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THE SOIL VEGETATION OF THE DANISH CONIFER PLANTATIONS AND ITS ECOLOGY

BY

MOGENS KØIE

WITH 9 FIGURES IN THE TEXT, 2 PLATES AND 23 TABLES

D. Kgl. Danske Vidensk. Selsk. Skrifter, naturv. og math. Afd. 9. Række, VII. 2.

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INTRODUCTION

Though Denmark lies outside the zone of forest-forming coniferous trees, there has, during the 150—200 years in which Denmark has harboured coniferous forests, developed a ground flora very similar to that which occurs where there is a spontaneous growth of conifers.

Though it cannot be said that generally speaking the planting or colonisation of an area with coniferous trees will involve a simplification of the original vegetation, coