.875	1.7	8	3	0.5	0.2	0.3
22	.875-.9	1.7	8	3	0.4	0.2	0.2
23	0.9-.925	2	5	1.5	0.3	0.1	0.2
24	.925-.95	2	5	1.5	0.5	0.3	0.2
25	.95-.975	2	5	1.5	0.8	0.4	0.4
26	.975-1.0	2	5	1.5	0.4	0.4	-
27	1.0-1.025	3.3	6	2	0.7	0.3	0.4
28	1.025-1.05	3.3	6	2	1.0	0.5	0.5
29	1.05-1.075	3.3	6	2	0.9	0.5	0.4
30	1.075-1.1	3.3	6	2	0.9	0.4	0.5
31	1.1-1.125	3.2	6	1.5	0.8	0.4	0.4
32	1.125-1.15	3.2	6	1.5	0.7	0.3	0.4
33	1.15-1.175	3.2	6	1.5	0.9	0.5	0.4
34	1.175-1.2	3.2	6	1.5	1.0	0.6	0.4
35	1.2-1.225	3	5	2	0.7	0.3	0.4
36	1.225-1.25	3	5	2	0.9	0.6	0.3
37	1.25-1.275	3	5	2	0.9	0.5	0.4
38	1.275-1.3	3	5	2	0.7	0.3	0.4
39	1.3-1.325	3.1	5.5	2	0.3	0.1	0.2
40	1.325-1.35	3.1	5.5	2	0.8	0.4	0.4
41	1.35-1.375	3.1	5.5	2	0.9	0.5	0.4

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm. sample Weight gm.	Length cm.	Breadth cm.	Weight of ½ section Untreated gm.	to be treated gm.	Weight retained gm.
42	1.375-1.4	3.1	5.5	2	1.1	0.6	0.5
43	1.4-1.425	2.3	5.5	1.5	0.6	0.3	0.3
44	1.425-1.45	2.3	5.5	1.5	0.6	0.4	0.2
45	1.45-1.475	2.3	5.5	1.5	0.6	0.3	0.3
46	1.475-1.5	2.3	5.5	1.5	0.3	0.2	0.1
47	1.5-1.525	2.8	5	2	0.6	0.2	0.4
48	1.525-1.55	2.8	5	2	0.8	0.3	0.5
49	1.55-1.575	2.8	5	2	0.6	0.3	0.3
50	1.575-1.6	2.8	5	2	0.7	0.4	0.3
51	1.6-1.625	2.4	5.5	2	0.6	0.3	0.3
52	1.625-1.65	2.4	5.5	2	0.7	0.2	0.5
53	1.65-1.675	2.4	5.5	2	0.5	0.3	0.2
54	1.675-1.7	2.4	5.5	2	0.4	0.2	0.2
55	1.7-1.725	2.5	5	1.5	0.6	0.3	0.3
56	1.725-1.75	2.5	5	1.5	0.5	0.2	0.3
57	1.75-1.775	2.5	5	1.5	0.7	0.3	0.4
58	1.775-1.8	2.5	5	1.5	0.8	0.4	0.4
59	1.8-1.825	2.3	5	1.5	0.3	0.1	0.2
60	1.825-1.85	2.3	5	1.5	0.5	0.4	0.1
61	1.85-1.875	2.3	5	1.5	1.0	0.5	0.5
62	1.875-1.9	2.3	5	1.5	0.5	0.2	0.3
63	1.9-1.925	2.5	6	2	0.7	0.4	0.3

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm. sample: Weight gm.	Length cm.	Breadth cm.	Weight of $\frac{1}{4}$ section: Untreated gm.	to be treated gm.	Weight retained gm.
64	1.925-1.95	2.5	6	2	4.5	0.2	4.3
65	1.95-1.975	2.5	6	2	0.7	0.4	0.3
66	1.975-2.0	2.5	6	2	0.5	0.2	0.3
67	2.000-2.025	2.2	4	1.5	0.3	0.1	0.2
68	2.025-2.05	2.2	4	1.5	0.6	0.4	0.2
69	2.05-2.075	2.2	4	1.5	0.7	0.4	0.3
70	2.075-2.1	2.2	4	1.5	0.6	0.4	0.2
71	2.1-2.125	3.1	6	2	0.5	0.2	0.3
72	2.125-2.15	3.1	6	2	0.8	0.4	0.4
73	2.15-2.175	3.1	6	2	0.8	0.4	0.4
74	2.175-2.2	3.1	6	2	0.9	0.4	0.5
75	2.2-2.225	2.7	5.5	1.5	0.7	0.4	0.3
76	2.225-2.25	2.7	5.5	1.5	0.9	0.5	0.4
77	2.25-2.275	2.7	5.5	1.5	0.6	0.3	0.3
78	2.275-2.3	2.7	5.5	1.5	0.6	0.3	0.3
79	2.3-2.325	2.3	5	2	0.4	0.2	0.2
80	2.325-2.35	2.3	5	2	0.8	0.5	0.3
81	2,35-2.375	2.3	5	2	0.6	0.4	0.2
82	2.375-2.4	2.3	5	2	0.5	0.2	0.3
83	2.4-2.425	1.4	6	2	0.3	0.1	0.2
84	2.425-2.45	1.4	6	2	0.4	0.2	0.2
85	2.45-2.475	1.4	6	2	0.4	0.2	0.2

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ½ section: Untreated gm.	to be treated gm.	Weight retained gm.
86	2.475-2.5	1.4	6	2	0.3	0.2	0.1
87	2.5-2.525	2.8	7	2	0.7	0.4	0.3
88	2.525-2.55	2.8	7	2	0.8	0.4	0.4
89	2.55-2.575	2.8	7	2	0.6	0.4	0.2
90	2.575-2.6	2.8	7	2	0.7	0.3	0.4
91	2.6-2.625	2.6	5	2	0.6	0.3	0.3
92	2.625-2.65	2.6	5	2	0.4	0.2	0.2
93	2.65-2.675	2.6	5	2	0.9	0.5	0.4
94	2.675-2.7	2.6	5	2	0.6	0.4	0.2
95	2.7-2.725	1.8	6	2	0.4	0.3	0.1
96	2.725-2.75	1.8	6	2	0.4	0.2	0.2
97	2.75-2.775	1.8	6	2	0.6	0.3	0.3
98	2.775-2.8	1.8	6	2	0.5	0.3	0.2
99	2.8-2.825	1	8	1.5	0.3	0.1	0.2
100	2.825-2.85	1	8	1.5	0.3	0.2	0.2
101	2.85-2.875	1	8	1.5	0.3	0.2	0.2
102	2.875-2.9	1	8	1.5	0.2	0.1	0.1
103	2.9-2.925	1.5	7	3	0.3	0.2	0.1
104	2.925-2.95	1.5	7	3	0.5	0.3	0.2
105	2.95-2.975	1.5	7	3	0.4	0.3	0.1
106	2.975-3.00	1.5	7	3	0.4	0.2	0.2
107	3.0-3.025	2.6	5	2	0.5	0.2	0.3

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ¼ section: Untreated gm.	to be treated gm.	Weight retained gm.
108	3.025-3.05	2.6	5	2	0.7	0.4	0.3
109	3.05-3.075	2.6	5	2	0.7	0.4	0.3
110	3.075-3.1	2.6	5	2	0.6	0.4	0.2
111	3.1-3.125	3.8	5.5	3	0.6	0.3	0.3
112	3.125-3.15	3.8	5.5	3	1.3	0.6	0.3
113	3.15-3.175	3.8	5.5	3	1.0	0.5	0.5
114	3.175-3.2	3.8	5.5	3	0.9	0.4	0.5
115	3.2-3.225	3.1	7	2.5	0.6	0.3	0.3
116	3.225-3.25	3.1	7	2.5	0.6	0.2	0.4
117	3.25-3.275	3.1	7	2.5	1.1	0.5	0.6
118	3.275-3.3	3.1	7	2.5	0.7	0.3	0.4
119	3.3-3.325	3	5	3	0.5	0.3	0.2
120	3.325-3.35	3	5	3	1.9	0.6	0.3
121	3.35-3.375	3	5	3	0.8	0.5	0.3
122	3.375-3.4	3	5	3	0.7	0.4	0.3
123	3.4-3.425	2.4	6	2	0.5	0.2	0.3
124	3.425-3.45	2.4	6	2	0.7	0.4	0.3
125	3.45-3.475	2.4	6	2	0.5	0.3	0.2
126	3.475-3.5	2.4	6	2	0.6	0.3	0.3
127	3.5-3.525	2.9	6	2.5	0.5	0.2	0.3
128	3.525-3.55	2.9	6	2.5	0.8	0.4	0.4
129	3.55-3.575	2.9	6	2.5	0.8	0.5	0.3

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ½ section: Untreated gm.	to be treated gm.	Weight retained gm.
130	3.575-3.6	2.9	6	2.5	0.5	0.4	0.1
131	3.6-3.625	3.6	5.5	2	0.8	0.5	0.3
132	3.625-3.65	3.6	5.5	2	0.9	0.4	0.5
133	3.65-3.675	3.6	5.5	2	1.0	0.5	0.5
134	3.675-3.7	3.6	5.5	2	0.8	0.4	0.4
135	3.7-3.725	3.7	5.5	2.5	0.8	0.4	0.4
136	3.725-3.75	3.7	5.5	2.5	0.9	0.3	0.6
137	3.75-3.775	3.7	5.5	2.5	0.9	0.4	0.5
138	3.775-3.8	3.7	5.5	2.5	0.8	0.5	0.3
139	3.8-3.825	3.3	6	3	0.8	0.6	0.2
140	3.825-3.85	3.3	6	3	1.1	0.5	0.6
141	3.85-3.875	3.3	6	3	0.8	0.4	0.4
142	3.875-3.9	3.3	6	3	0.5	0.3	0.2
143	3.9-3.925	1.8	8	1	0.3	0.1	0.2
144	3.925-3.95	1.8	8	1	0.7	0.3	0.4
145	3.95-3.975	1.8	8	1	0.5	0.2	0.3
146	3.975-4.0	1.8	8	1	0.3	0.1	0.2
147	4.0-4.025	2.2	5	3	0.6	0.3	0.3
148	4.025-4.05	2.2	5	3	0.6	0.4	0.2
149	4.05-4.075	2.2	5	3	0.5	0.3	0.2
150	4.075-4.1	2.2	5	3	0.3	0.2	0.1
151	4.1-4.125	1.8	6.5	2	0.4	0.2	0.2

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ¼ section: Untreated gm.	to be treated gm.	Weight retained gm.
152	4.125-4.15	1.8	6.5	2	0.4	0.2	0.2
153	4.15-4.175	1.8	6.5	2	0.5	0.3	0.2
154	4.175-4.2	1.8	6.5	2	0.3	0.2	0.1
155	4.2-4.225	1.2	8	2	0.2	0.1	0.1
156	4.225-4.25	1.2	8	2	0.4	0.2	0.2
157	4.25-4.275	1.2	8	2	0.3	0.1	0.2
158	4.275-4.3	1.2	8	2	0.3	0.2	0.1
159	4.3-4.325	1.3	7	1	0.2	0.1	0.1
160	4.325-4.35	1.3	7	1	0.3	0.2	0.1
161	4.35-4.375	1.3	7	1	0.4	0.3	0.1
162	4.375-4.4	1.3	7	1	0.3	0.2	0.1
163	4.4-4.425	2	7	2	0.4	0.3	0.1
164	4.425-4.45	2	7	2	0.5	0.3	0.2
165	4.45-4.475	2	7	2	0.6	0.3	0.3
166	4.475-4.5	2	7	2	0.3	0.1	0.2
167	4.5-4.525	4.7	5.5	3	0.7	0.3	0.4
168	4.525-4.55	4.7	5.5	3	1.2	0.4	0.8
169	4.55-4.575	4.7	5.5	3	1.4	0.8	0.6
170	4.575-4.6	4.7	5.5	3	1.3	0.5	0.8
171	4.6-4.625	4	6	2	0.7	0.3	0.4
172	4.625-4.65	4	6	3	1.0	0.5	0.5
173	4.65-4.675	4	6	3	0.9	0.4	0.5

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ½ section: Untreated gm.	to be treated gm.	Weight retained gm.
174	4.675-4.7	4	6	3	1.0	0.4	0.6
175	4.7-4.725	3.1	5	2	0.7	0.4	0.3
176	4.725-4.75	3.1	5	2	0.8	0.4	0.4
177	4.75-4.775	3.1	5	2	0.8	0.4	0.4
178	4.775-4.8	3.1	5	2	0.7	0.3	0.4
179	4.8-4.825	2.6	6	2	0.7	0.3	0.4
180	4.825-4.85	2.6	6	2	0.8	0.3	0.5
181	4.85-4.875	2.6	6	2	0.6	0.3	0.3
182	4.875-4.9	2.6	6	2	0.5	0.2	0.3
183	4.9-4.925	1.3	6	2	0.3	0.2	0.1
184	4.925-4.95	1.3	6	2	0.4	0.2	0.2
185	4.95-4.975	1.3	6	2	0.3	0.2	0.1
186	4.975-5.00	1.3	6	2	0.2	0.1	0.1
187	5.0-5.025	2.3	5	2	0.5	0.2	0.3
188	5.025-5.05	2.3	5	2	0.6	0.3	0.3
189	5.05-5.075	2.3	5	2	0.7	0.3	0.4
190	5.075-5.1	2.3	5	2	0.4	0.2	0.2
191	5.1-5.125	3.1	7	3	0.5	0.2	0.3
192	5.125-5.15	3.1	7	3	0.7	0.3	0.4
193	5.15-5.175	3.1	7	3	0.9	0.3	0.6
194	5.175-5.2	3.1	7	3	0.9	0.5	0.4
195	5.2-5.225	2.3	7	2	0.6	0.2	0.4

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ½ section: Untreated gm.	to be treated gm.	Weight retained gm.
196	5.225-5.25	2.3	7	2	0.6	0.2	0.4
197	5.25-5.275	2.3	7	2	0.6	0.2	0.4
198	5.275-5.3	2.3	7	2	0.4	0.2	0.2
199	5.3-5.325	2.7	7	2	0.5	0.3	0.2
200	5.325-5.35	2.7	7	2	0.8	0.4	0.4
201	5.35-5.375	2.7	7	2	0.6	0.3	0.3
202	5.375-5.4	2.7	7	2	0.7	0.3	0.4
203	5.4-5.425	2.4	8	1	0.5	0.3	0.2
204	5.425-5.45	2.4	8	1	0.8	0.4	0.4
205	5.45-5.475	2.4	8	1	0.6	0.3	0.3
206	5.475-5.5	2.4	8	1	0.3	0.1	0.2
207	5.5-5.525	2.5	6	1.5	0.4	0.2	0.2
208	5.525-5.55	2.5	6	1.5	0.7	0.3	0.4
209	5.55-5.575	2.5	6	1.5	0.7	0.4	0.3
210	5.575-5.6	2.5	6	1.5	0.6	0.3	0.3
211	5.6-5.625	2.9	6	2	0.9	0.4	0.5
212	5.625-5.65	2.9	6	2	0.9	0.3	0.6
213	5.65-5.675	2.9	6	2	0.6	0.3	0.3
214	5.675-5.7	2.9	6	2	0.5	0.2	0.3
215	5.7-5.725	2.4	7	2	0.5	0.2	0.3
216	5.725-5.75	2.4	7	2	0.9	0.4	0.5
217	5.75-5.775	2.4	7	2	0.6	0.3	0.3

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ⅓ section: Untreated gm.	to be treated gm.	Weight retained gm.
218	5.775-5.8	2.4	7	2	0.2	0.1	0.1
219	5.8-5.825	2	5	1.5	0.2	0.1	0.1
220	5.825-5.85	2	5	1.5	0.3	0.1	0.2
221	5.85-5.875	2	5	1.5	0.4	0.3	0.1
222	5.875-5.9	2	5	1.5	1.2	0.9	0.3
223	5.9-5.925	3	6	2	1.3	0.9	0.4
224	5.925-5.95	3	6	2	0.5	0.2	0.3
225	5.95-5.975	3	6	2	0.4	0.2	0.2
226	5.975-6.00	3	6	2	0.6	0.4	0.2
227	6.0-6.025	6.1	6	3	0.3	0.2	0.1
228	6.025-6.05	6.1	5	3	0.5	0.2	0.3
229	6.05-6.075	6.1	5	3	0.9	0.4	0.5
230	6.075-6.1	6.1	5	3	1.0	0.8	0.2
231	6.1-6.125	4.4	4	2	0.8	0.4	0.5
232	6.125-6.15	4.4	4	2	0.9	0.4	0.5
233	6.15-6.175	4.4	4	2	1.5	0.9	0.6
234	6.175-6.2	4.4	4	2	1.0	0.5	0.5
235	6.2-6.225	3.8	4	2	0.5	0.4	0.1
236	6.225-6.25	3.8	4	2	0.8	0.4	0.4
237	6.25-6.275	3.8	4	2	1.7	0.9	0.8
238	6.275-6.3	3.8	4	2	0.9	0.4	0.5
239	6.3-6.325	5.1	5	2	1.2	0.7	0.5

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ¼ section: Untreated gm.	to be treated gm.	Weight retained gm.
240	6.325-6.35	5.1	5	2	0.9	0.5	0.4
241	6.35-6.375	5.1	5	2	1.2	0.6	0.6
242	6.375-6.4	5.1	5	2	1.5	1.0	0.5
243	6.4-6.425	4.5	5.5	1	1.3	0.7	0.6
244	6.425-6.45	4.5	5.5	1	1.5	1.0	0.5
245	6.45-6.475	4.5	5.5	1	1.3	0.9	0.4
246	6.475-6.5	4.5	5.5	1	0.9	0.5	0.4
247	6.5-6.525	5.2	5	1	0.8	0.5	0.3
248	6.525-6.55	5.2	5	1	1.2	0.7	0.5
249	6.55-6.575	5.2	5	1	1.7	1.1	0.6
250	6.575-6.6	5.2	5	1	1.0	0.7	0.3
251	6.6-6.625	5.2	5.5	2	1.5	0.6	0.9
252	6.625-6.65	5.2	5.5	2	1.2	0.6	0.6
253	6.65-6.675	5.2	5.5	2	1.0	0.5	0.5
254	6.675-6.7	5.2	5.5	2	1.5	0.8	0.7
255	6.725-6.75	2.6	4	1	0.8	0.4	0.4
256	6.75-6.775	2.6	4	1	0.7	0.3	0.4
257	6.775-6.8	2.6	4	1	0.6	0.4	0.2
258	6.8-6.825	5.2	4	2	1.7	1.0	0.7
259	6.825-6.85	5.2	4	2	1.5	0.8	0.7
260	6.85-6.875	5.2	4	2	0.9	0.6	0.3
261	6.875-6.9	5.2	4	2	1.5	0.7	0.8
262	6.9-6.925	9.7	6	2	2.1	0.8	1.3

TABLE 2 (continued)

Number of slide	Depth m.	Measurements of 10 cm sample: Weight gm.	Length cm.	Breadth cm.	Weight of ¼ section: Untreated gm.	to be treated gm.	Weight retained gm.
263	6.925-6.95	9.7	6	2	3.4	0.9	2.5
264	6.95-6.975	9.7	6	2	1.8	0.8	1.0
265	6.975-7.0	9.7	6	2	2.6	1	2.5
266	7.00-7.025	3.7	4	1.5	1.0	0.8	0.2
267	7.025-7.05	3.7	4	1.5	1.0	0.8	0.2
268	7.05-7.075	3.7	4	1.5	1.0	0.9	0.1
269	7.075-7.1	3.7	4	1.5	0.5	0.4	0.1
270	7.1-7.125	3.9	5	1.5	0.7	0.6	0.1
271	7.125-7.15	3.9	5	1.5	0.9	0.7	0.2
272	7.15-7.175	3.9	5	1.5	1.2	1.1	0.1
273	7.175-7.2	3.9	5	1.5	1.2	1.0	0.2
274	7.2-7.285	4.5	4	1	1.2	1.1	0.1
275	7.225-7.25	4.5	4	1	1.4	1.3	0.1
276	7.25-7.275	3.5	4	1	0.7	0.5	0.2
277	7.275-7.3	4.5	4	1	0.9	0.8	0.1
278	7.3-7.325	6.7	4	1.5	1.3	1	0.3
279	7.325-7.35	6.7	4	1.5	2.1	1.7	0.4
280	7.35-7.375	6.7	4	1.5	1.5	0.9	0.6
281	7.375-7.4	6.7	4	1.5	1.7	1.5	0.2
282	7.4-7.425	8.3	4	2	1.7	1.5	0.2
283	7.425-7.45	8.3	4	2	3	2	1.0

TABLE 3

RECORD OF CUTICULAR FRAGMENTS SHOWING GROUPINGS, DEPTHS, COUNTS AND PERCENTAGE REPRESENTATION

Depth	Mosses				Ericoid		Sedge-like		Conifer		Unknown		Incidental		
	Sphagnum		Unknown										Wood	Stem	Seeds
m.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	No.
0.35-0.375	448	80.8			103	18.6	1	*			2	*	19	15	
0.375-0.4	169	50.8			150	45.0	10	3.1	1	*	3	*	11	33	
0.4-0.425	111	36.6			102	33.7	97	32.0			3	*	15	58	
0.425-0.45	350	53.4			155	23.6	92	14.0			59	8.9	10	51	
0.45-0.475	177	41.4			44	10.3	170	39.7			37	8.6	3	109	
0.475-0.5	172	56.2			77	25.2	31	10.1			26	8.5	9	77	
0.5-0.525	117	40.2			114	39.2	23	7.9			37	12.7	37	102	
0.525-0.55	473	72.3			87	13.3	48	7.3			46	7.0	28	252	
0.55-0.575	76	52.4			33	22.8	16	11.0			20	13.8	14	33	
0.575-0.6	119	60.0			57	28.5	5	2.5			19	9.5	5	68	
0.6-0.625	528	79.4			76	11.4	25	3.8			36	5.4	12	127	
0.625-0.65	533	88.7			32	5.3	20	3.3			16	2.7	4	111	
0.65-0.675	757	85.7			30	3.4	80	9.1			16	1.8	12	176	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
0.675-0.7	876	95.7			24	2.6	4	*			11	1.2	6	222	
0.7-0.725	297	67.8			94	21.5	37	8.4			10	2.3	6	99	
0.725-0.75	534	86.4			51	8.3	19	3.1	1	*	13	2.1	6	200	
0.75-0.775	784	88.0			60	6.7	25	2.8			22	2.5	2	276	
0.775-0.8	244	72.0			36	10.6	40	11.8			18	5.3	4	153	
0.8-0.825	569	72.5			85	10.8	49	6.2			83	10.3	11	292	
0.825-0.85	509	69.8			135	18.5	32	4.4			46	5.0	8	215	
0.85-0.875	399	55.2			160	22.1	21	2.9	133	18.4	10	*	1	102	
0.875-0.9	213	40.6			112	21.3	31	5.9	160	30.7	6	*	3	47	
0.9-0.925	281	41.8			154	22.9	44	6.5	181	26.9	9	*	3	73	
0.925-0.95	98	42.6			71	31.0	9	3.9	50	21.8	2	*	1	6	
0.95-0.975	130	62.2			49	23.4	11	5.2	16	7.6	1	*		18	
0.975-1.0	120	39.6			72	23.7	86	28.3	26	8.5	-	-		7	
1.0-1.025	155	62.7			79	31.9	1	*	11	4.4	1	*		27	
1.025-1.05	88	39.1			120	53.3	16	7.1	1	*				19	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	%	Mosses: Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental: Wood No.	Stem No.	Seeds No.
1.05-1.075	56	67.4			26	31.3	3	3.6						9	
1.075-1.1	199	80.5			46	18.6			1	*				12	
1.1-1.125	278	82.2			52	15.3	6	1.7	2	*				26	
1.125-1.15	216	76.0			54	19.0	2	*	3	*			9	17	
1.15-1.175	62	57.4			42	38.8	1	*	3	*				12	
1.175-1.2	135	75.4			40	22.3	2	*			1	*	1	11	
1.2-1.225	347	85.9			50	12.3	4				1	*		18	
1.225-1.25	300	75.4			98	24.6								15	
1.25-1.275	77	52.0			51	34.5	19	12.8			1	*		14	
1.275-1.3	215	62.8			114	33.3	10	2.9	2	*				14	
1.3-1.325	5	4.3			88	75.2	24	20.5						1	
1.325-1.35	52	35.0			80	54.0	14	9.4	1	*	1	*		14	
1.35-1.375	187	60.0			116	37.3	8	2.6	1	*				23	
1.375-1.4	322	72.2			123	27.5	1	*						17	
1.4-1.425	316	77.8			33	8.1	55	13.5			1	*		16	

TABLE 3 (continued)

Depth m.	Mosses				Ericoid		Sedge-like		Conifer		Unknown		Incidental		
	Sphagnum		Unknown										Wood	Stem	Seeds
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	No.
1.425-1.45	219	74.2			58	19.6	13	4.4	7	2.3				31	
1.45-1.475	156	75.7			33	16.0	14	6.8	3	*				11	
1.475-1.5	140	56.9			72	29.2	15	6.1	10	4.1			5		
1.5-1.525	23	26.4			56	64.4	8	9.1						7	
1.525-1.55	201	39.8			97	19.2	197	39.0	11	2.1				19	
1.55-1.575	284	64.8			145	33.1	7	1.5	1	*	2	*		28	
1.575-1.6	280	53.0			232	43.9	13	2.4	1	*	2	*		5	
1.6-1.625	118	63.7			49	26.5	18	9.7						3	
1.625-1.65	191	78.9			46	19.0	3	*	2	*				3	
1.65-1.675	381	79.4			108	22.3			1	*				3	
1.675-1.7	667	79.1			181	21.5	1	*	2	*	2	*		6	
1.7-1.725	241	71.1			96	28.3	1	*	1	*				12	
1.725-1.75	319	75.4			88	20.8	13	3.1	3	*				3	
1.75-1.775	347	59.1			94	16.1	137	23.3	5	*	1.	*	3	12	
1.775-1.8	339	78.1			84	19.3	4	*	2	*	1	*	3	27	

TABLE 3 (continued)

Depth m.	Mosses Sphagnum No.	%	Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Stem No.	Seeds No.
1.8-1.825	349	78.6			90	20.3	5	1.1						18	
1.825-1.85	426	91.4			30	6.4	9	1.9			1	*		12	
1.85-1.875	340	73.2			102	21.9	22	4.7						20	
1.875-1.9	407	74.2			126	22.9	16	2.9						11	
1.9-1.925	418	78.7			91	17.7	17	3.2	1	*	1	*	1	19	
1.925-1.95	79	84.9			6	6.4	6	6.4							
1.95-1.975	366	85.3			61	14.2	2	*						15	3
1.975-2.0	329	89.1			28	7.5	8	6.0			4	3.0		6	
2.0-2.025	254	80.6			57	18.1	2	*						5	
2.025-2.05	247	80.7			55	17.9	4	1.3						13	
2.05-2.075	249	70.1			92	25.9	12	3.3			1	*		14	
2.075-2.1	178	58.2			87	28.4	40	13.1						5	
2.1-2.125	408	85.3			64	13.3	6	1.2						23	
2.125-2.15	317	78.8			77	19.1	6	1.4			2	*		7	
2.15-2.175	378	76.9			92	18.7	22	4.5						15	

TABLE 3 (continued)

Depth m.	Mosses Sphagnum No.	%	Mosses Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Incidental Stem No.	Incidental Seeds No.
2.175-2.2	322	73.0			111	25.2	7	1.5			1	*		38	
2.2-2.225	249	65.7			84	22.9	43	11.3						24	
2.225-2.25	274	75.3			72	19.7	17	4.6						15	
2.25-2.275	361	84.7			54	12.6	10	2.3						28	
2.275-2.3	297	63.7			85	18.2	84	18						6	
2.3-2.325	393	91.2			31	7.2	14	3.2			1	*		15	
2.325-2.35	298	75.8			42	10.6	51	12.9						18	
2.35-2.375	280	72.7			70	18.2	37	9.6						16	
2.375-2.4	300	77.5			56	14.4	31	8						9	
2.4-2.425	155	52.5			4	7.3	138	46.5						2	
2.425-2.45	206	59.8			36	10.5	101	29.4			1	*		18	
2.45-2.475	211	61.5			31	9.0	101	24.0			1	*		10	
2.475-2.5	92	40.8			19	8.9	113	50.2			1	*		3	
2.5-2.525	324	62.8			119	23.1	73	14.1						10	
2.525-2.55	324	70.3			85	18.4	52	11.3						6	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
2.55-2.575	296	70.9			52	12.5	67	16			3	*		16	
2.575-2.6	135	62.5			14	6.5	68	31.5						7	
2.6-2.625	299	72.9			76	18.5	32	7.8			3	*		23	1
2.625-2.65	215	59.1			59	16.2	91	25						4	
2.65-2.675	209	61.1			81	23.6	52	15.2						9	
2.675-2.7	275	66.9			75	18.2	60	14.6			1	*		21	
2.7-2.725	249	69.9			48	13.5	58	16.2			1	*		18	
2.725-2.75	364	87.3			19	4.5	33	7.9						11	
2.75-2.775	369	77.8			69	14.5	16	3.5						20	
2.775-2.8	359	75.4			21	4.4	95	19.9			1	*		11	
2.8-2.825	105	75			30	21.4	4	2.8	1	*				3	
2.825-2.85	325	73.4			66	15.1	50	11.4			1	*		23	
2.85-2.875	59	19.9			55	18.6	182	61.5							
2.875-2.9	298	67.6			75	17.0	70	15.8						28	
2.9-2.925	200	62.9			48	15.1	68	21.3			1	*		7	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
2.925-2.95	216	64.6			48	14.3	70	20.9						13	
2.95-2.975	90	39.1			15	6.5	125	54.3						5	
2.975-3.0	205	76.5			44	16.4	19	7.1						15	
3.0-3.025	143	59.6			2	*	95	39.6							
3.025-3.05	169	85.8			8	4.0	20	10.1						14	
3.05-3.075	213	80.4			33	12.4	19	7.1						11	
3.075-3.1	288	80.9			50	14.0	18	5.0						19	
3.1-3.125	151	72.9			39	18.8	17	8.2						17	
3.125-3.15	145	58.0			84	33.6	22	8.8						14	
3.15-3.175	198	64.3			71	23.0	38	12.3			1	*		18	1
3.175-3.2	270	68.8			45	11.4	70	19.4			1	*		9	
3.2-3.225	244	66.8			49	13.4	80	19.1			2	*		16	
3.225-3.25	110	28.1			186	47.6	58	20.5			15	3.8		18	
3.25-3.275	227	52.7			141	32.8	126	13.5			4	*		11	
3.275-3.3	184	49.5			59	15.8	72	33.8			3	*		2	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
3.3-3.325	61	31.6			60	31.1	103	37.3						8	
3.325-3.35	194	58.1			36	10.7	103	30.8			1	*		8	2
3.35-3.375	144	56.0			38	14.7	76	29.3						9	
3.375-3.4	58	32.9			11	6.3	104	59.1			3	*		15	
3.4-3.425	55	25.5			32	14.8	126	58.3			2	*		3	
3.425-3.45	82	32.8			92	36.8	73	29.2			3	*		-	
3.45-3.475	119	21.3	261	46.7	115	20.6	61	10.9			2	*		16	
3.475-3.5	30	9.8	183	60.2	30	9.8	58	19.1			3	*		11	
3.5-3.525	14	9.3	56	37.3	19	12.6	59	39.3			2	*		7	
3.525-3.55	16	7.4	64	29.5	22	10.1	115	52.9						14	
3.55-3.575	33	12.7	42	16.2	11	4.2	172	66.4			1	*		4	4
3.575-3.6	39	15.5	61	24.3	34	13.5	113	45.1			5	2		8	
3.6-3.625	22	8.8	78	31.4	23	9.3	126	50.8							
3.625-3.65	21	8.5	67	27.0	44	17.7	116	46.7						3	6
3.65-3.675	23	7.0	203	62.3	9	2.8	93	28.4						6	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
3.675-3.7	11	4.9	96	42.8	66	29.4	51	22.7							3
3.7-3.725	11	4.8	117	51.1	41	17.9	58	25.3			2	*			2
3.725-3.75	4	1.8	80	37.7	106	50.0	22	10.3							1
3.75-3.775			198	58.5	108	31.9	34	10.1							
3.775-3.8	20	5.6	185	52.2	129	36.4	20	5.6							1
3.8-3.825	3	1.7	86	50.6	22	12.9	57	33.5			2	*		3	2
3.825-3.85	2	*	96	43.2	67	30.2	53	23.8			2	*		1	4
3.85-3.875	14	6.0	96	41.2	69	27.4	57	24.5			3	*		1	
3.875-3.9	5	1.7	200	69.2	25	8.6	53	18.3			3	*		2	3
3.9-3.925			3	1.1	9	3.4	96	37.1			150	57.9		2	
3.925-3.95	28	20.6	37	27.0	45	33.2	26	19.1			1	*		23	
3.95-3.975	65	21.5	116	38.4	104	34.4	17	5.6						3	3
3.975-4.0	51	35.9	21	14.7	22	15.5	47	33.1			1	*		4	4
4.0-4.025	3	*	99	31.2	102	32.1	111	35.0			2	*		16	
4.025-4.05	10	2.6	90	23.4	84	21.8	200	52.1			1	*		11	

TABLE 3 (continued)

Depth m.	Mosses Sphagnum No.	%	Mosses Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Incidental Stem No.	Incidental Seeds No.
4.05-4.075	189	40.4	107	22.8	54	11.5	117	25.0						10	1
4.075-4.1	170	34.3	107	21.6	68	13.7	83	16.7			1	*		10	
4.1-4.125	194	70.0	20	7.2	39	14.1	23	8.3			1	*		7	
4.125-4.15	48	25.9	83	44.8	48	25.9	6	33.2							
4.15-4.175	47	16.1	202	69.4	16	5.4	25	8.5						11	6
4.175-4.2	20	7.1	217	77.7	15	5.2	26	9.3			1	*		2	
4.2-4.225	115	41.2	82	29.4	15	5.3	67	24.0						1	
4.225-4.25	66	17.5	188	50.0	76	20.2	46	12.2						15	
4.25-4.275	95	24.3	162	41.5	59	15.1	73	18.7			1	*		7	
4.275-4.3	30	19.6	21	13.7	35	22.8	65	42.4			2	*		21	
4.3-4.325	71	73.9	4	4.1	6	6.2	14	14.5			1	*			
4.325-4.35	20	12.9	47	30.3	71	45.8	17	10.9						10	
4.35-4.375	9	4.6	14	7.2	147	76.1	23	11.9						3	
4.375-4.4	9	18.3	10	20.4	1	*	26	53.1			3	6.0		9	
4.4-4.425	106	31.7	136	40.7	47	14.1	55	16.4						10	2

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
4.425-4.45	141	40.7	63	18.2	75	21.6	65	18.7			2	*		12	1
4.45-4.475	10	4.6	5	2.3	127	59.1	69	34.2			5	2.3		10	
4.475-4.5	28	22.6	5	4.0	36	29.0	42	33.8			13	10.5		5	
4.5-4.525	6	1.8	252	77.7	32	9.8	29	8.9			2	*		2	
4.525-4.55	8	5.3	87	58.3	38	25.5	16	10.7						7	3
4.55-4.575	12	9.1	66	50.0	40	30.3	14	13.0						6	2
4.575-4.6	2	1.7	72	61.0	37	31.3	6	33.4			1	*		8	4
4.6-4.625	25	12.5	5	2.5	91	45.7	77	38.7						3	
4.625-4.65	7	5.9	17	14.4	50	42.3	38	32.2			6	5.1		1	6
4.65-4.675	3	1.5	99	51.0	72	37.0	19	9.7			1	*		12	
4.675-4.7	7	5.7	47	38.8	35	28.9	30	24.7			2	1.6		7	
4.7-4.725	30	13.5	92	41.6	68	30.7	31	14.0						4	
4.725-4.75	8	3.2	105	42.0	124	49.6	11	4.4			2	*		7	
4.75-4.775	2	*	235	76.3	66	21.4	2	*			1	*		1	
4.775-4.8	75	21.3	194	55.3	55	15.6	26	7.4			1	*		6	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Sphagnum %	Mosses: Unknown No.	Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Stem No.	Seeds No.
4.3-4.825	1	*	89	40.2	57	27.8	73	33.0			1	*		7	
4.825-4.85	1	*	193	84.2	13	5.6	22	9.6			1	*			1
4.85-4.875	10	3.6	148	54.0	101	36.8	12	5.8			4	1.4		5	
4.875-4.9	12	3.9	240	78.6	34	11.1	16	5.2			3	*		14	
4.9-4.925	12	10.0	17	13.3	16	13.3	42	35.0			33	27.5		14	
4.925-4.95	2	1.1	91	53.5	18	10.6	39	22.9			20	11.7		4	
4.95-4.975	8	3.5	142	62.8	11	4.8	32	14.1			23	10.1		5	
4.975-5.0	8	16.3	2	4.1	7	14.3	32	65.3							
5.0-5.025	5	2.1	123	51.8	51	21.5	58	24.4						4	
5.025-5.05			267	88.4	22	7.3	12	3.9						4	1
5.05-5.075			148	73.6	40	19.9	11	5.5			2	*		6	
5.075-5.1	217	51.4	199	47.1	4	*	2	*						1	
5.1-5.125	5	1.5	313	94.8	6	1.5	6	1.5						2	
5.125-5.15	3	*	269	79.6	66	19.5								1	
5.15-5.175	2	*	140	59.5	83	35.3	6	2.5			4	1.7		1	1

TABLE 3 (continued

Depth m.	Mosses Sphagnum No.	%	Mosses Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Stem No.	Seeds No.
5.175-5.2	16	8.3	136	70.8	37	19.3	1	*			2	*		1	1
5.2-5.225	7	2.0	260	78.5	29	8.2	27	8.1			6	1.8		3	1
5.225-5.25	17	5.6	250	83.0	21	6.9	13	4.3						1	
5.25-5.275	23	6.6	171	49.7	141	40.9	8	2.3			1	*		1	
5.275-5.3	21	10.5	143	71.5	16	8.0	19	9.5						4	
5.3-5.325	15	8.1	108	58.3	54	29.1	6	3.2			1	*			
5.325-5.35	13	4.7	225	82.1	23	8.3	12	4.3						2	
5.35-5.375	36	21.6	69	41.5	36	21.6	22	13.2						3	
5.375-5.4	9	3.8	183	77.2	43	18.1	3	1.2					1		
5.4-5.425	14	10.8	81	62.8	13	10.1	20	15.5			1	*	1	4	
5.425-5.45	8	4.1	144	75.0	34	17.7	5	2.6			1	*	1	3	
5.45-5.475			197	89.5	23	10.4								1	
5.475-5.5	3	1.1	231	84.9	37	13.6								1	
5.5-5.525	2	*	195	8.15	35	14.6	5	2.1			2	*		8	
5.525-5.55			164	75.5	52	23.9	1	*						9	

TABLE 3 (continued)

Depth m.	Mosses Sphagnum No.	%	Mosses Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Incidental Stem No.	Incidental Seeds No.
5.55-5.75	8	5.1	129	82.1	18	11.4	2	1.2					2	12	
5.75-5.6	6	2.5	198	85.3	23	9.9	3	1.2			1	*		1	
5.6-5.625			101	78.3	27	20.9					1	*			
5.625-5.65	28	16.7	113	67.6	18	10.7	8	4.7					1	2	
5.65-5.675	13	9.1	106	74.6	17	8.4	5	3.5			1	*	1	3	
5.675-5.7			242	91.6	9	5.3							1	1	
5.7-5.725	28	23.5	85	71.4	1	*					5	4.2	7	1	
5.725-5.75	1	*	350	97.2	9	2.5							3	1	
5.75-5.775	13	4.4	258	87.4	23	7.8	1	*					7	2	
5.775-5.8			184	95.3	4	2.1	1	*			1	*	3		
5.8-5.825	1	*	254	99.0											
5.825-5.85	2	*	255	98.1	2	*							3		
5.85-5.875	27	9.8	239	86.9	9	3.2					1	*			
5.875-5.9	9	18.0	27	54.0	9	18.0	5	10.0					4	3	
5.9-5.925	95	75.3	10	7.9	12	9.5	7	5.5			2	*		2	

TABLE 3 (continued)

Depth m.	Mosses				Ericoid		Sedge-like		Conifer		Unknown		Incidental		
	Sphagnum		Unknown										Wood	Stem	Seeds
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	No.
5.925-5.95	60	54.5	42	38.1	7	6.4	1	*							
5.95-5.975	57	16.6	272	79.5	3	*	10	2.9						1	
5.975-6.0	6	5.1	13	11.1	17	14.5	81	69.2					10	1	
6.0-6.025	8	14.2	32	57.1	9	15.1	4	7.1			3	5.2			
6.025-6.05	53	18.3	217	75.0	17	5.8							3		
6.05-6.075	1	*	164	65.0	68	26.9	19	7.5						3	
6.075-6.1	4	1.7	195	83.3	25	10.7	9	3.8						1	4
6.1-6.125	1	*	94	69.8	31	23.0	9	6.7						5	4
6.125-6.15	8	4.6	131	76.6	29	16.9	3	1.7						9	3
6.15-6.175	23	10.2	162	72.0	42	18.6	8	3.6						13	1
6.175-6.2	25	19.1	63	48.1	40	30.5	2	1.5			1	*		9	5
6.2-6.225	6	9.8	6	9.8	33	54.1	15	24.5			1	*		4	6
6.225-6.25	39	32.2	45	37.1	33	27.2	3	2.4			1	*		10	2
6.25-6.275	7	6.9	46	45.5	44	43.5	3	2.9			1	*		5	7
6.275-6.3	7	19.4	10	27.7	10	27.7	9	25.1						3	

TABLE 3 (continued)

Depth m.	Mosses Sphagnum No.	%	Mosses Unknown No.	%	Ericoid No.	%	Sedge-like No.	%	Conifer No.	%	Unknown No.	%	Incidental Wood No.	Incidental Stem No.	Incidental Seeds No.
6.3-6.325	8	6.1	54	41.0	67	50.7	3	2.2						6	
6.325-6.35	19	24.3	6	7.7	34	43.6	19	24.3						3	1
6.35-6.375	22	15.8	41	29.5	68	48.9	8	5.7						7	
6.375-6.4	4	2.5	41	26.1	110	70.1	2	1.2					4	2	
6.4-6.425	47	29.9	21	13.3	73	46.5	13	8.3			3	2		5	1
6.425-6.45	105	35.8	103	35.1	73	25.0	7	2.4			2	*			
6.45-6.475	39	27.4	48	33.8	54	38.0					1	*		5	
6.475-6.5	80	30.1	80	30.1	94	35.5	10	3.4			1	*		13	
6.5-6.525	24	27.2	44	50	19	21.6	1	1.1						1	
6.525-6.55	7	17.0	15	36.6	19	46.3								2	
6.55-6.575	68	33.5	50	24.6	80	39.4	2	*			2	*		14	1
6.575-6.6	11	12.6	9	10.3	57	66.0	10	11.4						11	3
6.6-6.625	8	12.7	23	36.5	26	41.3	5	7.9			1	*			
6.625-6.65	16	23.8	9	12.8	38	56.7	1	1.5			3	4.4		3	
6.65-6.675	10	10.3	34	35	46	47.4	4	9.1			3	3.1		3	

TABLE 3 (continued)

Depth	Mosses				Ericoid		Sedge-like		Conifer		Unknown		Incidental		
	Sphagnum		Unknown										Wood	Stem	Seeds
m.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	No.	No.
6.675-6.7	29	32.5	23	25.8	37	41.5								3	1
6.7-6.725	2	2.3	16	18.6	61	70.9	7	8.1						1	
6.725-6.75	4	13.0	4	13.0	22	73.0								2	
6.75-6.775	5	11.9	2	4.7	34	80.9					1	2.3		5	
6.775-6.8	6	16.6	5	13.8	24	66.6	1	2.7						2	
6.8-6.825	20	15.5	81	62.7	30	23.3								6	
6.825-6.85	31	40.2	31	40.2	15	19.5								16	
6.85-6.875	28	42.4	26	39.4	12	18.1								9	
6.875-6.9	47	52.8	25	28.1	17	19.1								12	
6.9-6.925	15	53.6	4	14.3	9	32.1								9	
6.925-6.95	6	12.7	5	10.6	34	70.3	2	4.2						17	
6.95-6.975	9	24.3	15	40.5	13	35.1								8	
6.975-7.0	175	64.4	57	20.9	35	12.8	5	1.8						11	1
7.0-7.025	2	18.2	8	72.7							1	9		2	
7.025-7.05	43	48.8	16	18.1	10	11.3	13	14.7			6	6.8		3	
7.05-7.075	33	38.8	6	7.1	13	15.3	16	18.8			24	28.2		10	
7.075-7.1	11	17.5	1	2.5	7	17.5	4	10.0			17	42.5		7	

TABLE 3 (continued)

Depth m.	Mosses: Sphagnum No.	Mosses: Sphagnum %	Mosses: Unknown No.	Mosses: Unknown %	Ericoid No.	Ericoid %	Sedge-like No.	Sedge-like %	Conifer No.	Conifer %	Unknown No.	Unknown %	Incidental: Wood No.	Incidental: Stem No.	Incidental: Seeds No.
7.1-7.125	58	68.2	11	12.9	12	14.1	3	3.5			1	1.1		24	
7.125-7.15	27	67.5	3	7.5	7	17.5	1	10.0			2	5.0		9	
7.15-7.175	44	67.7	7	10.7	10	15.4	3	4.6						23	
7.175-7.2	115	66.9	7	4.1	38	21.8	11	6.3			3	1.7		12	
7.2-7.225	20	34.5	17	29.3	10	17.2	10	17.2			1	1.7		18	
7.225-7.25	13	50.0			6	23.1	4	15.4			3	11.5		10	
7.25-7.275	24	60.0	3	7.5	8	20.0	5	12.5						7	
7.275-7.3	91	77.1	3	2.5	17	14.4	7	5.9						14	
7.3-7.325			9	64.3	3	21.4	1	7.1			1	7.1		16	
7.325-7.35	22	78.6	5	17.8			1	3.6						31	
7.35-7.375	10	62.4			1	6.2	5	31.2						4	
8.375-7.4	42	93.3	1	2.2										9	
7.4-7.425	12	80			2	13.3	1	6.6						5	
7.425-7.45	7	100.												1	

* Under 1%.

TABLE 4.

CUTICULAR MATERIAL PRESENT IN GIVEN CORE SAMPLES

Depth	Slide	Sphagnum No.	%	Unknown Moss No.	%	Ericoid No.	%	Sedge-like No.	%	Stem No.	%	Unidentified No.	%	Total No.
0.25 gm.	a	11	24			4	8	2	4	21	47	8	17	45
from 1.875-	b	109	67			23	14	1	*1	21	13	7	4	161
1.9 meter	c	191	65			27	12	1	*1	30	13	17	7	216
level.	d	198	75			26	13	3	1	6	3	14	7	197
0.2 gm.from	a	40	24	30	18	17	10	45	27	22	13	9	5	163
3.45-3.475m.	b	63	24	111	42	17	6	45	17	20	7	7	2	263
meter level	c	21	19	32	29	7	6	36	32	11	10	3	3	110
	d	59	44	18	13	17	13	31	23	7	5	1	*1	133

* Under 1%.

CHAPTER IV

DISCUSSION

In the extraction of the peat core, difficulty is encountered in the withdrawal of the samples from the chamber of the borer. As the width of the opening through which the samples are withdrawn is ¼ inch smaller than the diameter of the chamber, some compaction at the ends and sides of the samples results.

The correct depth was marked upon the wrappings at the site of extraction to prevent any confusion at a later date. After all the samples had been properly labelled they were taken to the laboratory and stored until required.

When the samples were unwrapped before treatment it was noticed that the peat had shrunk considerably in volume. Measurements of the weight, length and breadth of the sample were recorded. Preceding any chemical treatment each sample was divided into four equal parts. Each ¼ section was weighed before and after trimming so that the weight of the peat to be treated was known. It was assumed that every ¼ section represents 2.5 cm of the original. All physical data preceding chemical treatments are recorded in Table 2. A study of these data reveal that overall shrinkage had occurred with a tendency for the original one inch diameter core to be somewhat flattened. An increase is also observed in the weight of the samples obtained close to the underlying mineral layer. Failure of the peat sample to retain its original shape was no doubt due to loss in water content and method of withdrawal. These errors, which would be critical for any work involving spatial distribution within peat, need not concern us here, since it is only the isolation and identification of cuticular material that is pertinent.

Because of the importance of the method used in isolating cuticular material, details concerning the analytical procedure have been emphasized. The major technical difficulty encountered was the finding of a chemical treatment sufficient to dissolve the surrounding matrix and at the same time preserve the characteristics of the cuticular material. A number of methods make use of a layer, often rich in pectin, between the cuticular material and the inner cell-wall, to effect separation. Certain methods using macerating agents utilise this layer in order to detach the cuticular material from the underlying cell-wall by dissolving the cellulose, hemicellulose and lignin components (29, 48, 45, 44). No method employing strong saponifying agents, such as alcoholic alkali, can be used, as they tend to dissolve cutin, the principal ingredient of cuticular material (44). It is sometimes possible to strip the cuticle from the petals of certain flowers by hand; however, it is very difficult and in many cases impossible to do this with the cuticular material covering the epidermis of leaves. As previously mentioned, cuticle is often isolated by dissolving most of the other plant materials present. For example, such chemical compounds as cellulose, hemicellulose and pectins are often removed by means of concentrated sulphuric acid. Greater difficulty is encountered in the removal of lignin. According to the procedure recommended by Paech and Tracey (30), lignin can be removed with a macerating agent. However, they state that before such agents are employed, the materials must first be treated with concentrated sulphuric acid in order to remove any carbohydrates.

Since lignin is known to be present in most peats, maceration with an oxidizing agent must be included in any method to effect its removal.

Two experiments were carried out on peat samples to test the effectiveness of the oxidizing agent recommended by Harris (23). In the first experiment, a known quantity of peat was treated with concentrated nitric acid and the oxidant potassium chlorate. The second experiment used the same oxidizing agent, but with the recommended treatment of concentrated sulphuric acid preceding its use (30). Both treatments were followed by the use of ammonia to saponify the non-cuticular lipid material. From the results, no apparent contrast was observed in the morphological features of the isolated cuticles. The only difference was the greater length of time required, using concentrated sulphuric acid, to accomplish the same results. It was decided upon this basis to use the first mentioned procedure.

After the required treatment in the oxidizing agent the material was rinsed in water and the suspension separated by centrifugation. This was followed by treatment with ammonia, after which the material was washed in water and centrifuged. The encouraging results obtained from the isolation of cuticle in preliminary experiments, simplicity of method and the reaction taking place at room temperature, suggested this method for use in this investigation.

A possible source of error should be mentioned in connection with the use of this method. It frequently has been asked whether it exhibits any preference or selection of cuticle present in peat, or in other words, does the use of this method allow certain cuticles to pass untouched while others are dissolved or altered beyond recognition ? A preliminary test was conducted to see if any selectivity or alteration of the cuticle could be detected. A sample of peat weighing 0.6 gm. was divided into two equal lots of 0.3 gm. By dividing vertically it was anticipated that the composition of the cuticular material in each lot would be similar. One lot was subjected to the chemical treatment as outlined in Method. The other was placed in water to which a wetting agent (Kodak Photoflo) was added to reduce the surface tension of the dry peat. The slides with the isolated cuticular material from the first lot were then compared with those from the untreated peat. The examination of the untreated peat involved painstaking separation with forceps under a dissecting microscope. This experiment revealed that the condition of cuticular material was similar in each lot. The evidence suggests that little or no selectivity was exerted by this method.

A number of preliminary experiments were performed in order to determine the minimum quantities of chemicals needed and the time to be employed between each stage of the method. A more detailed examination is necessary in order to explain how the duration of each stage in the treatment was arrived at, since it pertains to the question of selectivity by the method.

In the first test, three samples from different levels of the peat profile, remained in concentrated nitric acid and potassium chlorate overnight. Upon examination the following day, it was found that the cuticles of mosses tended to fragment and in one sample to become almost unrecognisable. Another series of tests from various levels of the peat profile, were carried out using treatments of one, two, three, four, five, and six hours duration. For the treatments up to four hours respectively, no change was observed in the cuticle isolated. However, in those of five and six hours duration, a slight but perceptible fragmentation of the moss cuticles was discernible.

Treatments of one and two hours duration are not recommended on account of the amount of undissolved debris still present. After treatment for three hours only a small amount of debris was present and the cuticular material remained unaffected. To ensure maximum representation of the isolated cuticle and more efficient use of time involved, the three hour treatment was selected in preference to the other treatments, despite the presence of undissolved debris. The fragmentation of the moss cuticles after six hours of treatment appeared to indicate that there is a difference in chemical composition between the cutin of mosses and higher plants, worthy of future investigation.

It was found that the number of washings followed by centrifugation could be considerably lessened by using slightly alkaline water before the ammonia treatment and slightly acidified water after its use.

The process of manually separating the prominent cuticles in each treated sample ensured their presence in the results of a particular depth. The remainder of the cuticular material is microscopic and approximately 1 ml. of this material was selected at random by means of an eye dropper and placed upon a slide. Usually a prominent cuticle and 1 ml. of microscopic material were placed upon the same slide. When more than 1 ml. sample was considered necessary, for example, in the presence of a large quantity of cuticular material, the prominent cuticles and each 1 ml. sample were placed on separate slides. In such cases, where there is more than one slide for a given depth, the numerical data from the 1 ml. sample slides are averaged and the results from the prominent cuticle slides added to this average.

The placing of all cuticular material isolated from each peat sample upon slides in 1 ml. portions was considered impracticable. The number of slides involved would be large and the information gained from such action would not justify the time spent.

To show that this decision was warranted, two samples from varying depths of the peat core (1.875 - 1.9 and 3.45 - 3.475 meter depths) were taken and the isolated cuticular fraction placed upon slides in 1 ml. portions. The last slide containing less than 1 ml. was discarded. The results show that generally, the same percentage can be expected each time for the predominant cuticles present. These results are recorded in Table 4.

The decision to use no media in mounting the cuticles, was made after testing a number of mounting media with the cuticular material. When various media such as Euparal, Balsam, Xam, Permount, and Corn Syrup, were used and the results studied under a microscope, a fading of the relief pattern upon the various cuticles was noted. The use of media appears to obscure the diagnostic morphological detail necessary for identification. The absence of mounting media served to emphasize the various diagnostic patterns embedded in the cuticular material.

The cuticular materials have been upon slides for at least six months and no deterioration of structure has been noted. Some deterioration has occurred in the non-cuticular material, where small pieces of wood have become powdery, probably through bacterial or fungal action, and disappeared. Thus this method, because it offered the best way to show morphological detail and because of its simplicity, was adopted for use. This evidence tends to suggest that it can be considered as further proof of the unusual physic-chemical stability possessed by cuticular material.

At this point consideration should be given to the nature of the material isolated. Up to now it has been referred to as "cuticle" and "cuticular material."

The original meaning of the term "cuticle" has become somewhat altered in recent years as a result of continual research being conducted into the structure, composition and function of this water repellent layer. A number of investigators, particularly Roelofson (44) and Priestley (33) have recognized the need for a more up-to-date explanation of the so-called "cuticle". Roelofson has advanced a series of proposals attempting definition of this outermost layer. However, before proceeding with any consideration of these proposals, brief mention should be made of the original meaning of "cuticle" as defined in the Shorter Standard Oxford English Dictionary (46).

The word "cuticle" is an English adaptation of the Latin '<u>Cuticula</u>' meaning 'the skin'. The diminutive of <u>cuticula</u> is '<u>cutis</u>' from which the word 'cutin' - the principal component of cuticle - is derived. This term was first formed in 1615, when it was defined as "the primary integumentary tissue" (46). However, since then, as this source of reference points out, it has come to mean, "a superficial film formed of the outer layer of the epidermal cells." (46).

The proposals submitted by Roelofson are discussed at great length by him in his book "The Plant Cell-Wall" (44). Since they are only briefly mentioned here, readers desiring further information on the subject are referred to this source. Roelofson points out that in recent years, a number of investigators employing various techniques have been able to demonstrate for most plants that the 'cuticle' is composed of at least two layers. They have also been able to isolate and identify the chief chemical components of these layers, which they have shown to consist of mainly cutin, waxes, cellulose, pectin as well as certain resin-like and tannin-like compounds.

The two layers can be differentiated from each other by their chemical composition. The outermost layer consists almost entirely of cutin. Waxes are found in this layer but to what extent is unknown. Roelofson has surmised that this layer probably originates from either the direct secretion of cutin or its precursors from the underlying cells. This process of formation has been referred to by Esau as "cuticularization" (13). Roelofson uses the terms 'cuticle' or 'cuticle proper' to describe this layer.

The second layer is situated between the true epidermal cell-wall and the cuticle proper. Its chemical composition as reported by a number of investigators shows that it is predominantly a mixture of cutin, wax, cellulose and sometimes pectins as well as certain resin-like compounds (44). This layer is reported to be formed by the incrustation or impregnation of cutin within the interstices of the cellulose fibres and fractions, which in turn are said to originate from the outermost layer of the cell-wall proper. A schema of the structure of this layer constructed by Roelofson from the work on the outer wall of the epidermal cells of Aloe species by Fritz, shows that it consists of several alternating sub-layers of cutin, cellulose, and pectin (44). Priestley (33) also reported finding a sub-layered construction in this region. No mention was made of the position of wax in this schema. Roelofson refers to the work of M. Meyer who showed that wax is present as platelets or lamellae embedded within the cutin (44). The process of incrustation or impregnation of cutin from which these various sub-layers are said to arise, has been termed by Esau "cutinization" (13). The layer that is formed by cutinization is described be Roelofson as the "cuticular layer" (44).

To avoid any confusion in using the term 'cuticle', Roelofson proposed that it be restricted solely to the outermost layer of cutin and that the term 'cuticular membrane' be substituted for the combined layers constituting this water-repellent layer. Some difficulty was experienced as to what should be the proper term of reference for the cuticular material isolated during core analysis. The division of the cuticular membrane into two distinct layers does not hold true for all terrestrial plants, for, it is only the cuticular membrane of most mesophytes and xerophytes that possess the two-layered construction. In certain mesophytes and most hygrophytes no cuticular layer is present. Thus only the Conifer, Ericoid, Shrub and certain of the Herb groups appear to possess the two-layered cuticular membrane. However, since standardization of our terms of reference is required, the complete water repellent layer of most plants will be referred to as the 'cuticular membrane', bearing in mind the above mentioned distinctions.

It should be stated at this point that no microchemical or physical tests were undertaken to prove conclusively that the material isolated from the peat samples or the standards was cuticular. These tests which utilise such techniques as saponification, fractional distillation, determination of polarity, X-Ray diffraction, ultra-violet examination and others, await further investigation. However, this is not of immediate necessity, since comparison between the isolated cuticular membranes from peat and the known properties derived by other investigators using the above techniques, often suffice.

Perhaps the most outstanding of all cuticular properties is its resistance to physical decomposition. This property is possessed by other botanical components to varying degrees but none can equal the remarkable stability of the cuticular membrane. For instance, it can resist prolonged immersion in strong oxidizing agents and concentrated inorganic acids at room temperatures. The only means of altering this material is to saponify it, for example, alcoholic alkali at high temperatures, and even then prolonged treatment is usually required. Even the most delicate of the isolated materials, here considered to be from Drosera rotundifolia L., was able to withstand the strong oxidative action of the macerating agent. Further evidence of this remarkable property is suggested, when it is remembered that even fossilization does not appear to alter the cuticular stability. Its resistance to the forces of fossilization is most likely due to a combination of factors, chief of which are its chemically stable nature, and the conditions under which it is fossilized. The method of mounting the cuticular membranes upon the slides also suggests its resistance to the oxidizing action of the atmosphere.

Thus the material under study, while not proven conclusively to be cuticular, does appear to fulfil most of the properties of cutinized materials.

The difficulties encountered in identifying and interpreting the isolated cuticular material, were attributed to its delicate nature. In particular the problem of identification involved more than simple comparison between the standard cuticular membranes and the isolated material. For instance, the major portion of the cuticular material from the peat was isolated in a fragmented state with only an occasional whole leaf being found. This fragmentation was attributed to the physical processes involved in peat formation since no such separation into fragments occurred in the isolation of the standards. This process is called disintegration by Dachnowski (10) who defined it as follows:

> "a mechanical soil-forming process by which peat materials are broken into separate and smaller fragments of their constituent plant remains."

Disintegration, when almost complete, produces a finely divided, structureless or amorphous peat, which is distinct from other peats with their visible roots, woody fragments, twigs, sedge and moss remains. The process occurs to some degree throughout any peat profile but is most active at or near the surface. The physical phenomena involved in disintegration are changes in moisture content, fluctuations in temperature, thawing and freezing, and the penetration of plant roots and fungal hyphae. The combination of these criteria and possibly others, contribute to the physical break-up of the peat. Perhaps the best example of the process is the fragmentation produced by the freezing of water in cellular plant tissues. Another example is the effect of the natural vegetation with its penetrating network of roots that create small cracks or crevices in newly formed peat. This results in a splitting of the large lumps of plant material into smaller fragments with an increase in oxidation from better aeration. In a similar manner Roelofson points out that the network of hyphae from fungal mycelia mechanically disrupts the cellular structure and at the same time fragments the enveloping cuticular membrane (44).

The finely divided amorphous peat, that predominates at the bottom of the peat profile under study, is probably due in part to disintegration. It appears to represent the well-decomposed and disintegrated fractions of the first vegetation upon the small lake that has eventually become the Copetown bog.

The isolated fragments raised the questions of what should be the minimum size of the cuticular membranes before they are recorded. A somewhat arbitrary number of five cell outlines was chosen. This number was based upon the minimum number of cell outlines that could be recognized, under the low power of the microscope, in the plant possessing the smallest cells, Vaccinium Oxycoccos L. . Thus to ensure constancy in counting no fragments with less than five cell outlines were recorded.

Sometimes a large cuticular membrane would occur that occupied a number of microscopic fields. When this happened each microscopic field was recorded as a single unit. This was necessary in order to standardize the method of recording whole cuticular membranes and fragmented parts together,

Another difficulty lies on the fact that a leaf has an upper and lower epiderma with two different types of cell pattern embedded in the cuticular membrane. The upper cuticular membrane is usually thicker and has fewer stomata than the lower. Sometimes these layers possess certain features such as trichomes (Plate VIII, Fig. 1), wax-like protrusions (Pl.VII, Fig. 1) and openings other than stomatal (Plate XV, Fig. 1) which distinguish it from the other. This difficulty does not arise with the standards, it only occurs when identifying the fragmented remains of the isolated cuticular material. Certain known cuticular membranes (Plate VIII, Fig. 2, Pl. XIV) have features peculiar to either the upper or lower epidermis but not to both. When cuticular fragments of these types occur, there may be a tendency to place them in the wrong group; but as the majority of standards show, the cell-wall outlines on both sides are basically similar.

Originally it was thought that similarities in features alone would be sufficient to differentiate the various groups but exceptions to them kept occurring. These exceptions consisted of plants that possessed similarities in life-form but had different cuticular features. Rather than create new groups and increase the chance of confusion, it was decided to organize these groups - first, on the basis of life-form and then by similarity of cuticular features. The classification of the 23 known species classified as standards into 6 separate groups is summarized in Table 1 and illustrated on Plates I - XVI.

The interpretation of data recorded from the isolated cuticular material presented a few problems. Preliminary surveys of the slides had revealed that classification of the cuticular material into groups was feasible. A few exceptions occurred in this classification where the identity of the cuticular materials are unknown. These fragments, which did not appear to belong to any group, were listed separately under the unknown group. Thus, for the standards only six groups were required, whereas for the isolated cuticular material seven groups were necessary and an additional group for the recording of such incidentals as seeds, stems, etc.

Perhaps the most difficult of the problems concerns the method used to record the cuticular material upon the slides. Two methods of recording were considered. The first involved the use of random sampling techniques similar to that employed by palynologists (12). A consideration of this technique showed that it was inadequate, since by this method a number of more prominent cuticular membranes that had been separated manually were often missed. The second method consisted of counting every fragment of cuticular material greater than 5 cells in area. It should be emphasized, that this is only a qualitative method of assessment and interpretation of data. No attempts have been made to estimate the actual numbers of plants that have contributed to a given volume of peat; or to assay in quantitative terms the contribution of species to the bulk of the peat.

It was decided to use this method, mainly because it ensured fuller representation. Similarly a note was made of the presence of non-cuticular materials. In this manner, everything upon the slides came under surveillance and thus more accurate estimates of the groups present were made. Thus, by this method it was hoped to illustrate any trends that have occurred in the floral history of the Copetown bog.

To illustrate these trends graphically the actual numbers recorded from the 283 slides, each representing the equivalent of 2.50 cm., were converted to percentages of the total count. In this way, some idea of the predominant species that have contributed to the structure of peat was gained. The percentages are summarized in Table 3 and illustrated by Plate XXXVI.

From the results illustrated graphically (Plate XXXVI), the largest of the groups on a numerical basis are the mosses. This group consists of two genera; the first is Sphagnum and the second, while suspected of being Hypnum is still listed as unknown. Sphagnum leaves are found throughout the profile in varying concentrations (Plate XXXVI) but below the 3.45 meter level this moss is thinly represented being more concentrated above the level. Possible explanations for the sparse representation below the 3.45 meter level are either contamination from core extraction or poor representation of this moss during this period of peat formation. The latter is regarded as more feasible since precautions such as trimming the samples before treatment were carried out. The unknown moss predominates below the 3.45 meter level and was placed within this group because its leaf size and general morphology led to its tentative identification as Hypnum. It has, as seen in Plate XXVI, Fig. 1 a moss-like habit that is revealed by stems with leaves still attached. Also, other investigators, such as Dachnowski (9) have found similar concentration of peat with Hypnum in a number of bog profiles from the northern United States. Unlike Sphagnum this moss is not represented throughout the profile but stops abruptly at the 3.45 meter level and does not appear again. This cessation of growth suggests that a sudden change in environmental conditions may have been the reason for its disappearance from the centre of the bog. Thus on a numerical basis and despite their small size it appears that the mosses may contribute significantly to the bulk of the peat.

Following the mosses, the Ericoid group is second in relative abundance. This group is represented throughout the profile in varying concentrations. Such concentrations occur at the 1.3 - 2.0 meter level, the 4.4 - 4.8 meter level, and in the layer next to the mineral sublayer. Representative cuticular membranes of this group are shown from various levels on the following Plates XVII, Fig. 2, XXII, Fig. 2, XXX, Fig. 1.

It is suspected that further refinements in technique and identification will reveal other groups present in the Ericoids. For instance, the cuticular membranes isolated from the lowermost layers of the peat profile are believed to be aquatic plants with similar cuticular features, but it is still possible that this concentration at the bottom of the peat deposit was formed by ericoid plants from the vegetation surrounding open water, the dead leaves and debris of which were swept to the central area of the bog by water currents or wind action. The concentration of this group at the 4.4 - 4.8 meter level is believed to be truly representative of this group, since reddish-brown roots similar to those of Chamaedaphne calyculata (L.) Moench. have been brought to the surface. However, whether this is actually due to the growth of such plants at the equivalent depth of peat, or to the deep penetration of ericoid roots when a greater depth of peat existed, is unknown.

The third group present consists of those plants with Sedge-like characteristics. On the whole, they appear to be concentrated in the region between the 2.5 - 5 meter level with maximum representation at the 3.2 - 3.6 meter level. This group is barely represented at the lower and upper depths of the profile. This appears to support the view that the lower ericoid group is really composed of aquatic plants since if the leaves and debris had been swept in towards the centre of the former lake, then there would have been some evidence of Sedge-like plants as they are invariably present at this stage of bog development. The region of maximum representation of this group is of interest since it is at this level the unknown moss disappears. At the time this occurred the centre of the bog was well represented by sedge-like groups, so it is possible that changes in the underlying peat brought about by the increased numbers of Sedge-like plants altered the growing condition necessary for the mosses' survival. Another possibility is that some other conditions, such as drought or a fire not recorded in the peat may have caused its extinction from the central area. One of the important diagnostic characteristics of this group is the positions of the stomata upon the cuticular membrane. The fragments of this group rarely contained stomata and thus specific and generic identification were not attempted.

The Conifer group is only sparsely represented in the upper portions of the profile. This was probably owing to the nature of these plants where the needles upon falling, tend to be scattered under the tree and in the direction of the prevailing wind. The maximum representation of this group occurred at the 1 - 1.1 meter level and may have been due to the presence of a nearby conifer. The earliest evidence of the conifers occurs at the 2.8 - 2.825 meter level. The only representative of this group that has been isolated and identified is Picea mariana (Mill) B.S.P. (Plate XXIV Fig. 1). The sparse representation of this group suggests that the leaves do not contribute much to the peat. However from the stratigraphy of the profile it is seen that this group contributes a good portion of the woody component, along with the Ericoid group, to the gross structure of the peat. Stumps of trees are believed to be at the 2 meter level, where up to 10 cm. of preserved wood has been extracted with the Hiller borer .

No representatives of the Herb and Shrub group were found. This does not, however, exclude the possibility of them being present, where they may have been included under the unknown group. The present distribution of these groups upon the bog surface supports this view (Plate XLII). If the number of identified cuticular membranes increases, then representatives of these groups may be isolated.

The unknown group is represented sporadically throughout the profile. This group includes all unidentified cuticular materials and often contains material of rather peculiar shape (Plate XX, Fig. 1 Plate XXV, Fig.1, Plate XXXV). Possible elements of this group are the cuticular membranes from airborne leaves from the vegetation of the surrounding mineral terrain. This is suggested by the evidence of scattered leaves of Quercus and Acer found embedded in the upper layers of the Sphagna near the site of the core. The largest concentration of this group occurs at the 3.9 - 3.925 meter level (Plate XXVII, Fig.1).

Cuticular materials, other than those that originate from leaves, including the more resistant fractions of the adhering matrix, were also isolated. Of particular note are the stems of mosses. In some of the stems all internal cellular matter had disappeared leaving the cuticular membrane with its characteristic pattern, while in others, little or no internal matter had dissolved. The identification of these stems was based on two factors, (a) the distinct morphology of the stem with its characteristic shape and large rectangular cell outlines (Plate XXVII, Fig.2, Plate XXXIV, Fig.2); and (b) moss leaves were occasionally found adhering to the stem (Plate XXII,Fig.1). The stems were counted and their numbers included in Table 3. Upon examination of this Table it is seen that, in most cases, wherever there are moss leaves the stems are also present.

Present in varying amounts are the more resistant parts of the woody elements. They originate mostly from the roots, since aerial portions are more subject to the processes of decomposition and disintegration. The only groups, by their very nature, that can contribute to the woody portion, are the Conifer, Ericoid and Shrubs. The presence of wood in the peat is probably correlated with the advance of the Ericoid and Conifer groups towards the centre of the bog. Woody peat appears to be confined to the upper portions of the profile as revealed by the stratigraphy of the peat core. Also isolated were a few charred woody fragments that produced a black smudge when rubbed between the fingers. This suggested its carbonaceous nature and its possible origin from a fire that was either in the immediate or surrounding area.

Another material recorded at various depths was a fine fibrous hair-like substance. It was suspected of being the fine adventitious root structure of the sedge-like plants. Another possible suggestion is, that it is fine fungal hyphae. However, nothing is known as to its exact nature.

A number of unidentified empty seed shells were found at various levels along with an occasional seed-like structure (Plate XX , Fig.2, XXI, Fig. 1). No correlation was found between the cuticular material and these structures. However, should they be identified in the future, a valuable supplement to the identification of cuticular material will be attained.

Perhaps the most intriguing of the unidentified fragments are the clear chain-like structures shown in the following photomicrographs (Plate XXI, Fig. 2). They appeared at the 0.775 - 0.8 meter and 0.875 - 0.9 meter levels in appreciable numbers. Their shape and size suggest either a fungal or algal origin, but, so far, positive identification has not been attempted.

The only non-organic substance present in concentration was a finely divided silt-like material. This material was isolated during centrifugation and may have originated in the upper portions of peat from airborne dust. It appeared throughout the profile in varying quantities. It is very prominent in the lowermost layers of peat as is shown by the increased weight of the samples (Table 2). The origin of the non-organic substance in this layer is unknown but it is suspected that it represents the settling of fine mineral particles from the original body of water or from local flooding.

A fuller understanding of the implications derived from the isolated cuticular material is possible, when consideration is given to the stratigraphy of the peat core. The surface vegetation in the immediate vicinity of the core is illustrated in the quadrats (Plate XXXVII, Plate XXXVIII, Plate XXXIX), and photomicrographs (Plate II, Fig. 1), The upper 30 - 40 cm. is occupied by a watery brown peat that could be extracted by the borer. From 40 cm. down to a depth of 2.2 meters, a woody fibrous peat, with identifiable portions of sedge and moss, prevailed, and was light brown in colour with a water lens at 85 cm. - 90 cm. and black flecks of carbonaceous material at 2.0 - 2.2 meters. The peat between 2.2 - 6.0 meters consisted mostly of a sedge - moss mixture with occasional woody particles and was generally light to dark brown in colour, with bands of orange-brown moss occurring at the following levels: 4.5 - 4.8 meters, 5.0 - 5.06 meters, 5.1 - 5.2 meters, and 5.5 - 5.6 meters. A band of almost pure sedge-like material occurs at 3.6 - 3.8 meter level. Present throughout this region are the numerous hairlike structures which were suspected of being the adventitious roots of the sedge-like plants. The spherical orange-brown seed shells were evident from the 4 to 7 meter level. Small pockets of watery peat occurred at the 4.3 - 4.4 and 3.3 - 3.4 meter level and small flecks of carbonaceous material were present at the 5.35 meter level. From the 6 to 7.45 meter level there was a change of the moss-sedge mixture colour from dark brown to light brown and eventually to light grey. This change in colour from brown to grey coincides with the increase in mineral content. Bands of pure orange-brown moss were found at the 6.0 - 6.12 meter and 6.32 - 6.34 meter levels. Around the 7 meter mark a heavy grey clayey mixture of peat prevailed. It should be pointed out that no line of demarcation exists between the peat and the underlying mineral layer. There is a gradual increase of the mineral content at the expense of the peat. At 7.46 to 7.50 meter level pure clay without any discolouration from organic material was found, and thus the 7.45 meter level was chosen as the final depth of the peat.

Brief consideration should be given at this point, to the watery layer of peat. The surface vegetation, composed chiefly of the Sphagna is separated from the underlying consolidated peat by a lacuna filled with watery peat. It was noticed during the construction of the transect that this layer of watery peat extends across the bog. From the literature one finds that a number of investigators have noticed the same phenomenon.

In particular Morrison (28) in his work on Irish bogs mentions two possibilities in an attempt to explain its origin. The first explanation, which he considers the more probable, required the capture of the lake beneath a floating carpet of Sphagna, spread far in advance of the other elements of vegetation. As these Sphagna continues its growth and the accumulation of sphagnum-peat increases, the floating carpet, because of its composition, remains buoyed up on the water. Morrison notes:

> "This type of lacustrine colonization - depending of course on the oligotrophy of the lake water - has been recorded from a number of North American sites (Taylor, 1910: Transeau, 1905; Rigg, 1951)." (28).

The second explanation, which he considers the less probable also required the capture of the lake by Sphagna; but it differs from the first in that the sphagnum-peat formed later, separates. This separation is brought about by a raising of the water-level of the lake basin. As Morrison states:

> "Since the Sphagna do not have roots and rhizomes which would bind them to the fen it is just conceivable that such a separation could come about, though it would seem to require a very considerable change in the water-level." (28)

Connected with these explanations is a related one concerning the probable reason why the bog surface never becomes flooded after heavy spring rains. Kulczynski ( ) in his work on the bogs of Polesie in Poland noticed this condition and found that the underlying lacuna of watery peat can expand through absorption of water. This expansion is balanced by a heaving of the bog surface upwards. The reverse occurs in times of drought where the layer of watery peat becomes small resulting in the contraction of the bog surface. Morrison notes that the essence of this mechanism, controlled by the hydrological conditions of the bog, is understood if one considers that:

> "the elasticity of the peat gives it a buffering with respect to changes of precipitation." (28).

From borings carried out at different times of the year in the Copetown bog, it was noticed that the depth of this watery layer does vary with the existing hydrological conditions. Generally, the greatest contraction of the bog surface took place during the Winter, when this layer was completely frozen. The maximum expansion occurred in the Spring and early Summer, where depths of 45 cm. were recorded for the lacuna, in the central area. A possible reason why there is no large expansion and contraction of the bog surface coinciding with the oscillations of the water-table, is found in the existence of the lagg. From the borings on the transect it was found that this layer is connected with the surrounding lagg which is flooded in the Spring and early Summer. This suggests that the lagg acts as a safety valve for the release of water from this layer thus preventing any large upheavals of the bog surface.

At this point mention should be made of the two principal agents at work in the bog converting the dead plant remains into peat. These two agents are disintegration and decomposition, but no distinction can be made as to where one begins and the other ends. Disintegration, which has been mentioned before, is the physical breakup of plant tissue and decomposition its biochemical breakdown.

Decomposition is what principally occupies us here, since it is the agent responsible for the non-physical changes that occur in the peat with depth. The word decomposition has been used in many different senses. For instance, Dachnowski states that:

> "it includes on the one hand the alterations which plant remains undergo as a source of energy with the drained and aerated or cultivated surface layers of a peatland; and on the other hand it involves the separation from the resistant material of those constituents which are soluble and may nourish crops." (10).

One of the important factors that control this process are the oscillations of the ground water level. When peat is saturated, very limited decomposition can take place because oxygen which is necessary for the efficient functioning of the aerobic micro-organisms responsible for the breakdown of peat is restricted (10). Similarly, temperature exerts a controlling influence upon these agents and as both these environmental factors are subject to seasonal variation it is suggested that the rate of decomposition increases during the Summer months and decreases in the Winter months. Thus, the processes that go on within peat are varied and complex, with some of the more resistant organic constituents broken into smaller fragments through disintegration, (cutin, wax, lignin, cellulose, pectin) and others changed in their chemical composition (lignin, cellulose) with the soluble portion either remaining in the peat or going into solution and being transported elsewhere (10).

The decomposition of the cuticular membrane has never been observed and when the membrane is perforated by fungi it is destroyed by being mechanically ruptured. However, it is suspected that even this stable substance succumbs to the agents of decay in time, for as Roelofson points out:

> "In the soil, e.g. in the mud of ditches, cutin nevertheless seems to be subjected to a slow decay, but this has so far not been proved by means of experiments." (44).

The rate at which the organic matter accumulates under the surface vegetation on a bog has interested numerous investigators. From the literature one gathers that the rate depends not only on the quantity of these organic remains but also upon the rate at which these deposits are acted upon by the decomposing agents. In particular, Leisman in his contribution to this particular subject, states that:

> "...Accumulation is the net result of deposition minus decomposition. If deposition exceeds decomposition, accumulation will occur, the amount depending upon the difference in the two rates" (27).

The rates of accumulation and the quantities of organic matter involved are influenced by a multiplicity of factors, many of which have been discussed. The general statement made by Bjorling and Gissing (2) that a high relative humidity and a mean annual temperature ranging a few degrees below or above 7°C. for the maximum rate of accumulation, is too simplified to account for the many climatic variations in which peat occurs.(27).

Leisman has also given an estimate of the rate of accumulation occurring in the six successive stages proposed by Soper (27). He estimates that the slowest rate of accumulation takes place in the first three stages, where decomposition proceeds at a rapid rate. A greater rate of accumulation occurs in the last three stages, with a maximum reached at the sphagnum - bog - heath stage. He regards the role of Sphagnum as the most important of all the peat-forming plants; and this is supported in part by the results of the core analysis. These results indicate that Sphagnum has the predominant role above 3.45 m., whereas another moss, as yet unidentified, predominates below this level.

Thus, the agents of decomposition control either directly or indirectly the conditions necessary for the accumulation of organic matter.

Further work, particularly in the identification of species composing the peat should increase our knowledge of the rate of organic accumulation and the quantities involved.

CHAPTER V

CONCLUSION AND SUMMARY

The employment of a suitable technique revealed the presence of cuticular membranes in peat. The use of a well-known macerating agent provided a simple but effective means for isolating the cuticular material. The procedure used in mounting the material was the simplest attempted. It served a two-fold purpose by illustrating the necessary morphological detail and demonstrating the stability of the cuticular membranes.

This technique has not been employed before, as far as the investigator is aware, with the present objectives in mind. Since it is an old technique with a new application, a number of refinements are possible. For example, other macerating agents should be sought after that require less time, and possess greater ability, to dissolve the non-cuticular material. The overall time for the treatment of the samples is still too long and new ideas should continually be tested in order to improve upon this aspect. This is necessary so that more peat cores can be treated and greater accuracy attained by comparing the results.

The botanical constituents from which the isolated cuticular material originated were identified by relating life-form and morphological features to those possessed by the cuticle of conspicuous elements of the present vegetation. This method of identification was simple to use, has contributed to our knowledge of the botanical composition of peat and should, upon refinement, yield results of greater dimension and accuracy. The basis of identification rested upon the 23 standard cuticular membranes organized into six groups. The method used to record the fragmented cuticular membranes provided a basis for the qualitative assessment of the presence of specific and generic indices of past floras.

The apparent order of the stratigraphic arrangement of plant remains as revealed by this investigation encourages the assumption that the original sequence of their deposition is truly reflected. From the stratigraphy of this profile there appears to have been a chronological progression of certain groups on the contemporary surface followed by a regression and replacement by others and the sequence of their occurrence may now be used to illustrate the history of the Copetown bog.

The phenomenon of progression and regression of the surface vegetation has been mentioned rather extensively by a number of workers, the most prominent of whom are Dansereau and Segadas-Vedas (11), Auer (1) and Dachnowski (9).

The bog was formed in the hollow of an abandoned glacial channel. It is surrounded and underlain by such fluvioglacial deposits as silt, clay and sand. The hollow appears to have been filled with water at one time, but has since become congested and filled with the remains of past and present vegetation. This appears to be the general mode of water reclamation by vegetation and for those requiring detailed knowledge of this process reference is made to Transeau (51), Soper (49), Auer (1) and in particular Dansoreau and Segadas-Vedas (11) who investigated this aspect on the bogs of the Laurentian Plateau.

Whether the Copetown bog has progressed through the six successive stages mentioned by Soper (49) during the course of its evolution, awaits further investigation. From the results of the central core, it is suggested that not all six stages were involved. It appears that a relatively short aquatic-plant stage existed which was immediately followed by the Mosses, Ericoids and Sedge-like plants. There is some doubt that Ericoid-like plant remains are present near the bottom but this awaits confirmation. The regression of one species may be so drastic, as a result of adverse environmental conditions, that it disappears from the profile. This is what probably happened to the unknown moss component which disappears completely at the 3.45 meter level. At this level Sphagnum becomes the predominant moss and between 3.3 meters and 3.7 meters the Sedge-like plants appear to have maximum representation. The Moss, Ericoid and Sedge-like plants are joined by another group, the Conifers, in the upper layers of the core. The Moss, Sedge-like, Ericoid, Conifer and Unknown groups are present in various combinations in the peat profile and except in the bands of pure plant remains, such as the Moss and Sedge-like strata, this variation in group representation is observed throughout.

It appears then that the growth and decay of surface vegetation and consequent formation and accumulation of peat is a dynamic process.

The success of this investigation, in revealing presence of identifiable cuticular material in peat and the stratigraphic associations that exist, may now be said to provide a basis for interpretation of organic terrain in palaeoecological terms.

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PLATE I

Magnification from Plate III onwards x 120 unless otherwise stated.

Oblique aerial photograph of Copetown bog. Altitude 1000'.

PLATE II

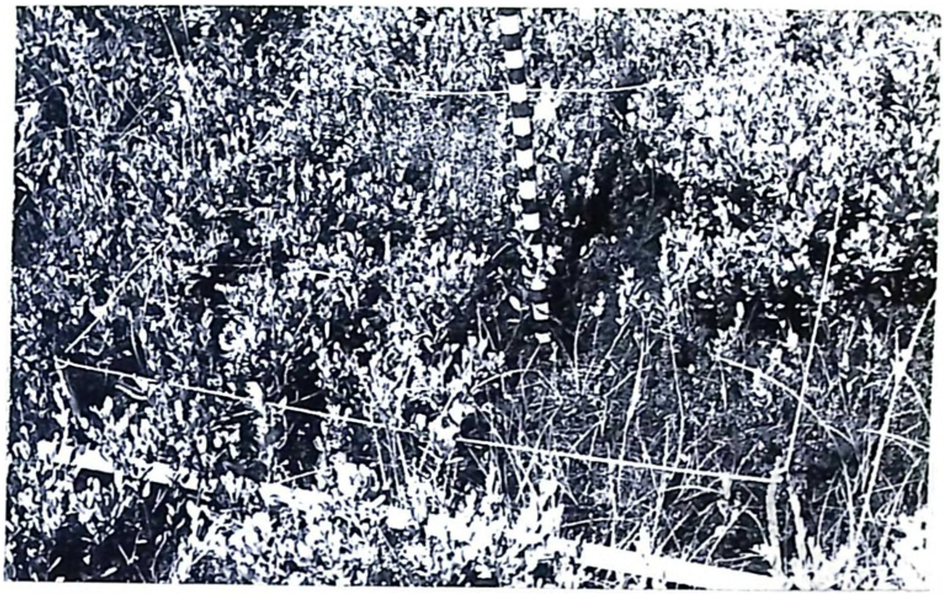


Figure 1. One meter quadrat at core site.

Figure 2. Lagg, surface vegetation and surrounding hills. Spring 1960.

PLATE III

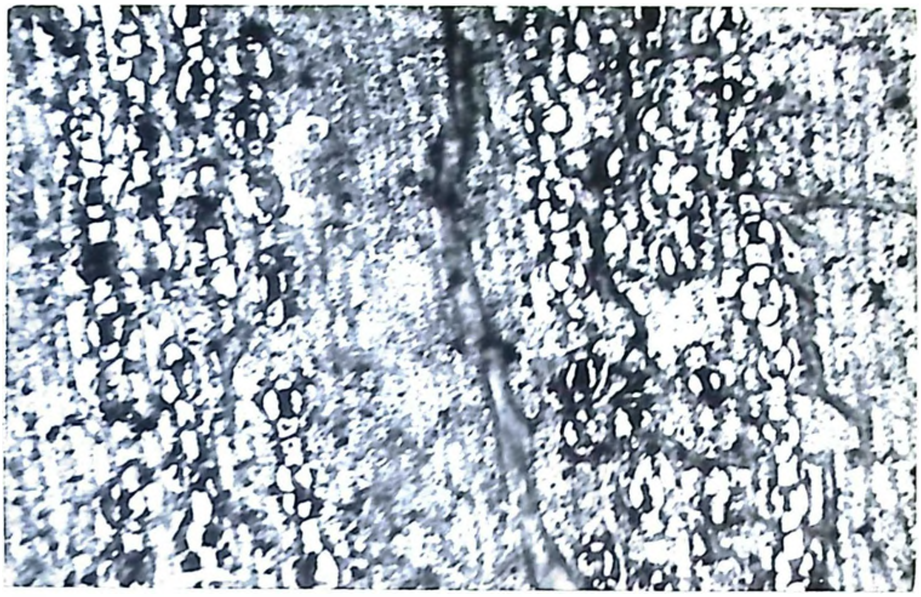


Figure 1. Picea mariana. Conifer group. Reflected light. x 220.

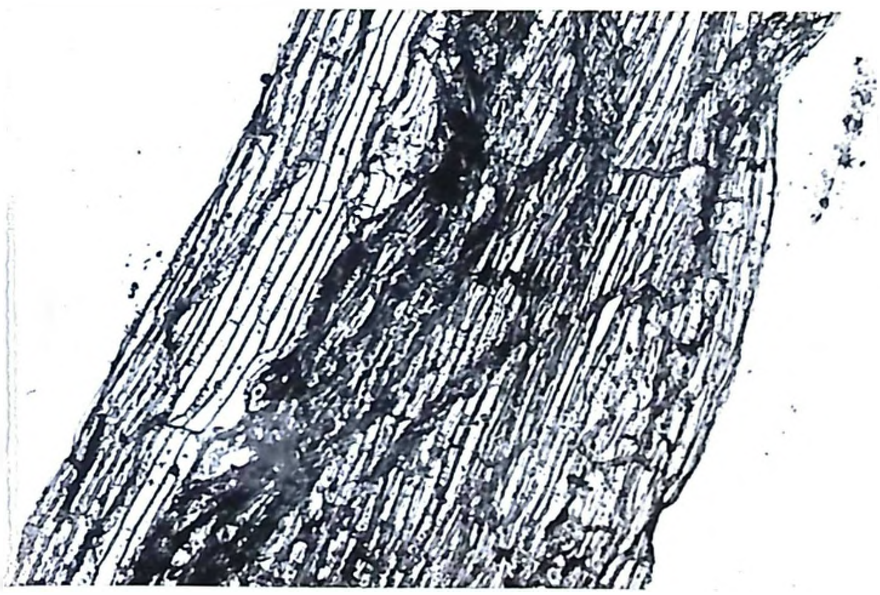


Figure 2. Larix laricina. Conifer group.

PLATE IV

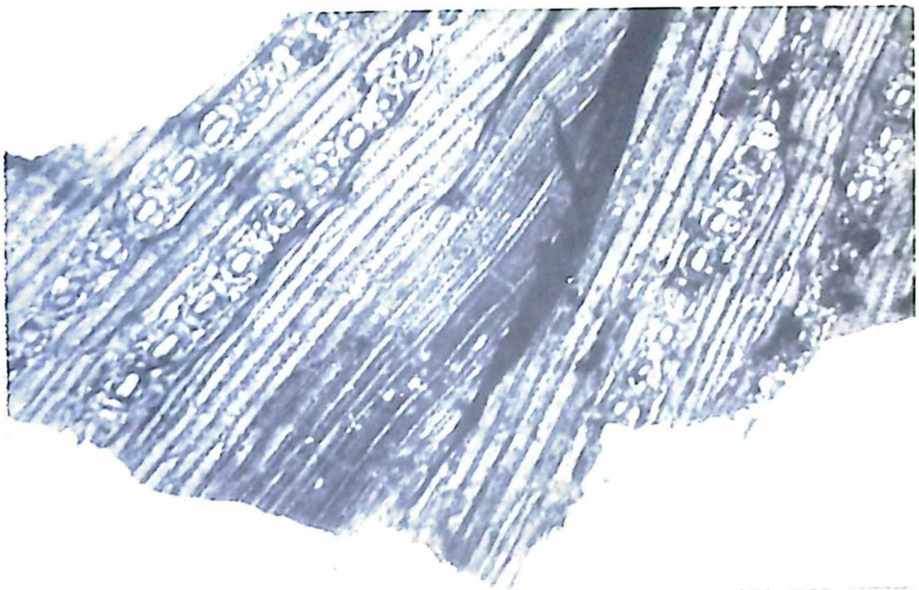


Figure 1. Pinus Strobus. Conifer group. Reflected light. x 220.

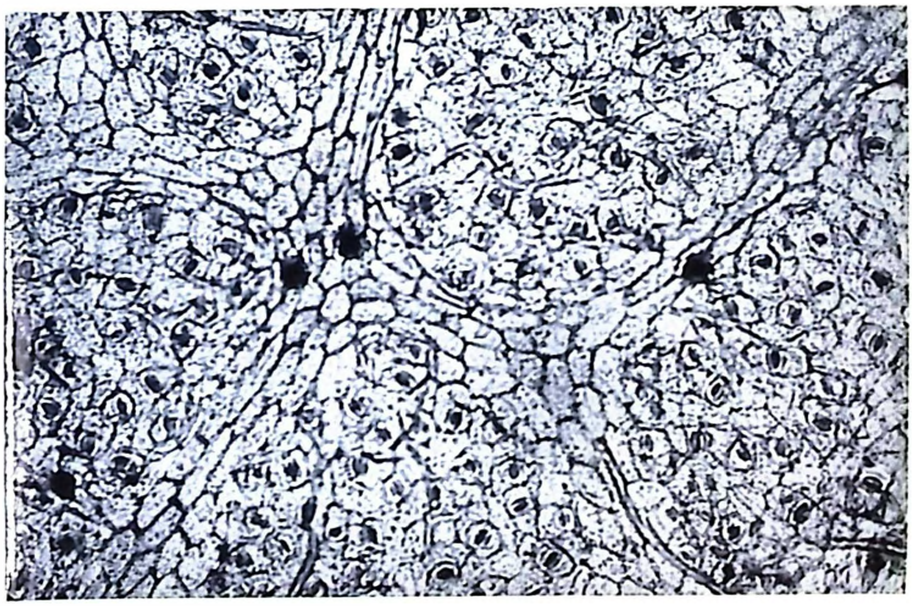


Figure 2. Salix spp. Shrub group.

PLATE V

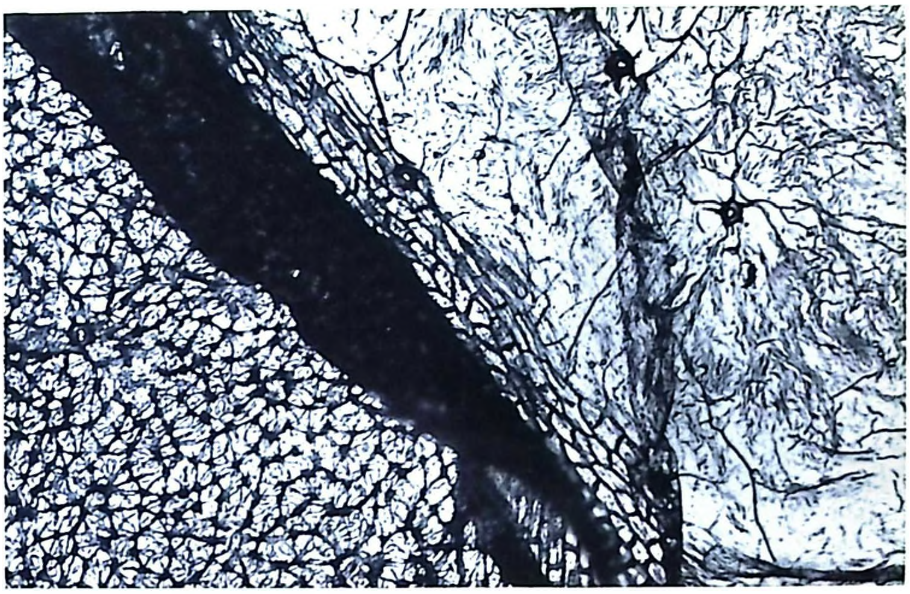


Figure 1. Cornus stolonifera. Shrub group.

Figure 2. Ilex verticillata. Shrub group.

PLATE VI

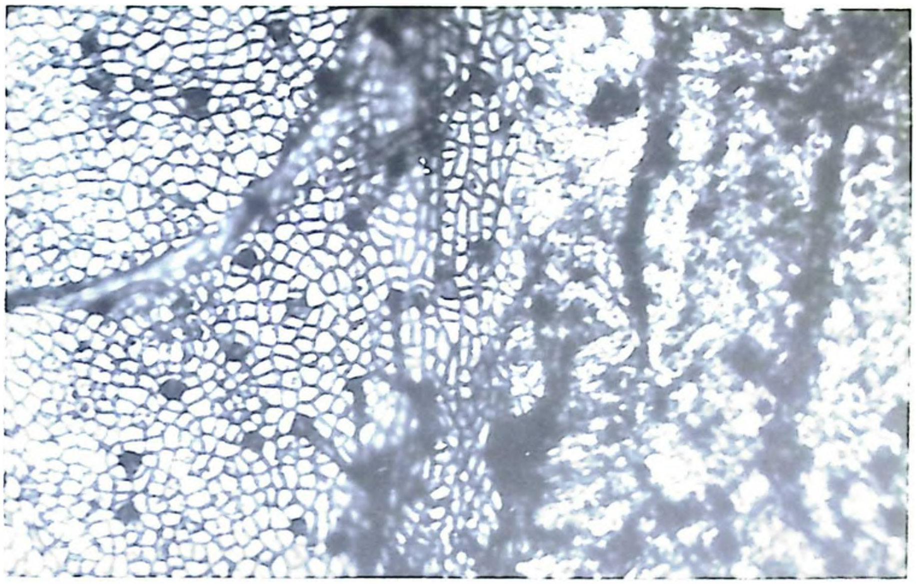


Figure 1. Vaccinium corymbosum. Shrub group. Reflected light. x 220.

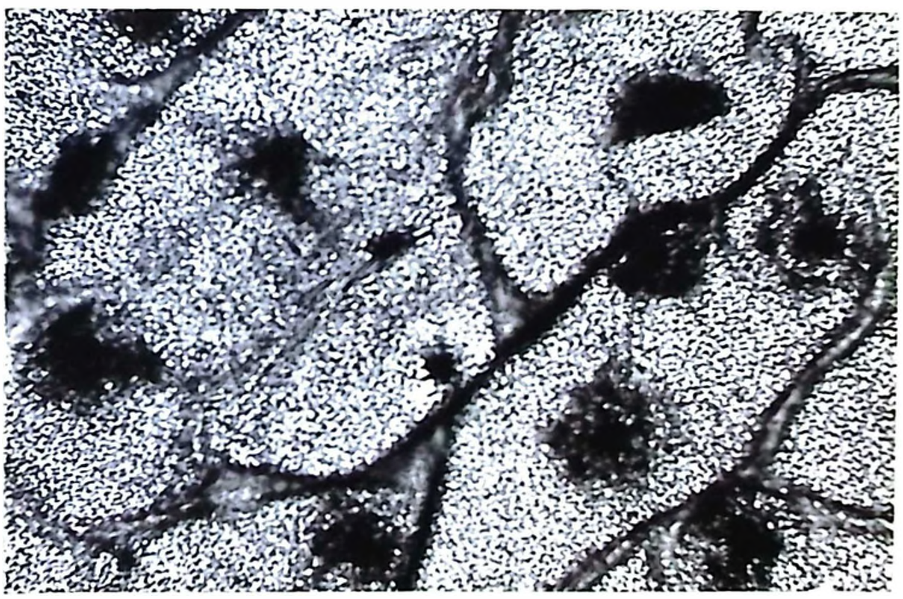


Figure 2. Chamaedaphne calyculata. Ericoid group. Upper cuticular membrane.

PLATE VII

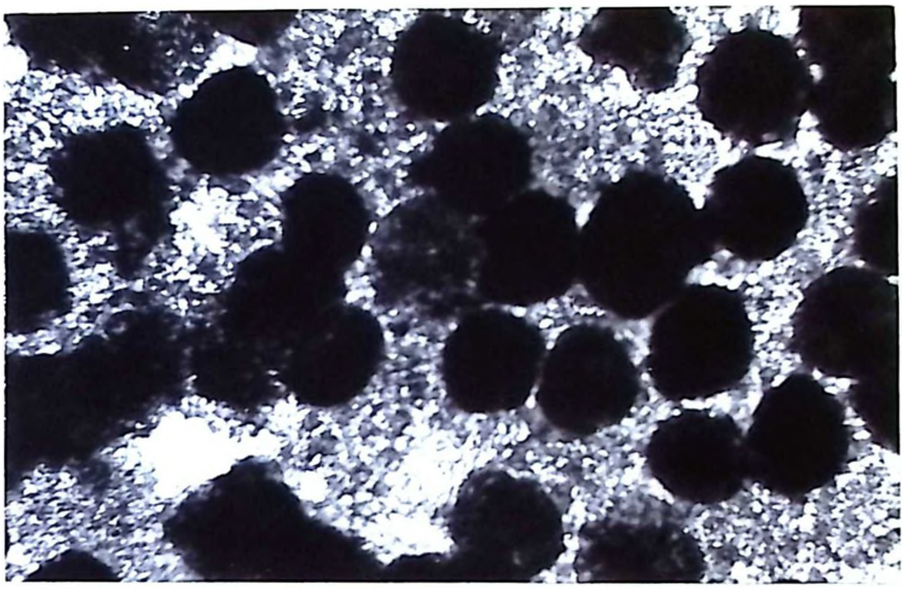


Figure 1. *Chamaedaphne calyculata.* Ericoid group. Lower cuticular membrane.

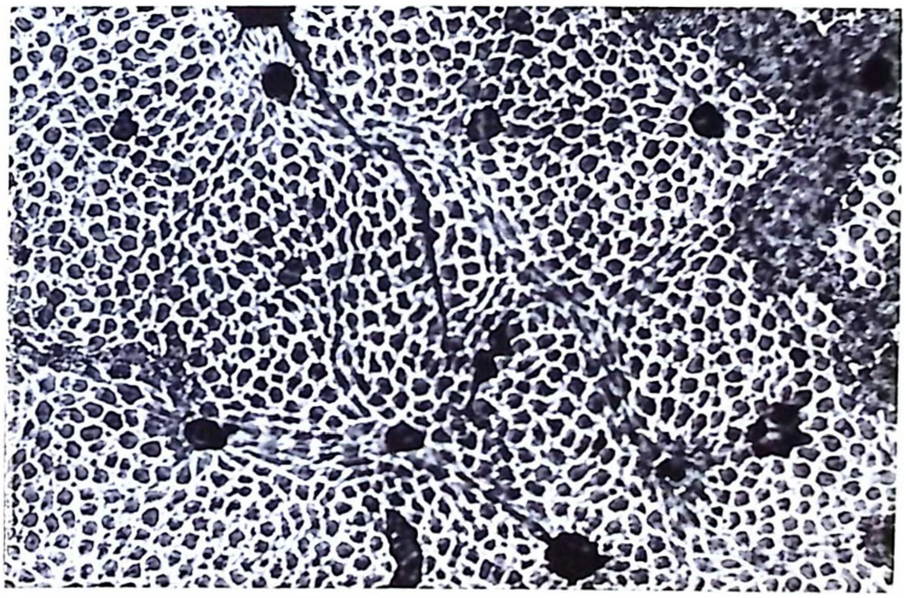


Figure 2. *Ledum groenlandicum.* Ericoid group. Upper cuticular membrane. Reflected light. x 220.

PLATE VIII

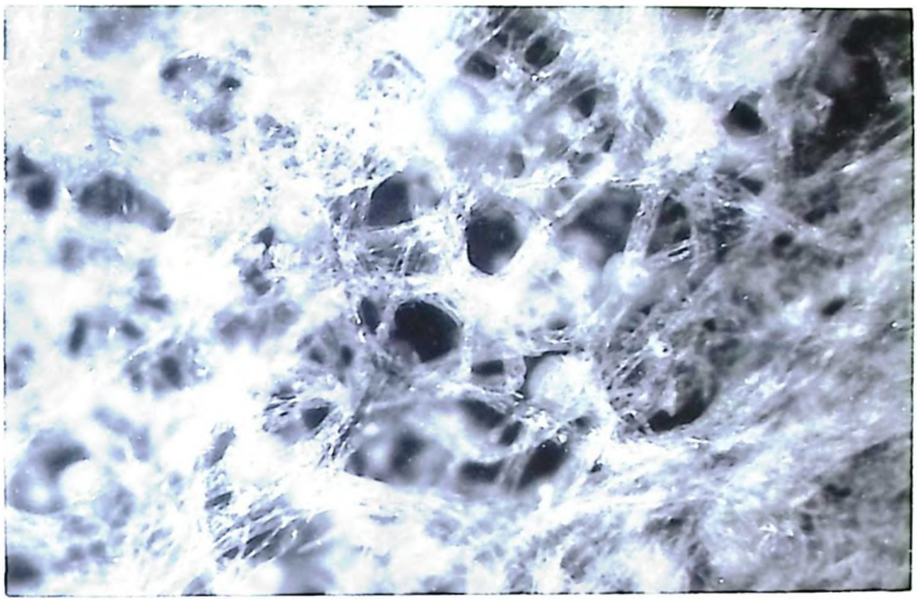


Figure 1. Ledum groenlandicum. Ericoid group. Lower cuticular membrane. Reflected light. x 220.

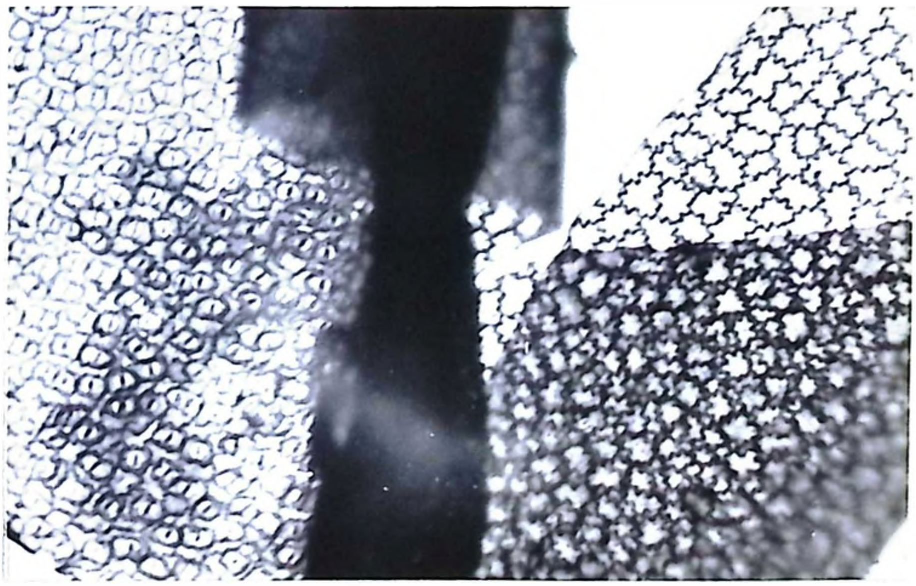


Figure 2. Vaccinium Oxycoccos. Ericoid group. Both upper and lower cuticular membranes illustrated. Reflected light. x 220

PLATE IX

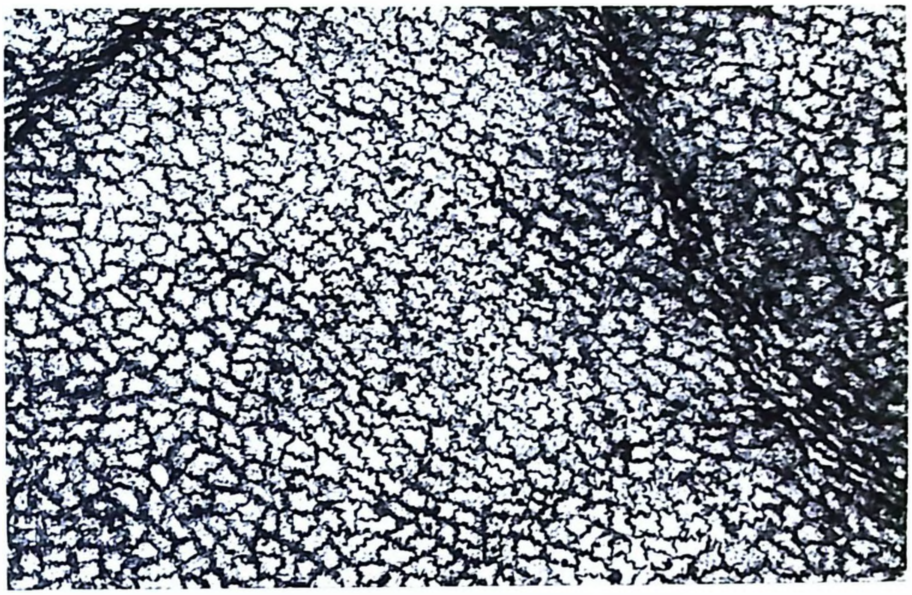


Figure 1. *Andromeda glaucophylla.* Ericoid group. Upper cuticular membrane.

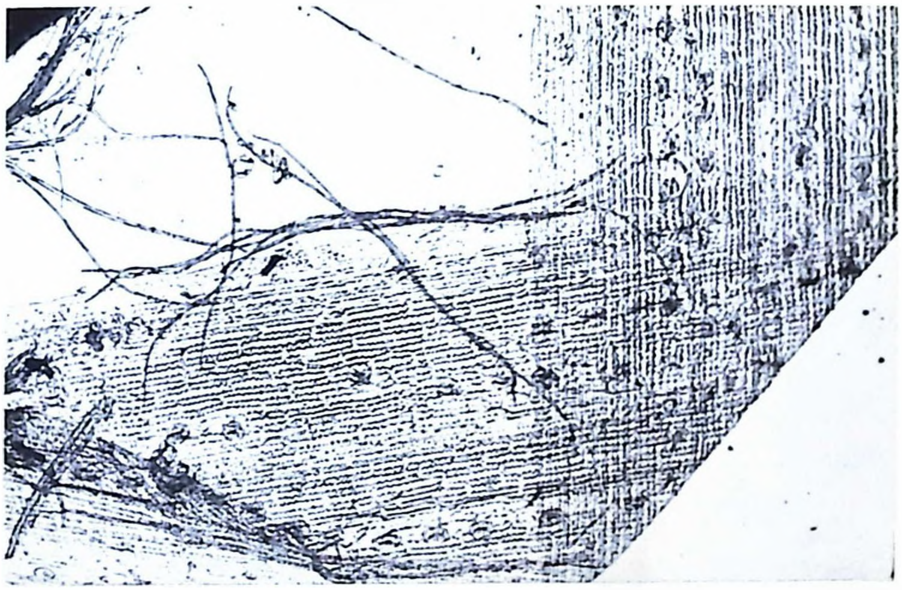


Figure 2. *Carex* spp. Sedge-like group.

PLATE XI

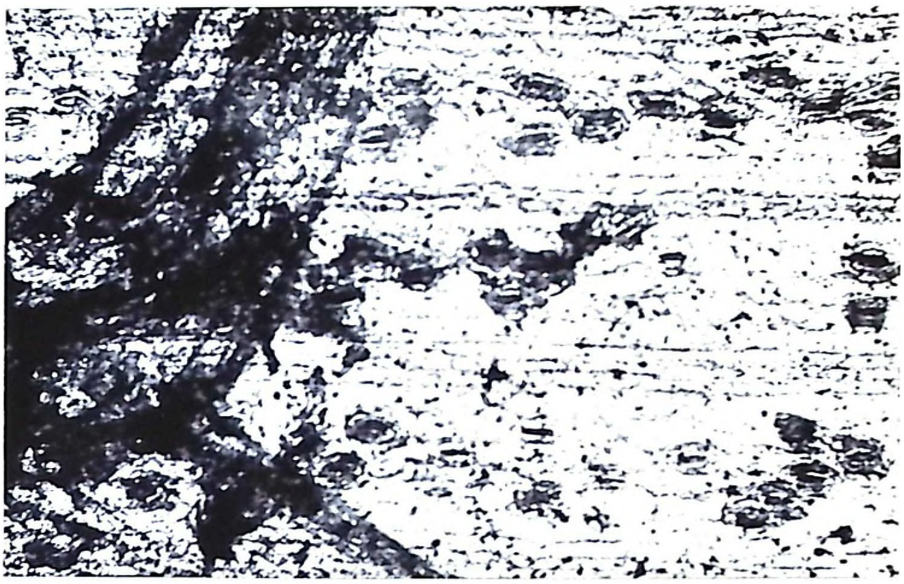


Figure 1. Eriophorum angustifolium. Sedge-like group. x 350.

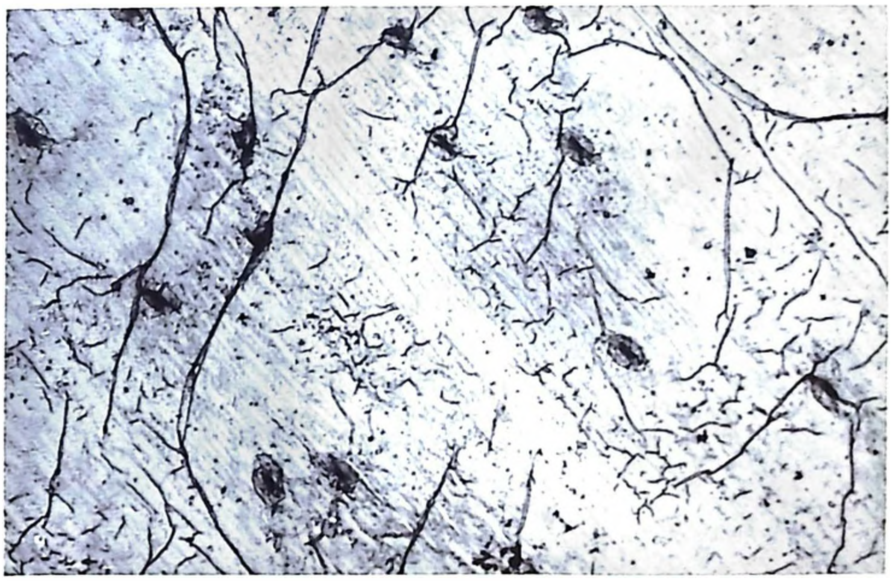


Figure 2. Juncus canadensis. Sedge-like group.

PLATE XXI

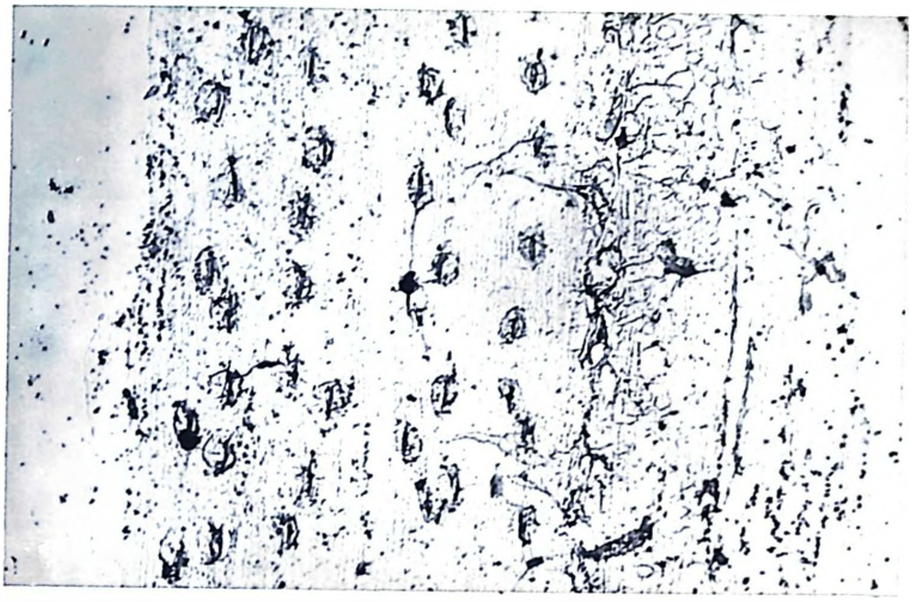


Figure 1. Dulichium arundinaceum. Sedge-like group.

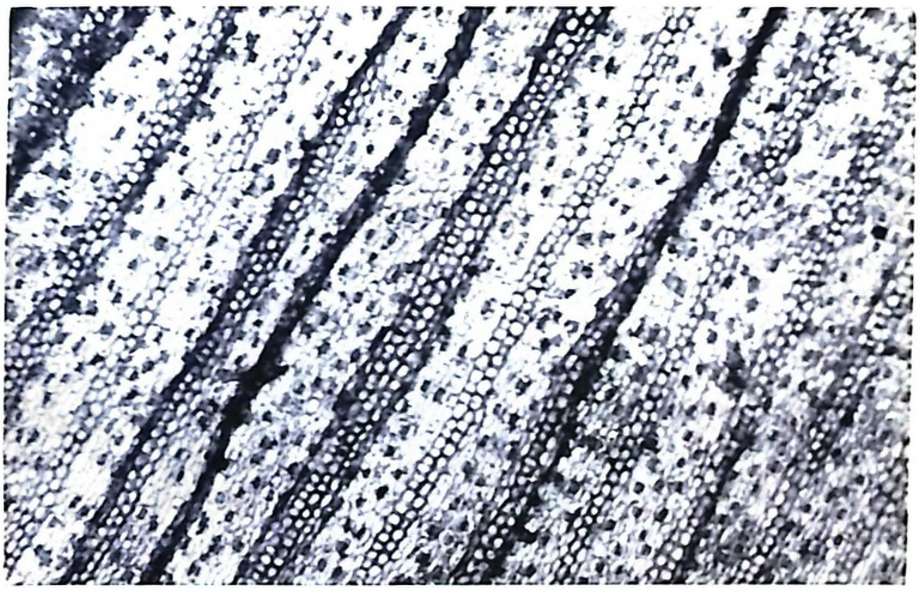


Figure 2. Typha latifolia. Sedge-like group.

PLATE XIII

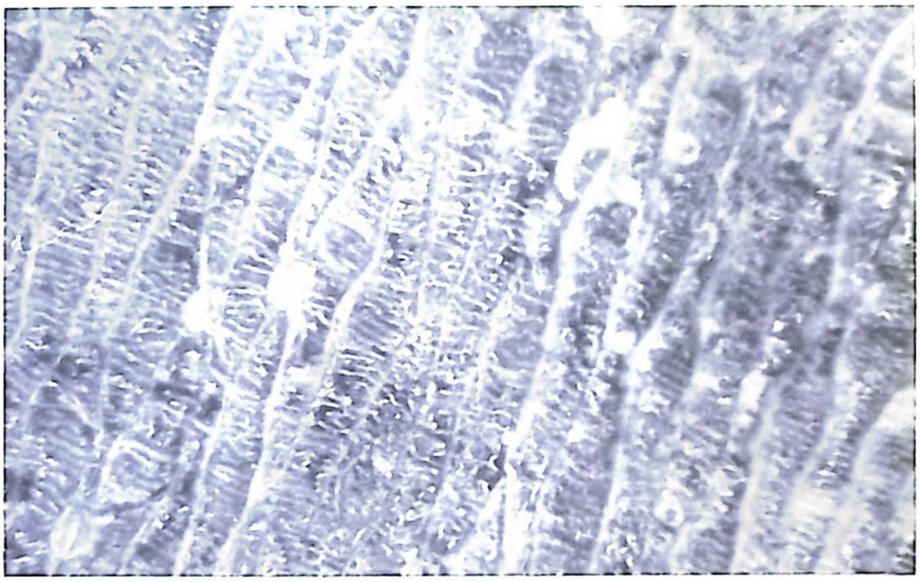


Figure 1. Iris versicolor. Sedge-like group. Reflected light. x 220.

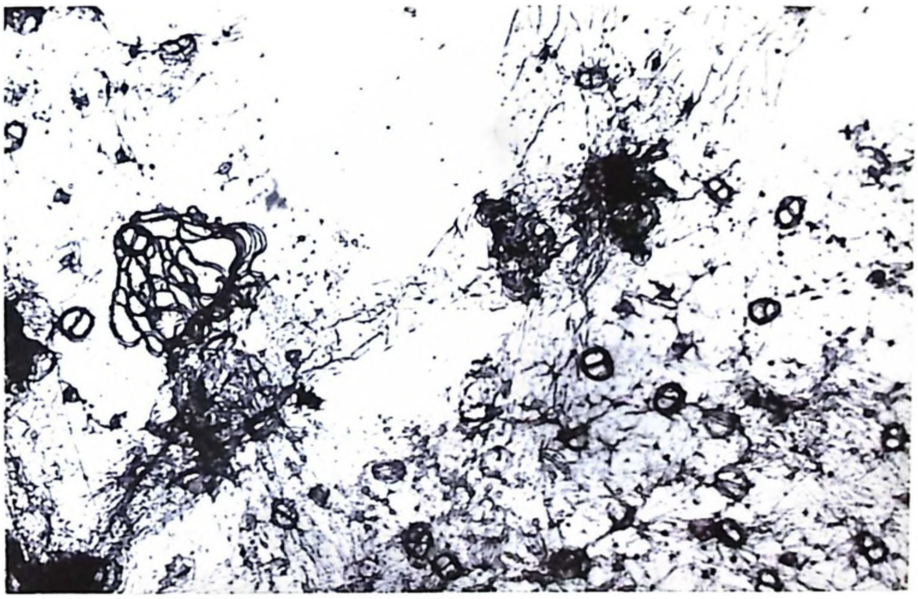


Figure 2. Drosera rotundifolia. Herb group.

PLATE XIV

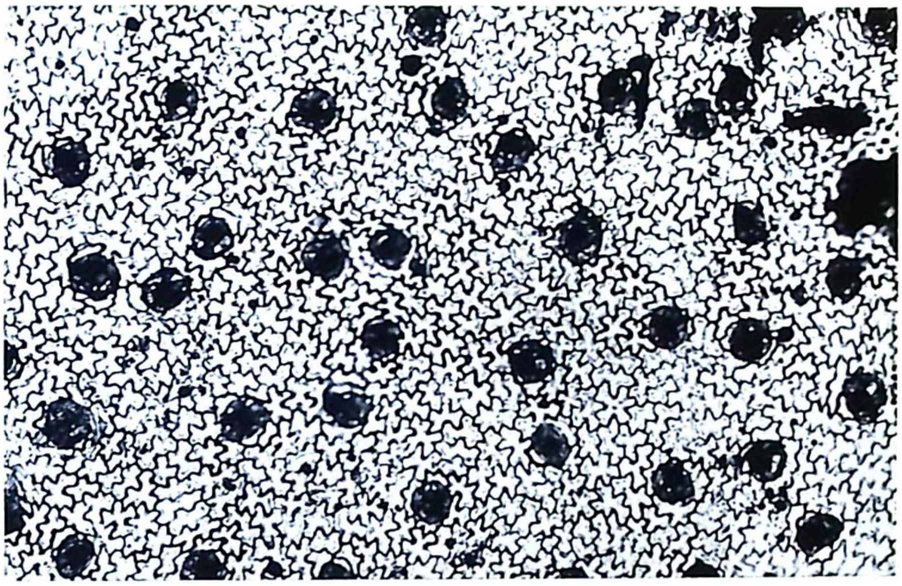


Figure 1. Sarracenia purpurea. Herb group. Upper cuticular membrane.

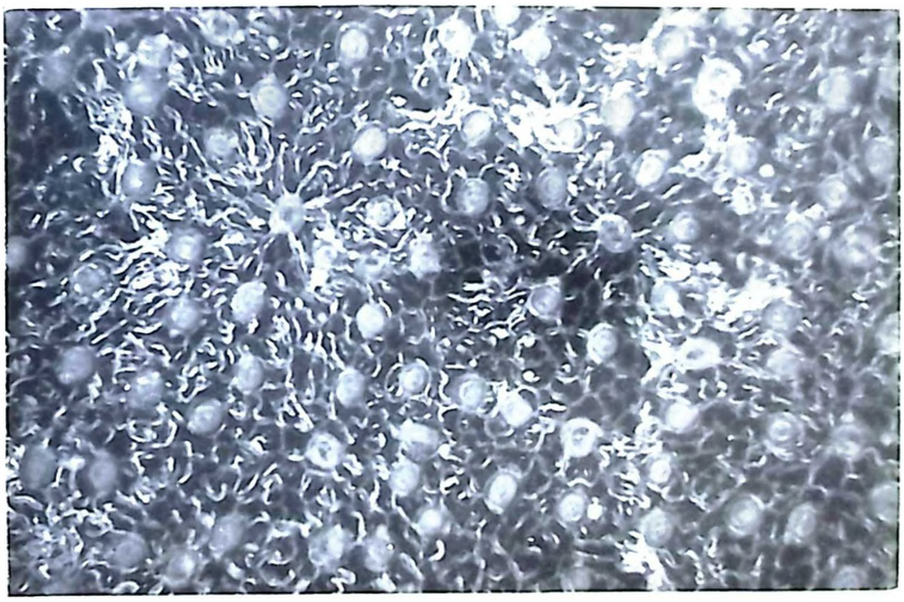


Figure 2. Sarracenia purpurea. Herb group. Lower cuticular membrane (inner surface). Reflected light. x 220.

PLATE XV

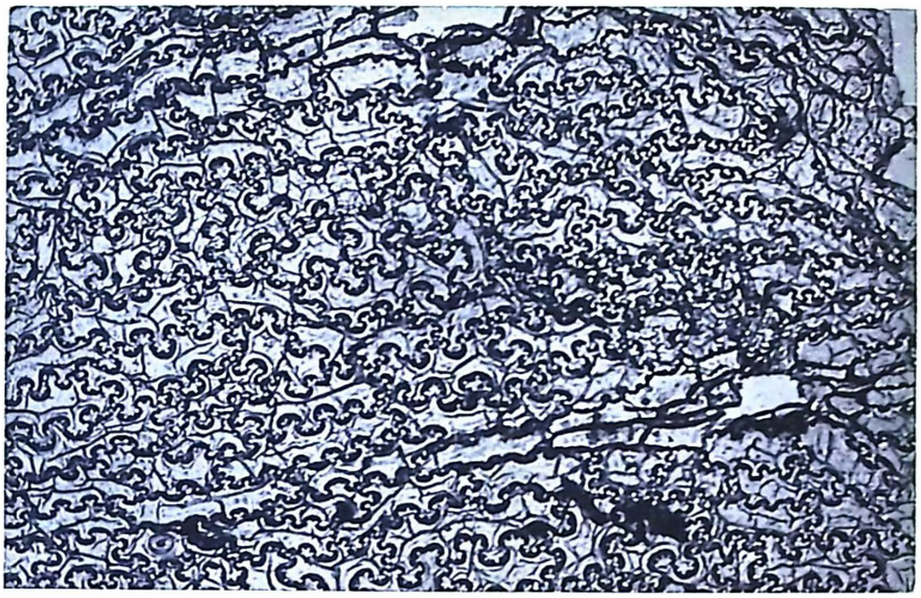


Figure 1. Woodwardia virginica. Herb group.

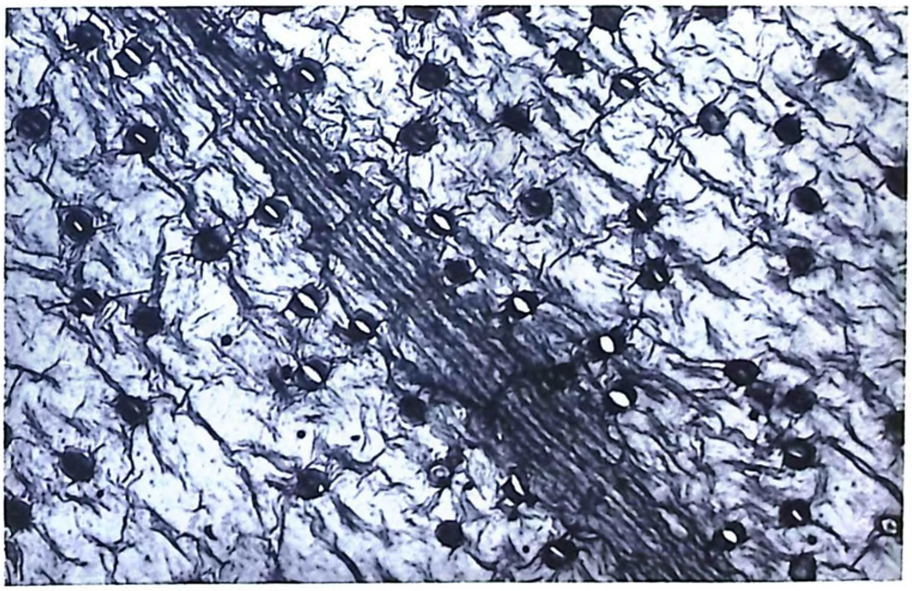


Figure 2. Calla palustris. Herb group.

PLATE XVI

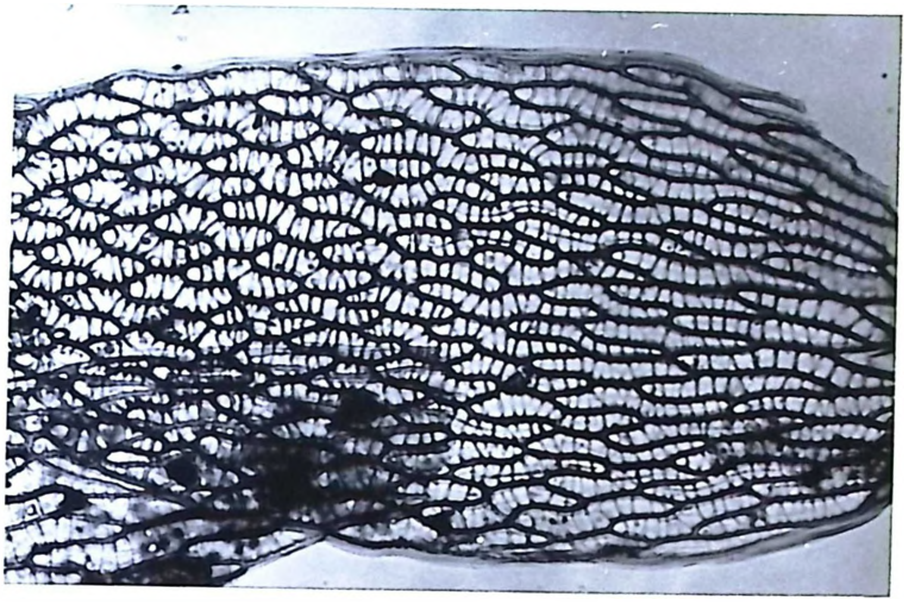


Figure 1. *Sphagnum palustre.* Moss group. x 250.

PLATE XVII

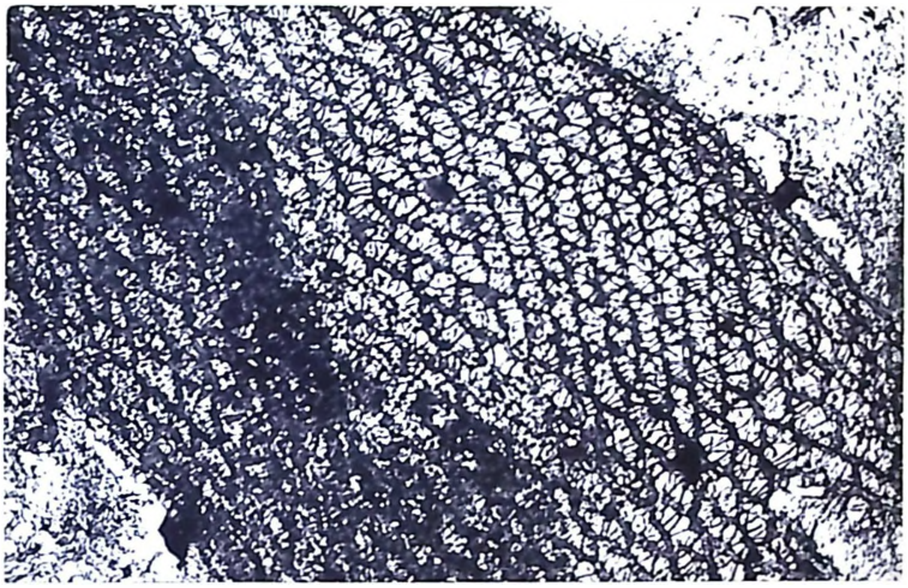


Figure 1. Sphagnum spp. Moss group. Depth 0.75 - 0.775 meters.

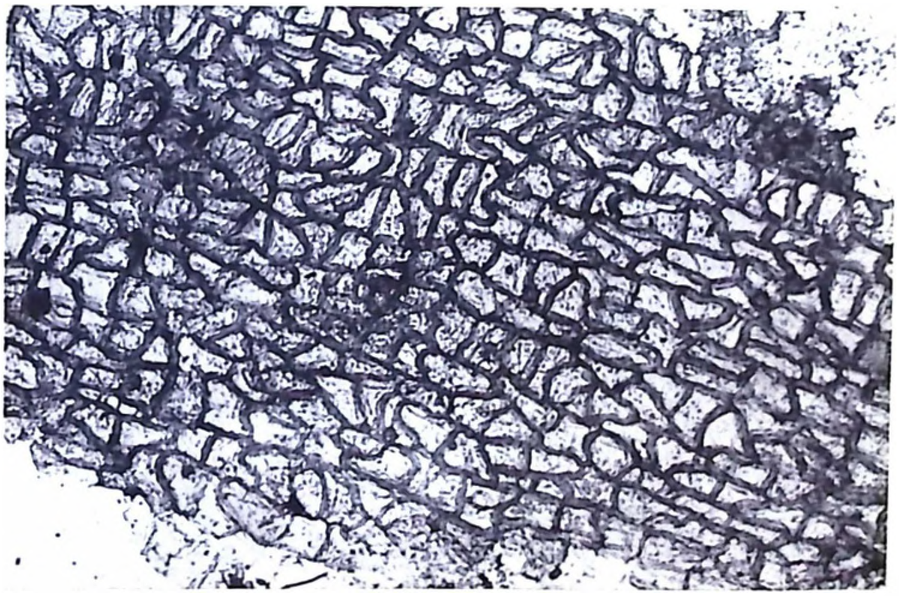


Figure 2. Ericoid group. Depth 0.375 - 0.40 meters.

PLATE XVIII

Figure 1. Ericoid group. Depth 0.6 - 0.625 meters.

Figure 2. Picea mariana. Conifer group. Depth 0.55 - 0.575 meters.

PLATE XIX

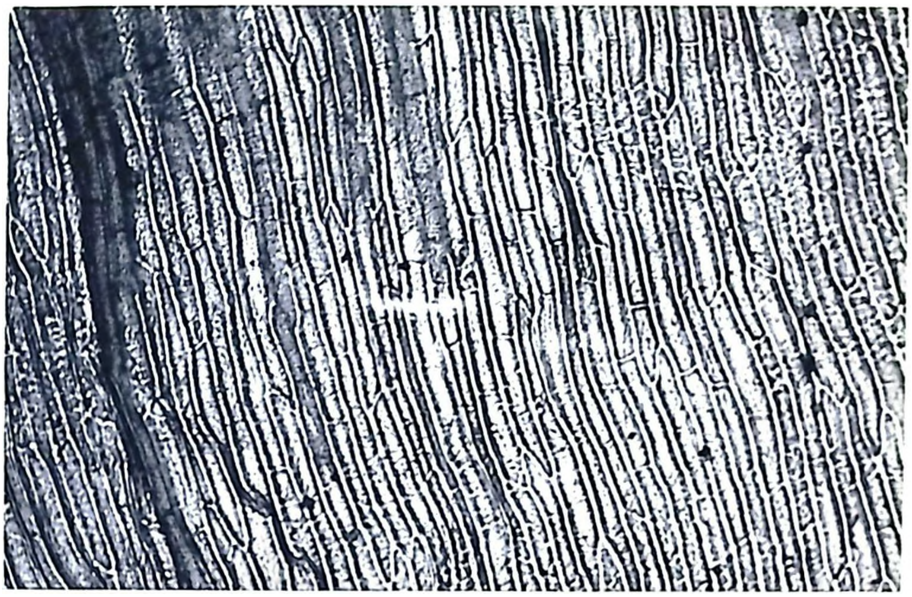


Figure 1. Sedge-like group. Depth 0.6 - 0.625 meters.

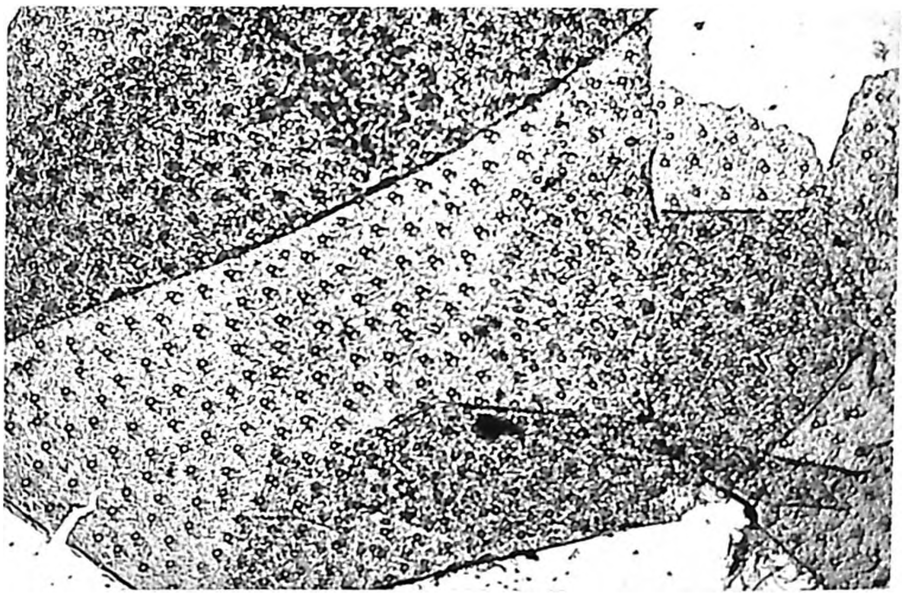


Figure 2. Unknown group. Depth 0.6 - 0.625 meters.

PLATE XX

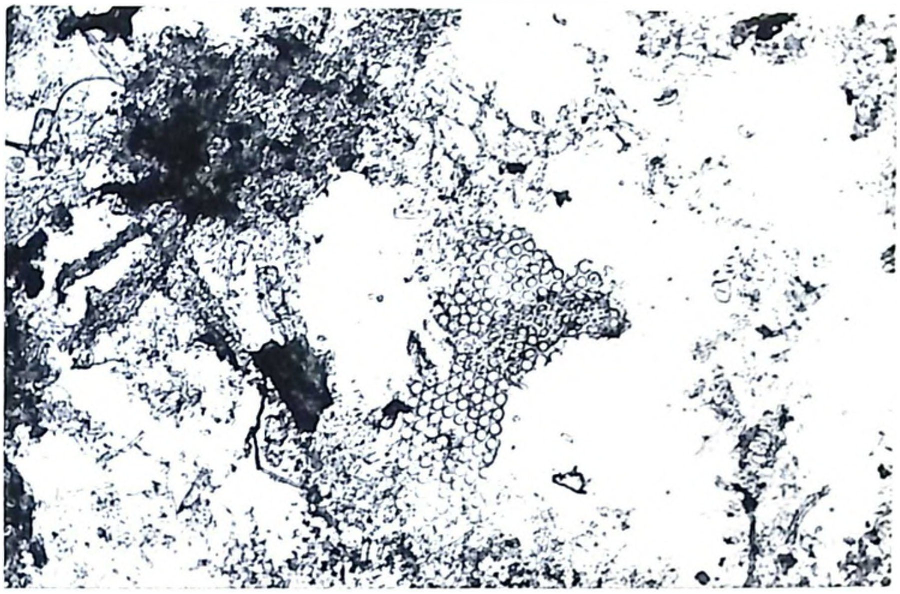
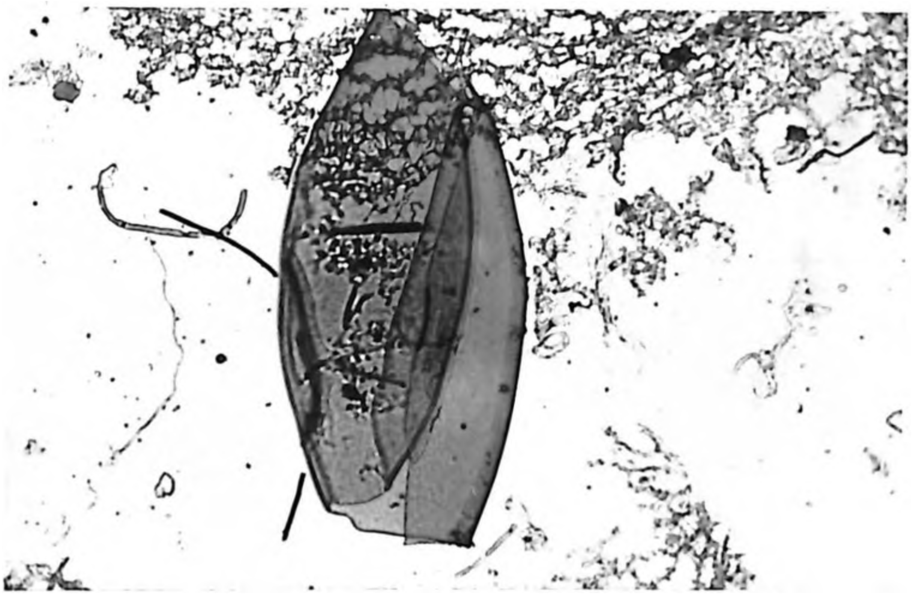


Figure 1. Unknown group. Depth 0.525 - 0.55 meters.



Figyre 2. Incidental group. Seed coat-like structure.
Depth 0.675 - 0.7 meters.

PLATE XXI

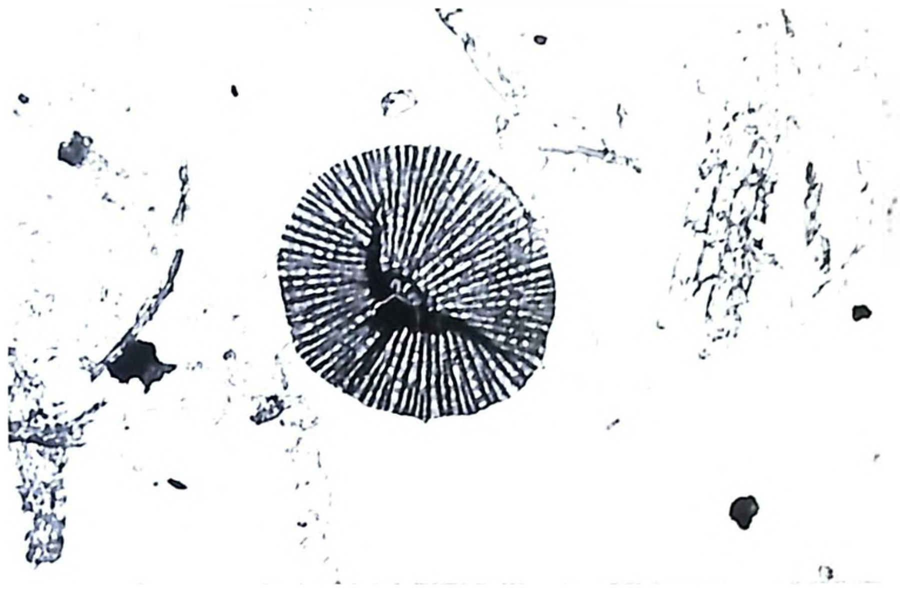


Figure 1. Incidental group. Seed-like structure. Depth 0.45 - 0.475 meters. x 250.

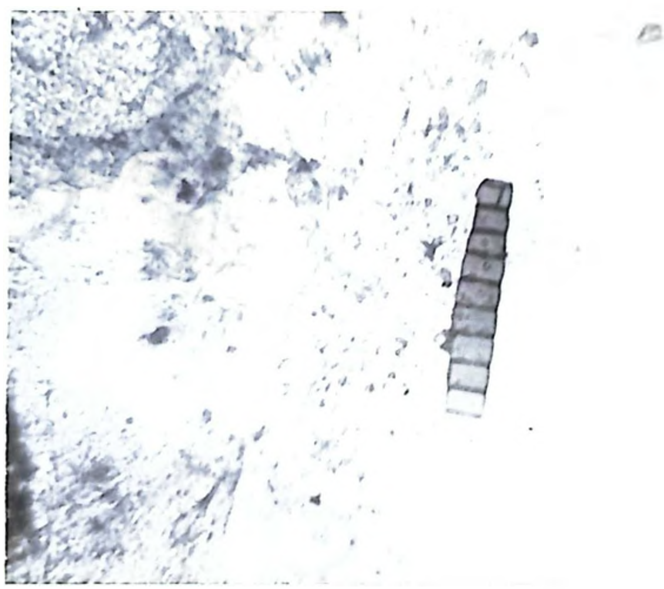


Figure 2. Incidental group. Algal or fungal-like structure. Depth 0.9 - 0.925 meters. x 350.

PLATE XXII

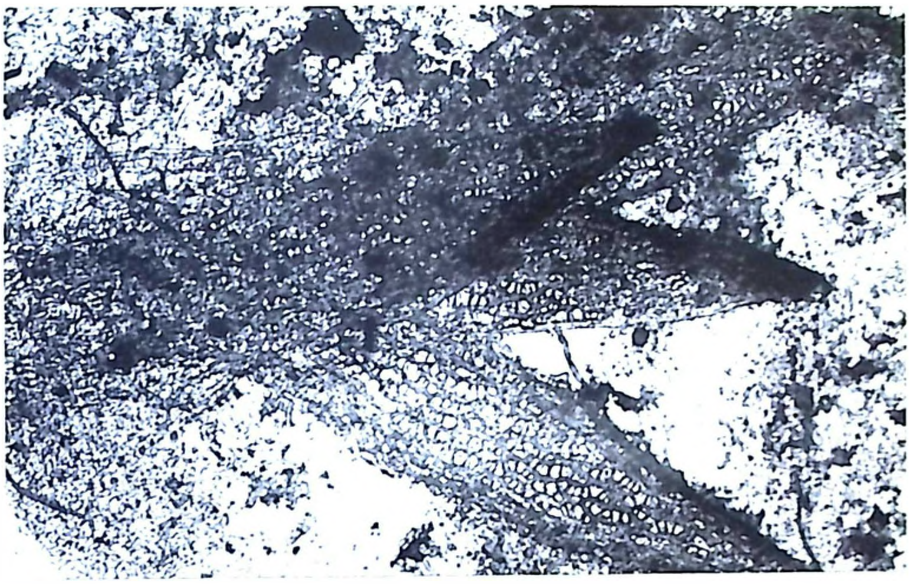


Figure 1. *Sphagnum* spp. Leaves attached to stem. Moss group. Depth 1.2 - 1.225 meters.

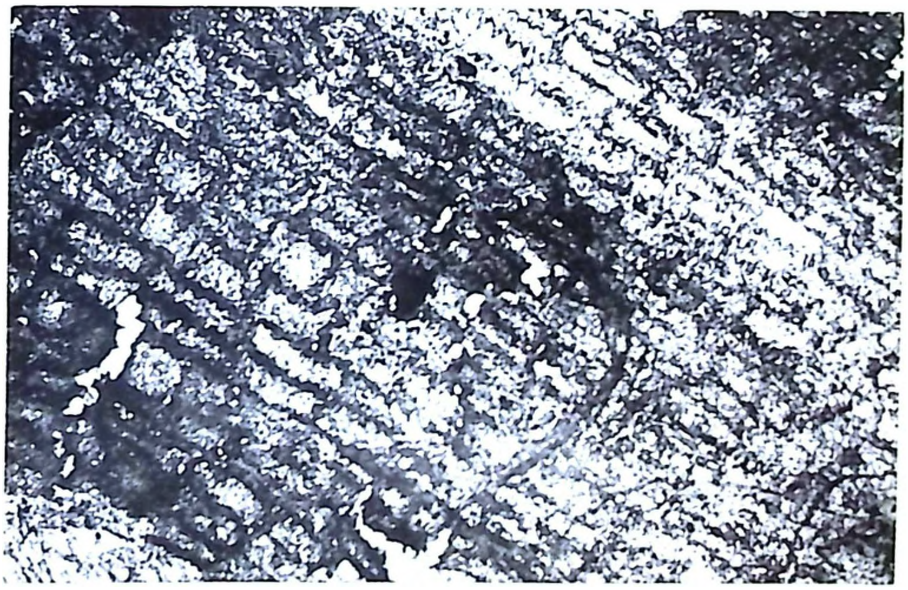


Figure 2. Ericoid group. Depth 1.9 - 1.925 meters.

PLATE XXIII

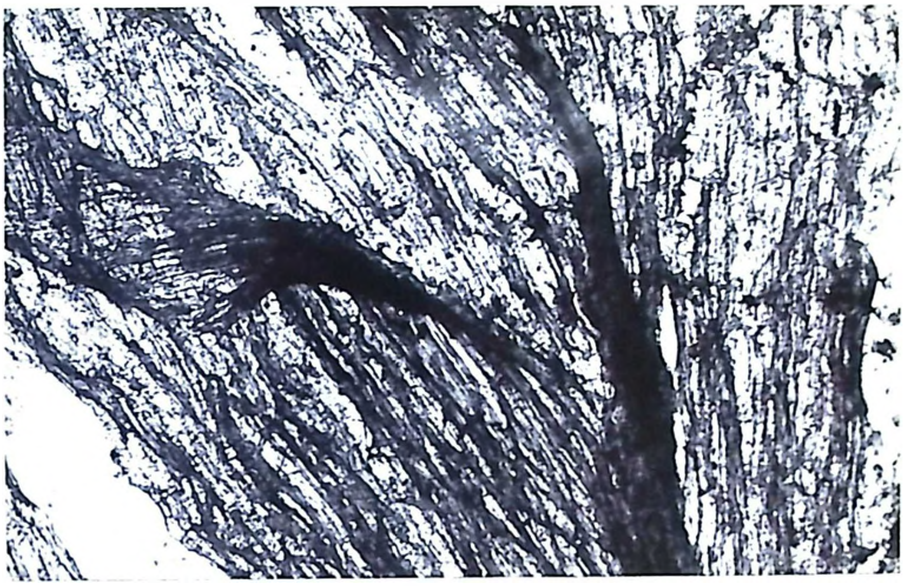


Figure 1. Incidental group. Stem. Depth 1.25 - 1.275 meters.

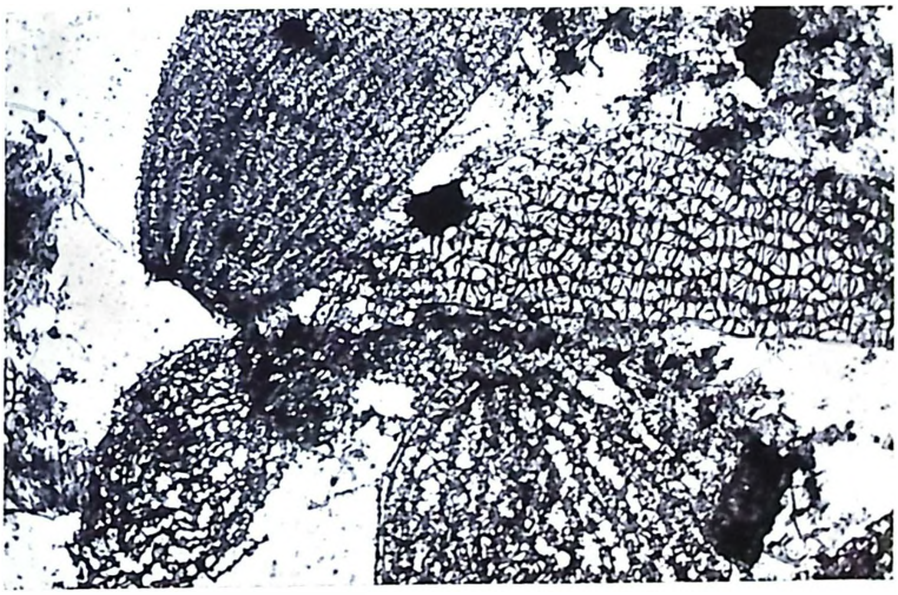


Figure 2. Sphagnum spp. Moss group. Depth 2.6 - 2.625 meters.

PLATE XXIV

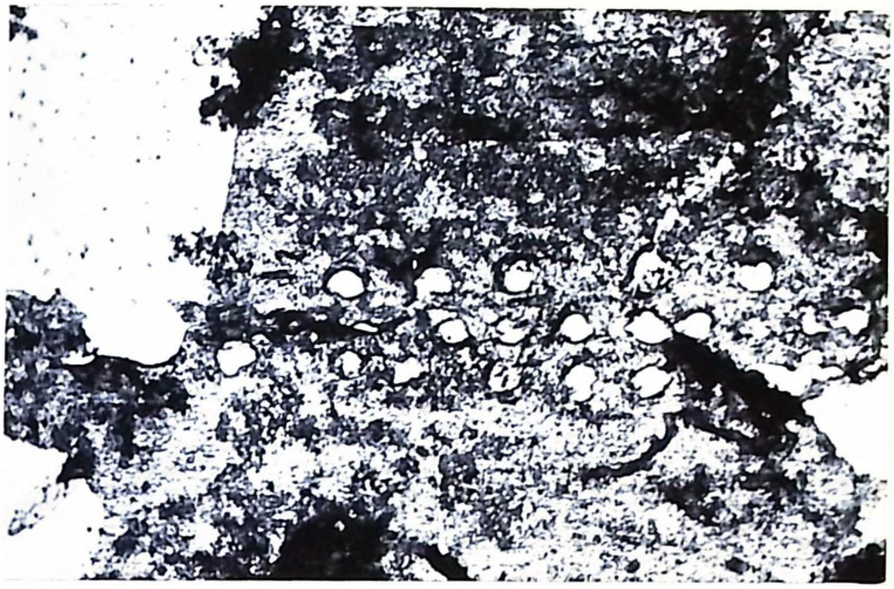


Figure 1. Conifer group. Depth 2.8 - 2.825 meters.

Figure 2. Sedge-like group. Depth 2.25 - 2.275 meters.

PLATE XXV

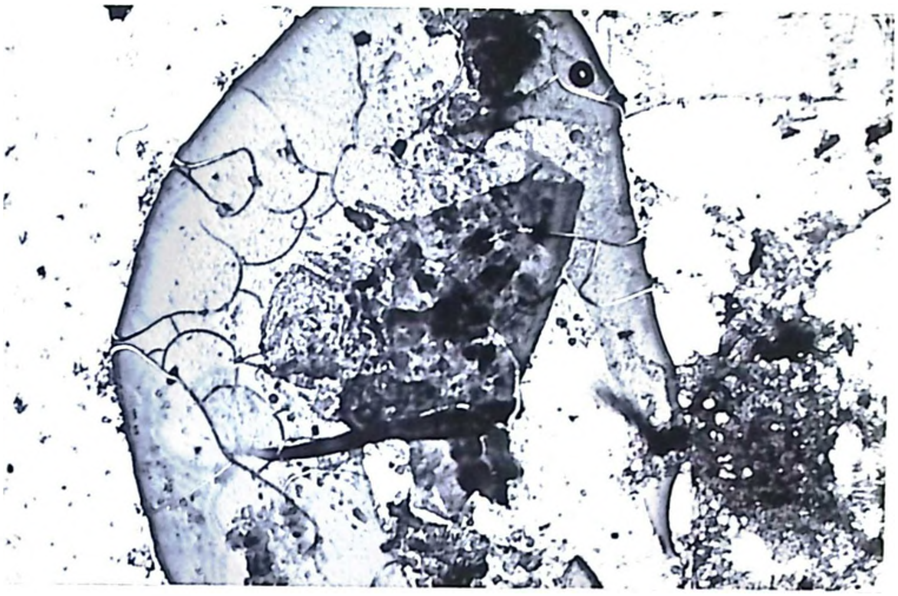


Figure 1. Unknown group. Depth 2.9 - 2.925 meters.

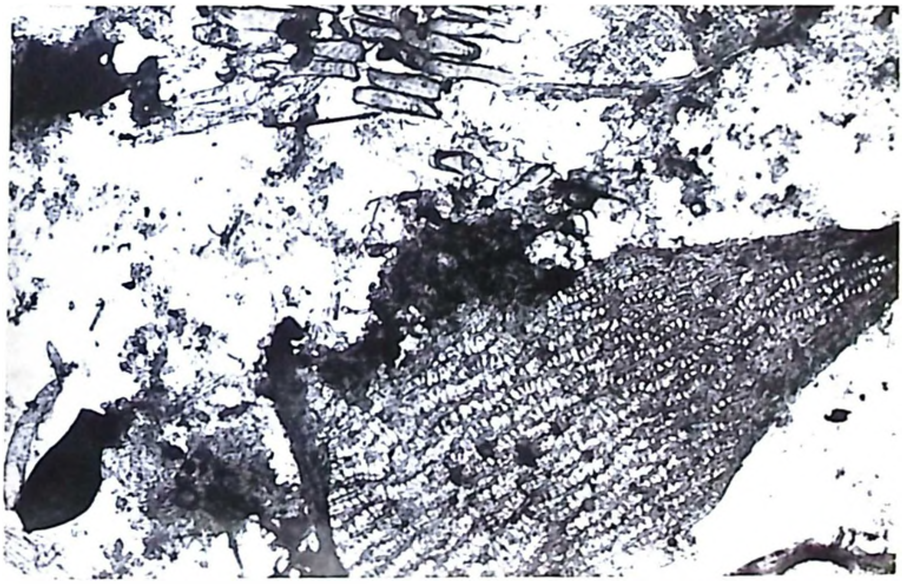


Figure 2. *Sphagnum* spp. Moss group. Depth 3.4 - 3.425 meters.

PLATE XXVI

Figure 1. Unknown moss. Moss group. Depth 3.45 - 3.475 meters.

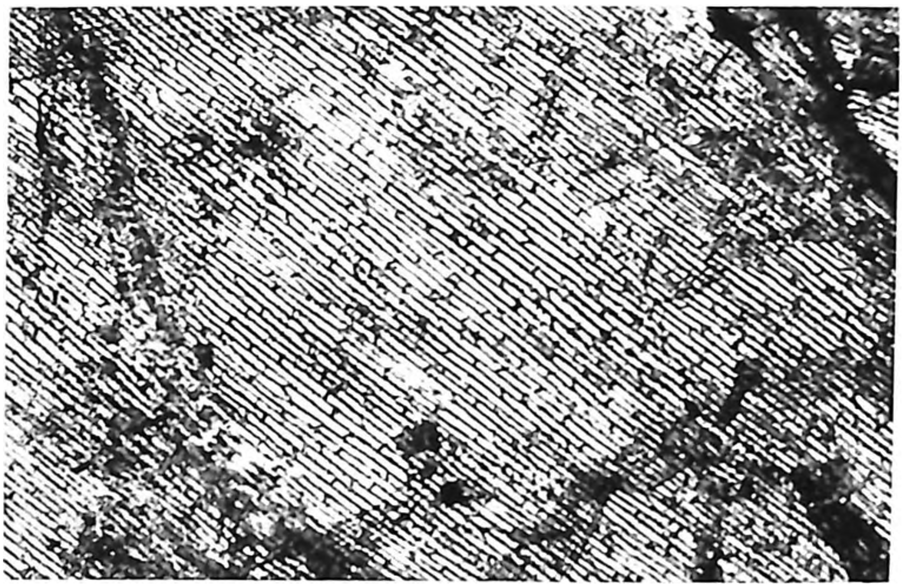


Figure 2. Sedge-like group. Depth 3.0 - 3.025 meters.

PLATE XXVII

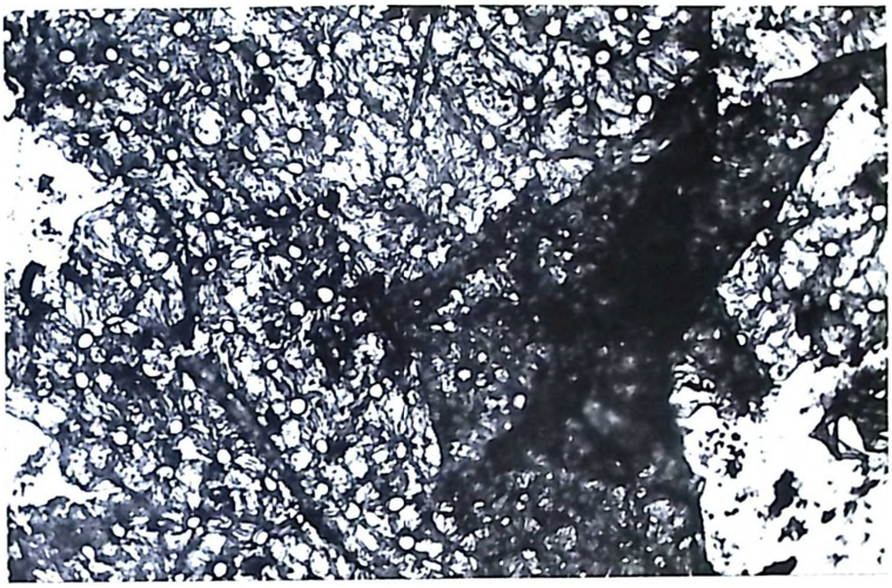


Figure 1. Unknown group. Depth 3.9 - 3.925 meters.

Figure 2. Incidental group. Stem. Depth 3.6 - 3.625 meters.

PLATE XXVIII

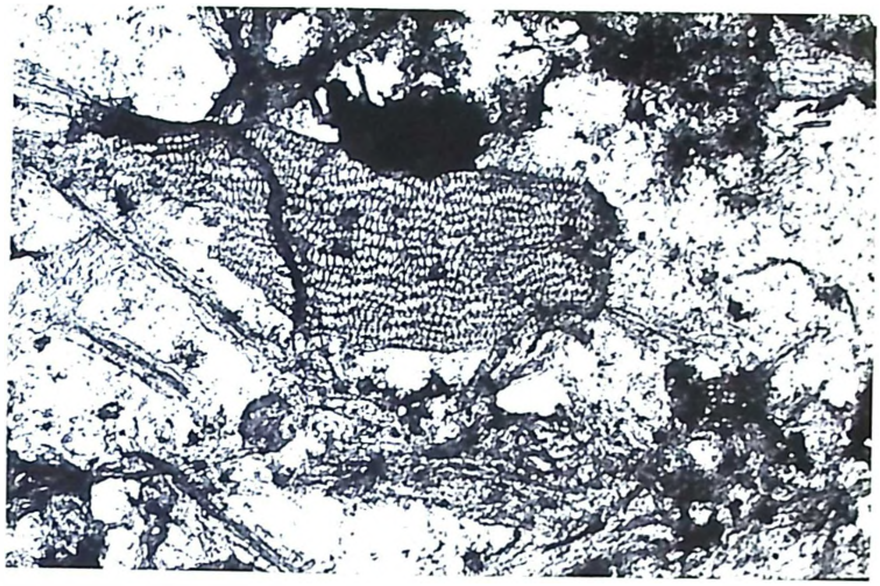


Figure 1. *Sphagnum* spp. Moss group. Depth 4.0 - 4.025 meters.

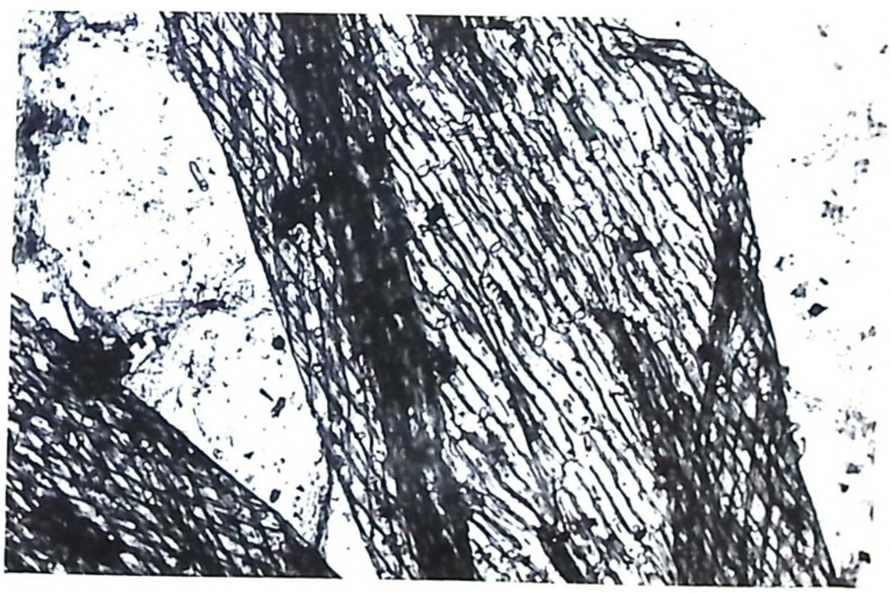


Figure 2. Sedge-like group. Depth 4.425 - 4.45 meters.

PLATE XXIX

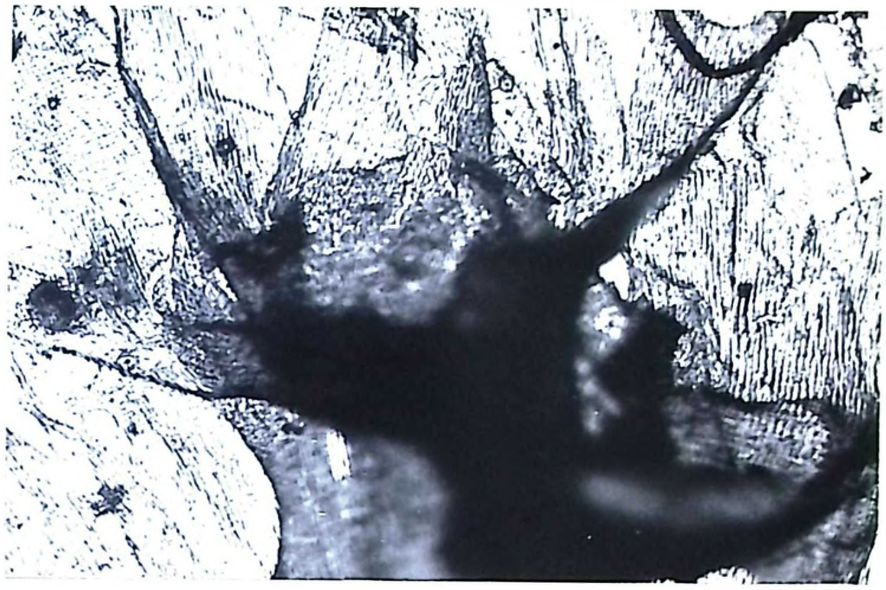


Figure 1. Unknown moss leaves attached to stem. Moss group. Depth 5.1 - 5.125 meters.

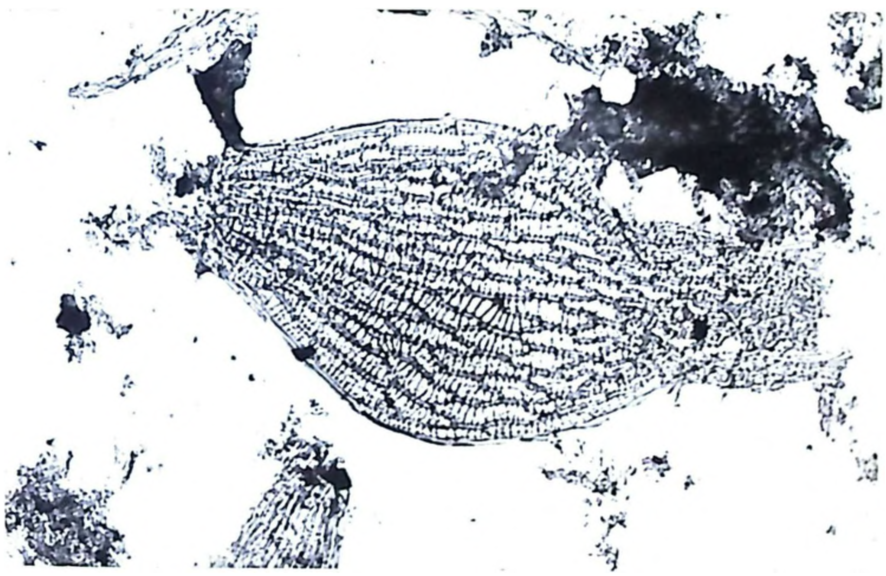


Figure 2. Sphagnum spp. Moss group. Depth 5.7 - 5.725 meters.

PLATE XXX

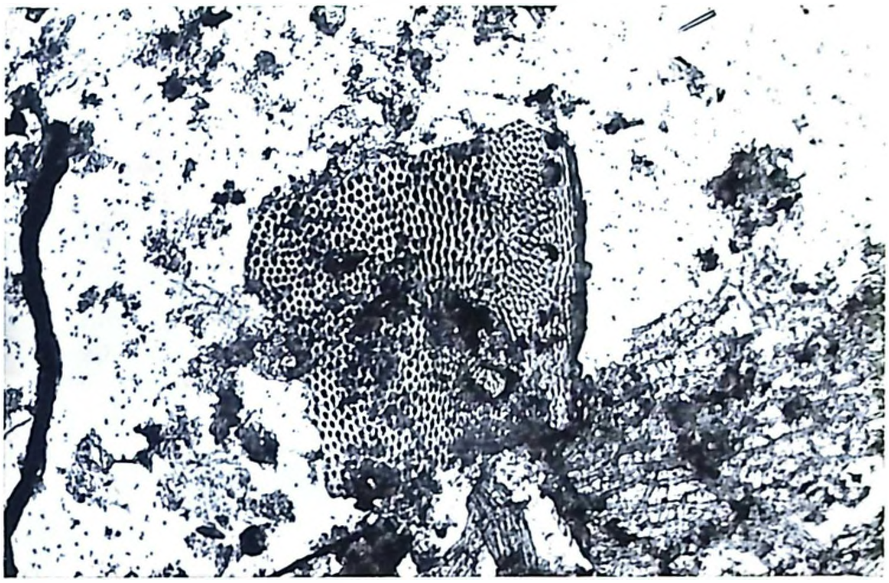


Figure 1. Ericoid group. Depth 5.3 - 5.325 meters.

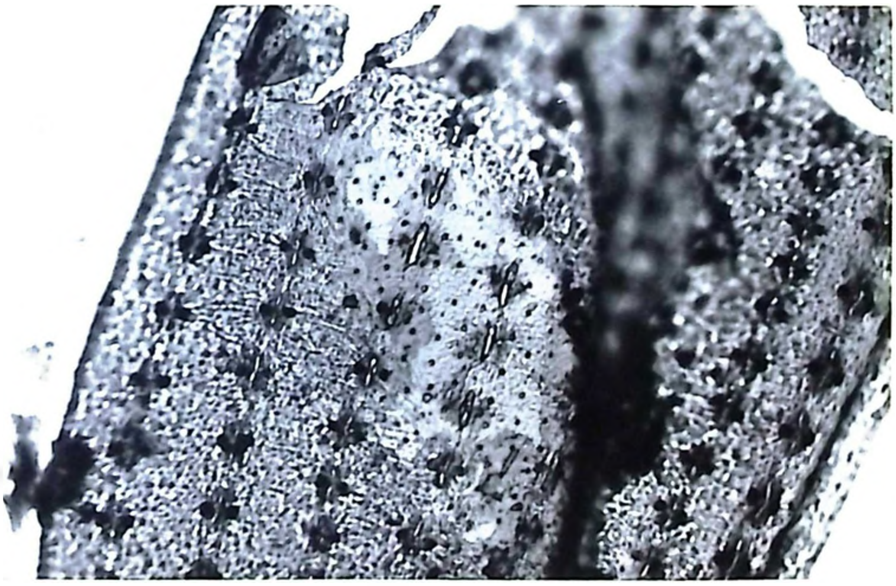


Figure 2. Unknown group. Depth 5.4 - 5.425 meters.

PLATE XXXI

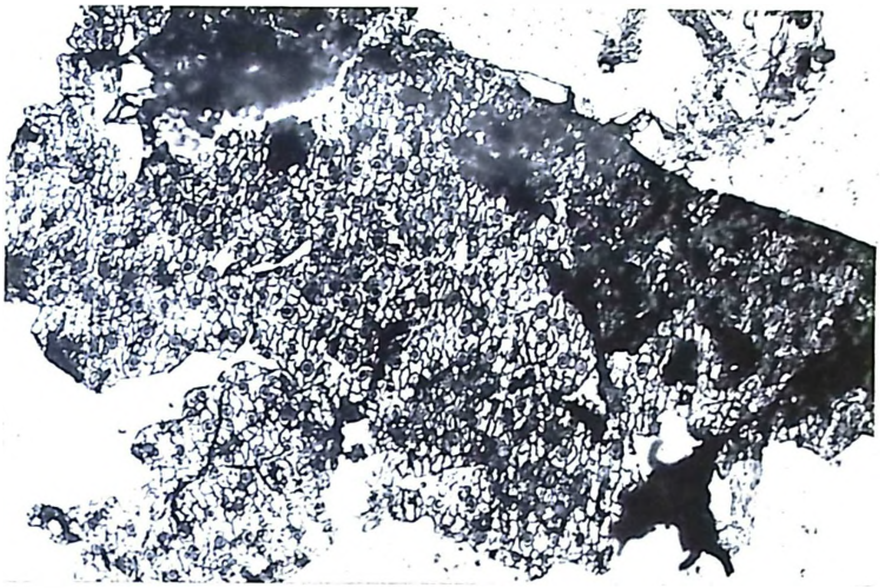


Figure 1. Unknown group. Depth 5.15 - 5.275 meters.

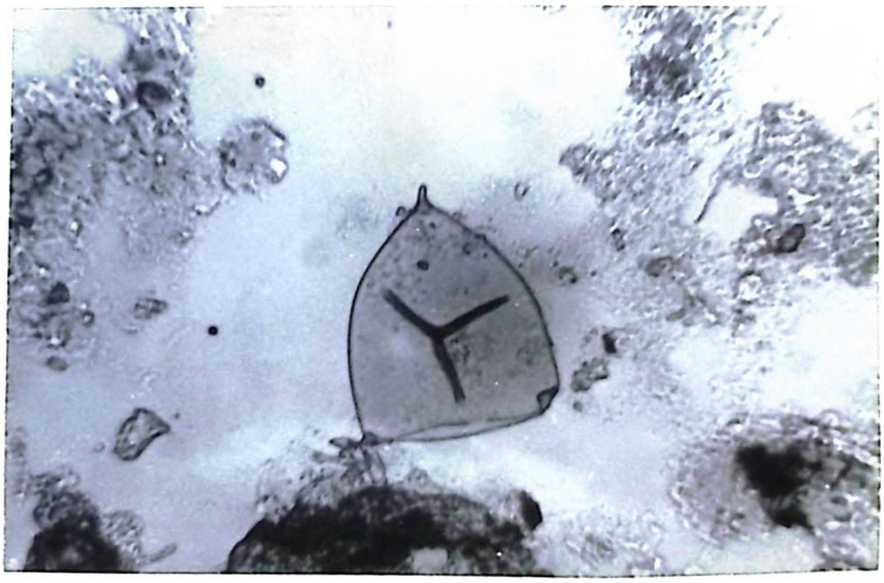


Figure 2. Incidental group. Spore-like object. Depth 5.25 - 5.275 meters. x 350.

PLATE XXXII

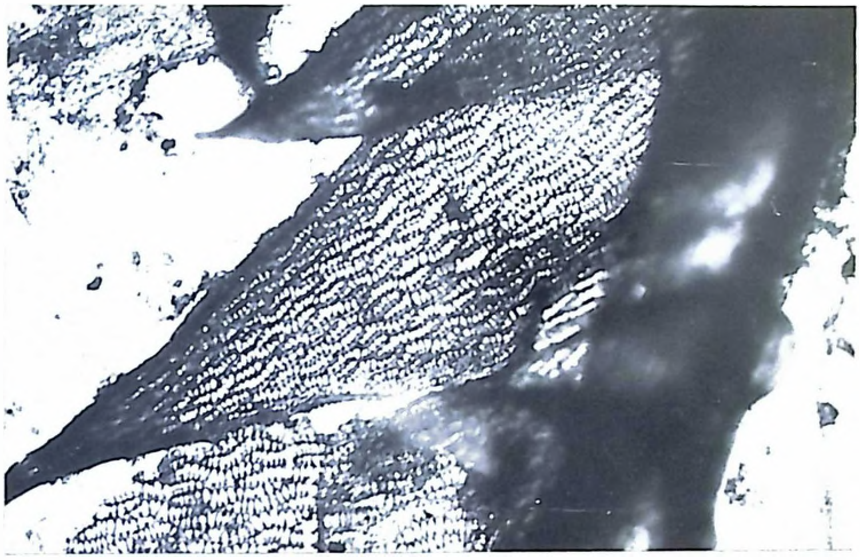


Figure 1. *Sphagnum* spp. Leaves attached to stem. Moss group. Depth 6.0 - 6.025 meters.

Figure 2. Unknown moss leaves attached to stem. Moss group. Depth 6.025 - 6.05 meters.

PLATE XXXIII

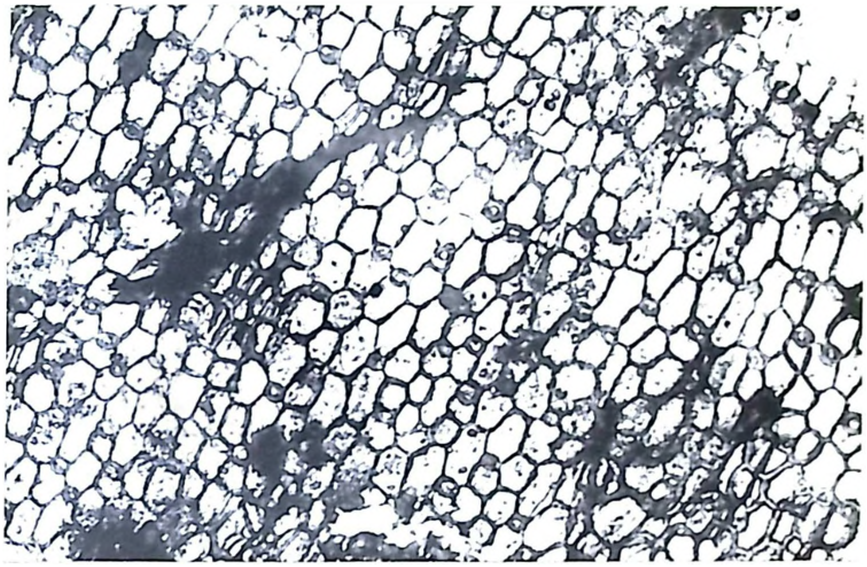


Figure 1. Incidental group. Stem. Depth 6.1 - 6.125 meter.

Figure 2. Sphagnum spp. Moss group. Depth 7.025 - 7.05 meters.

PLATE XXXIV

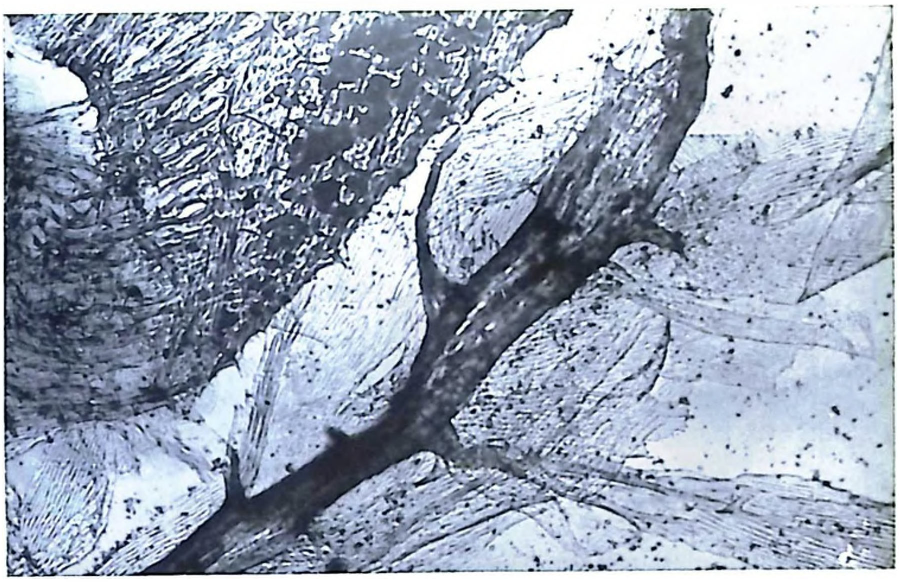


Figure 1. Unknown moss leaves attached to stem. Moss group. Depth 7.2 - 7.225 meters.

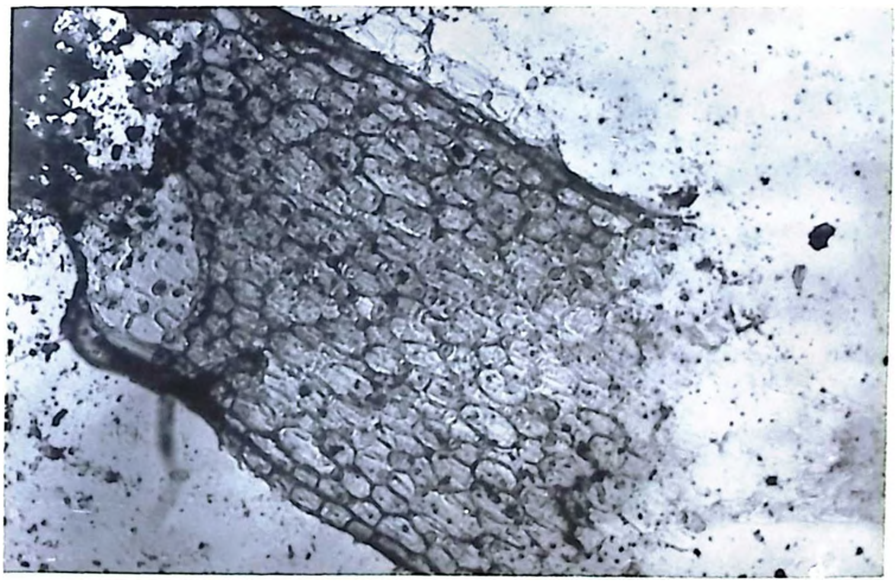


Figure 2. Incidental group. Stem. Depth 7.3 - 7.325 meters.

PLATE XXXV

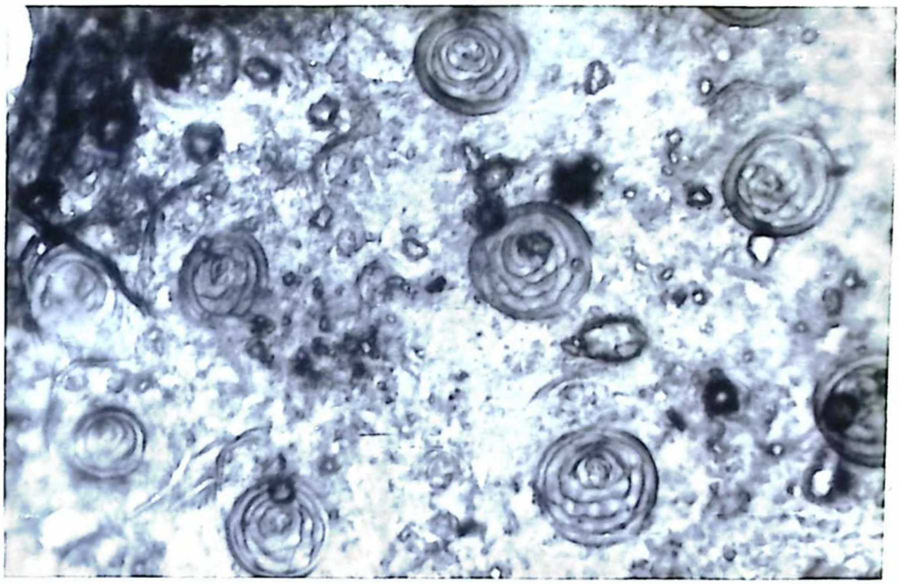


Figure 1. Unknown group. Depth 7.1 - 7.125 meters x 350.

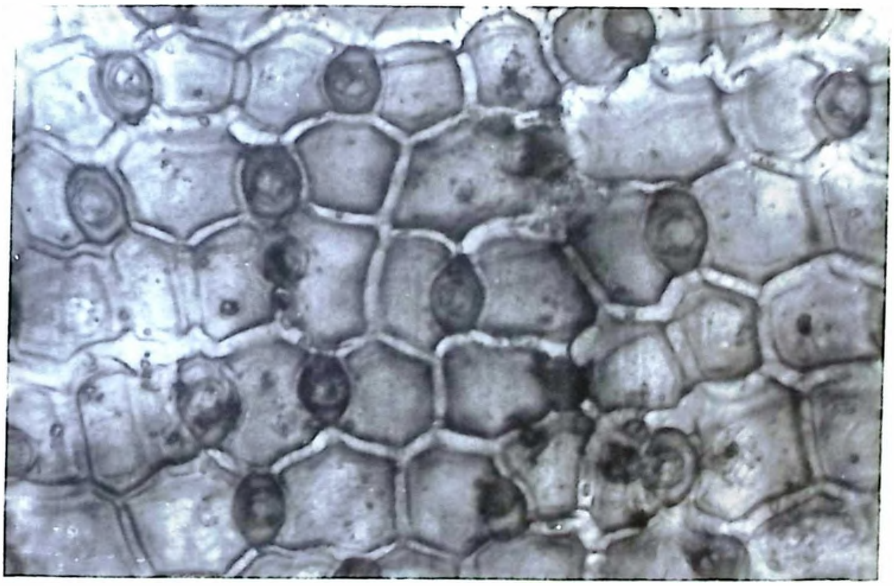


Figure 2. Unknown group. Depth 7.1 - 7.125 meters. x 350.

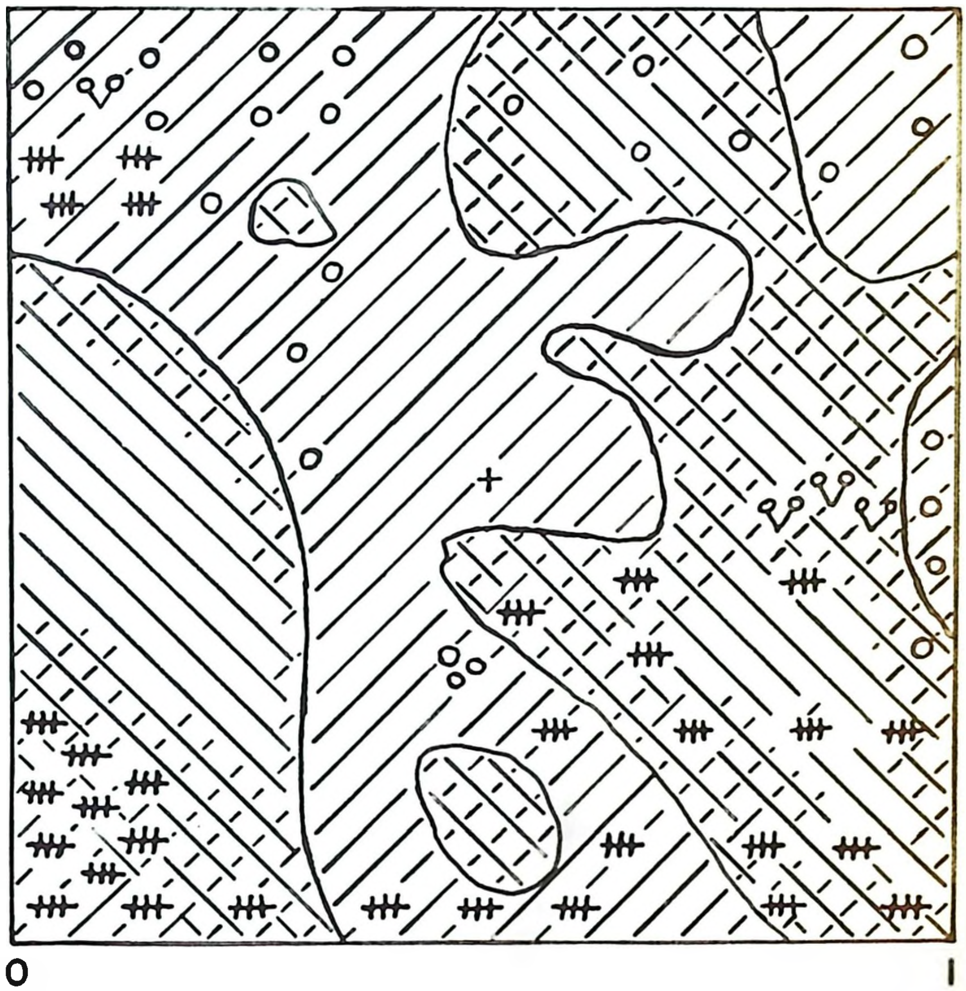
PLATE XXXVI

A graphic illustration of results showing relative proportion of groups by percentage of total count with depth.

PLATE XXXVII

One meter quadrat.

One Meter Quadrat



Sphagna. Carex spp. Vaccinium Oxycoccos.

Chamaedaphne calyculata. Drosera rotundifolia.

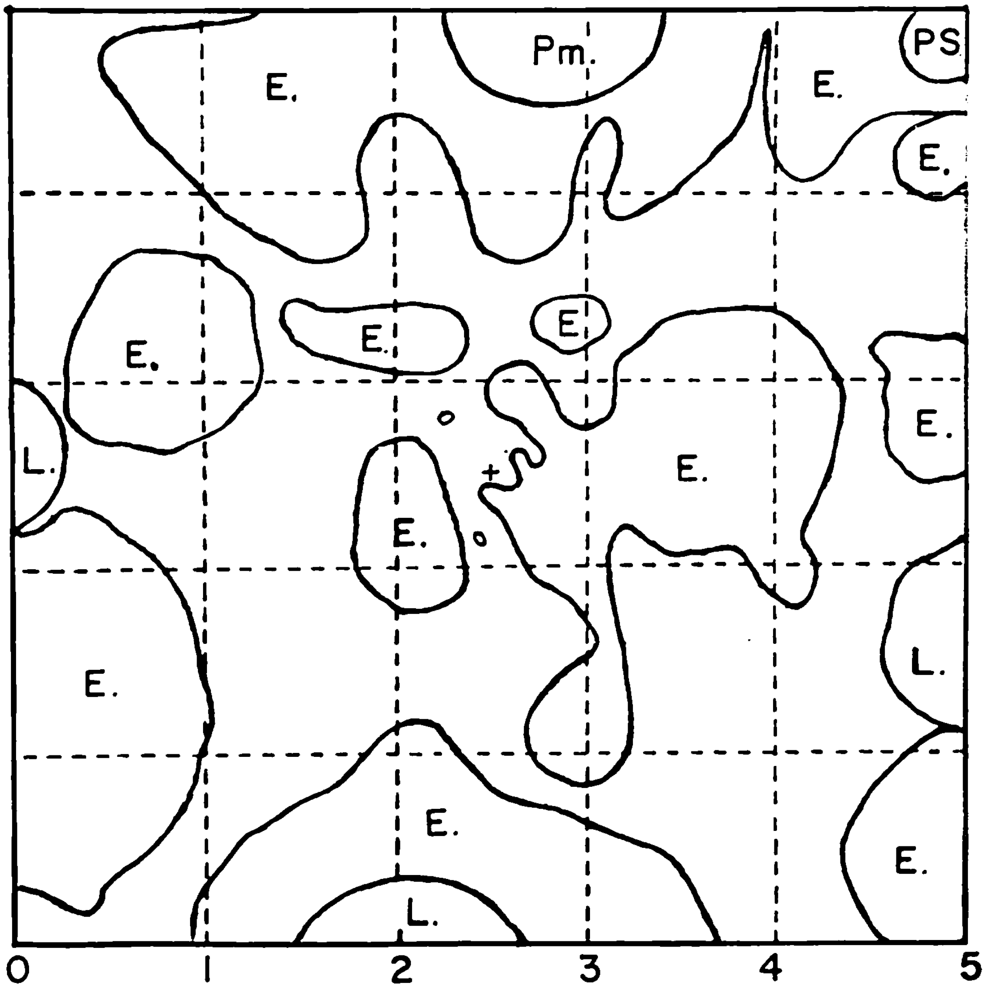
Boundary between hummock and depression.

+ Core Site.

PLATE XXXVIII

Five meter quadrat.

Five Meter Quadrat.



(Pm.) Picea mariana. (PS.) Pinus Strobus.

(L.) Larix laricina. (E.) Ericoid hummock.

\+ Core Site.

PLATE XXXIX

Ten meter quadrat.

Ten Meter Quadrat.

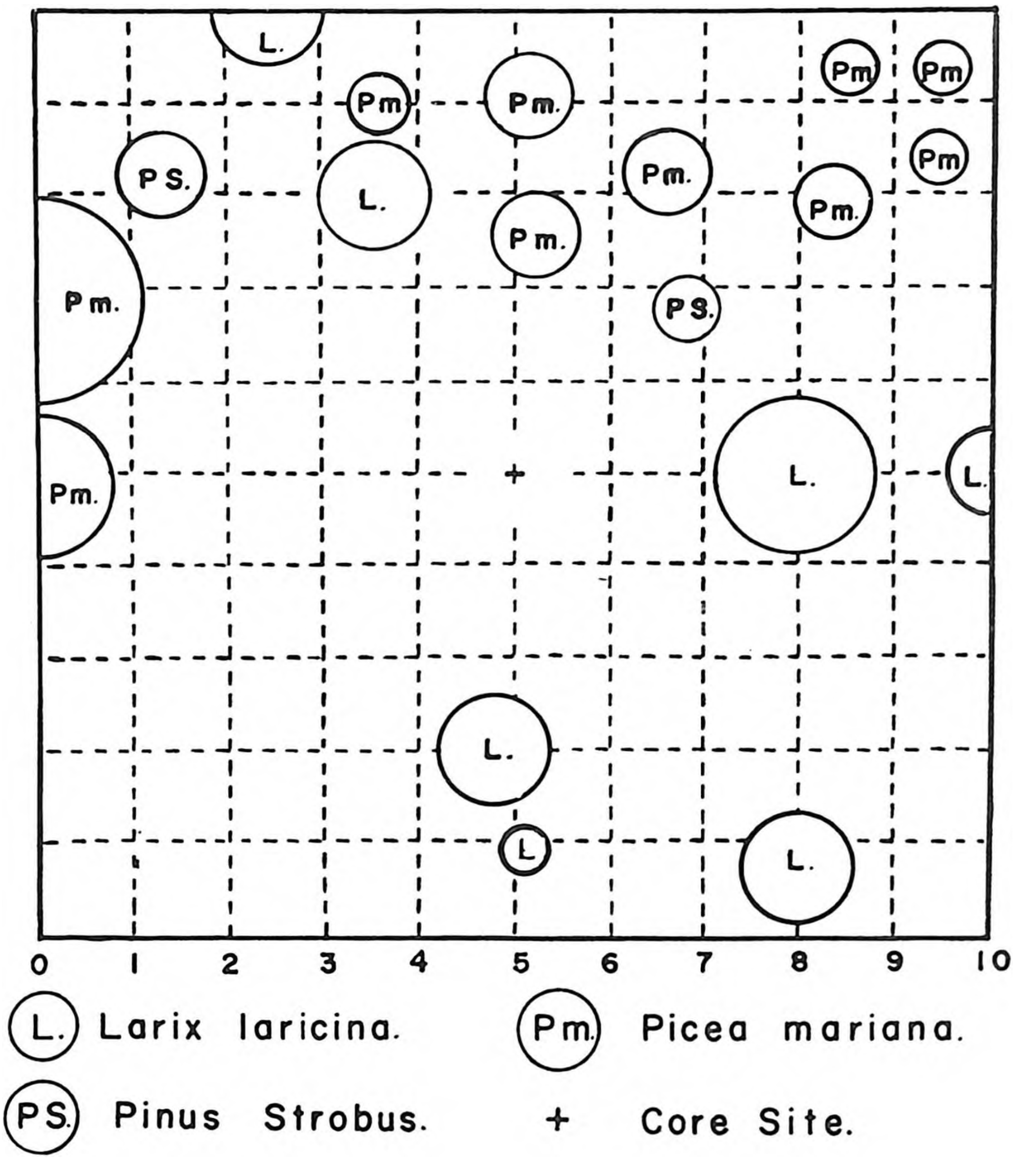


PLATE XL

A levelled transect through the Copetown bog illustrating the general topography.

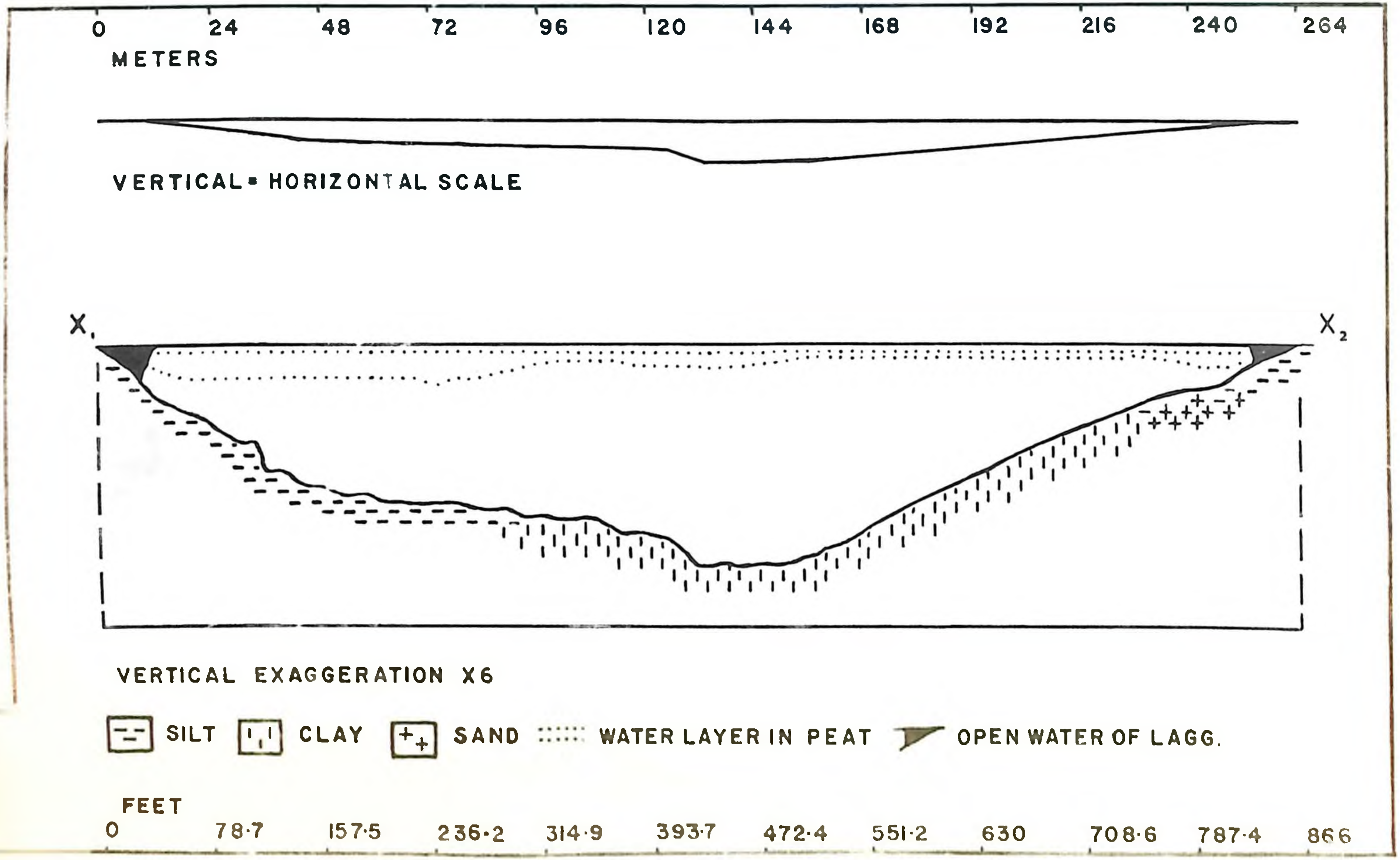
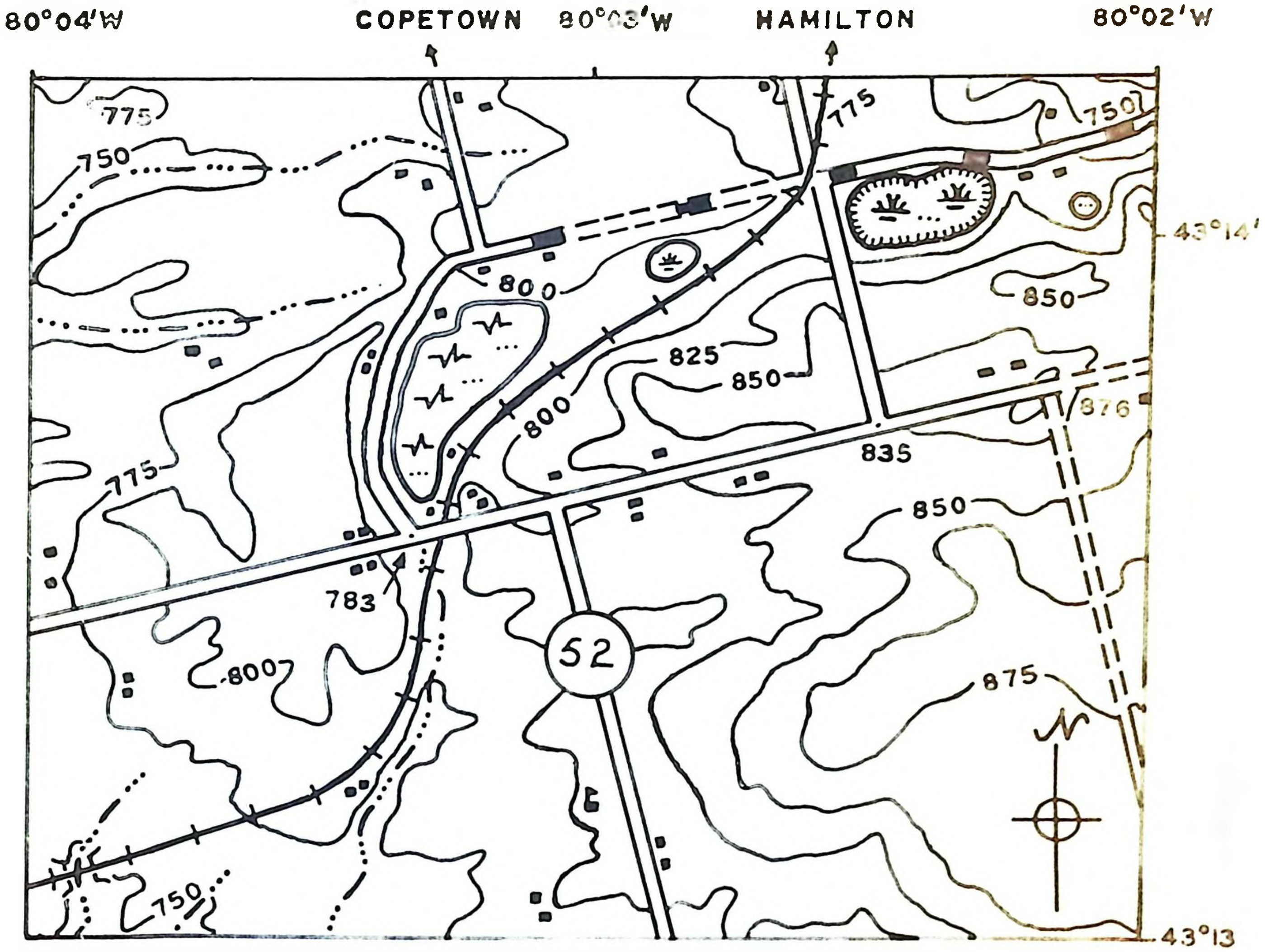

0 24 48 72 96 120 144 168 192 216 240 264
METERS
VERTICAL = HORIZONTAL SCALE
X1
X2
VERTICAL EXAGGERATION X6
SILT
CLAY
SAND
WATER LAYER IN PEAT
OPEN WATER OF LAGG.
FEET
0 78·7 157·5 236·2 314·9 393·7 472·4 551·2 630 708·6 787·4 866

PLATE XLI

Geographical location of Copetown bog.

GEOGRAPHICAL LOCATION

OF COPETOWN BOG



REFERENCE.

Roads: hard surface.

loose surface.

Railway:

House, Farm:

School:

Bog:

Spot Elevation: ·783

Contours: Elevation. 850

Depression.

Contour interval 25 feet.

Stream, intermittent:

Highway: 52

Swamp:

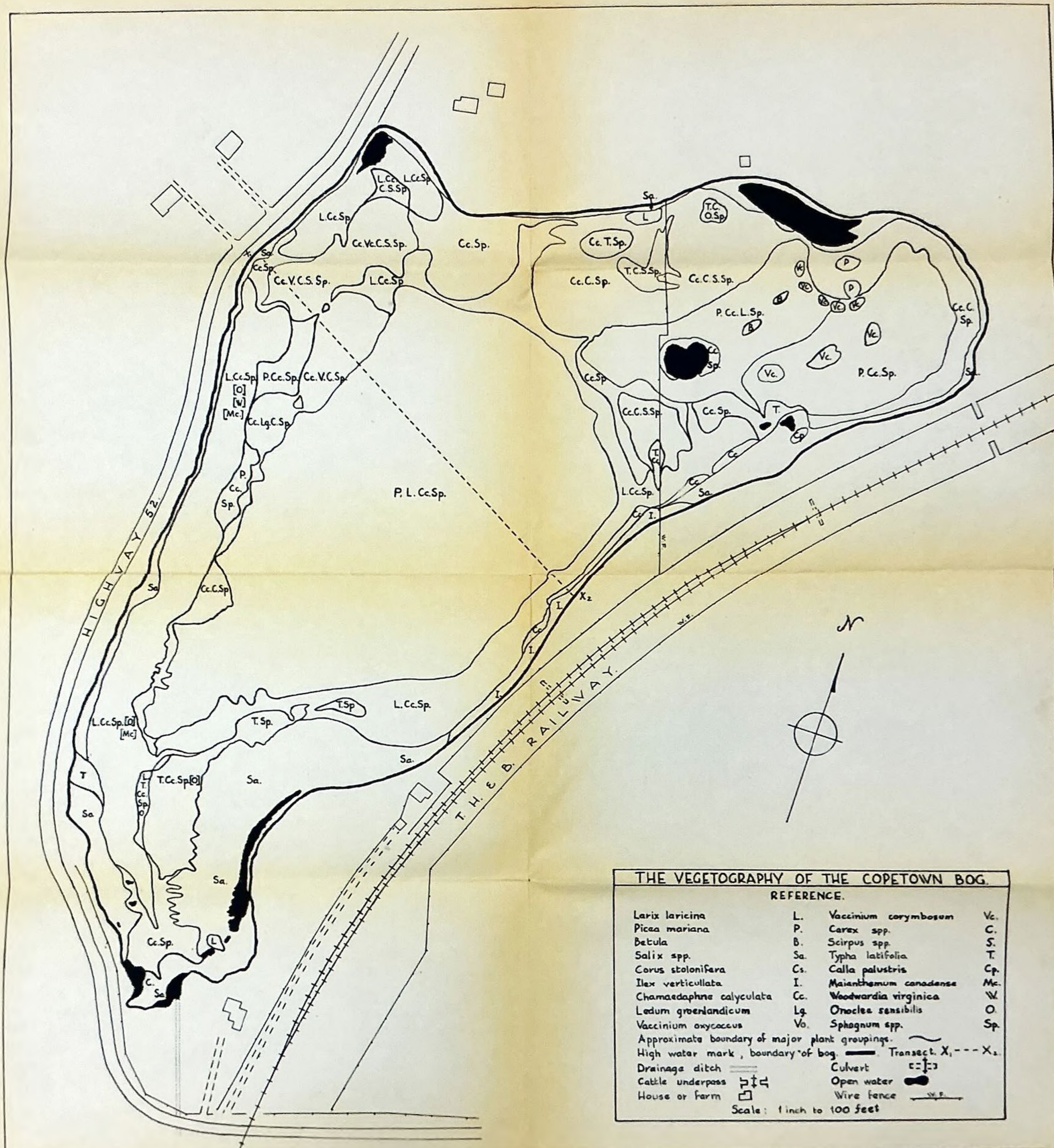
Scale: 3·86 inches to 1 mile approximately.
6 cms. to 1 km.

PLATE XLII

Vegetography of the Copetown bog.

ERRATUM.

Plate XXI. Fig. 1. - replace seed-like structure with Fungus, Ascomycetes, Microthyriales.


THE VEGETOGRAPHY OF THE COPETOWN BOG.
REFERENCE.
Larix laricina L.
Picea mariana P.
Betula B.
Salix spp. Sa.
Corus stolonifera Cs.
Ilex verticullata I.
Chamaedaphne calyculata Cc.
Ledum groenlandicum Lg.
Vaccinium oxycoccus Vo.
Vaccinium corymbosum Vc.
Carex spp. C.
Scirpus spp. S.
Typha latifolia T.
Calla palustris Cp.
Maianthemum canadense Mc.
Woodwardia virginica W.
Onoclea sensibilis O.
Sphagnum spp. Sp.
Approximate boundary of major plant groupings.
High water mark, boundary of bog.
Transect. X1 - - - X2.
Drainage ditch
Culvert
Cattle underpass
Open water
House or farm
Wire fence
Scale: 1 inch to 100 feet
HIGHWAY 52
T. H. & B. RAILWAY
N
P. L. Cc. Sp.
L. Cc. Sp.
Cc. Sp.
P. Cc. Sp.
P. Cc. L. Sp.
Cc. C. S. Sp.
Cc. C. Sp.
Cc. T. Sp.
T. C. S. Sp.
Cc. V. C. S. Sp.
Cc. Vc. C. S. Sp.
L. Cc. C. S. Sp.
Cc. Lg. C. Sp.
L. Cc. Sp. [O] [Mc]
T. Cc. Sp. [O]
T. Sp.
Sa.
X2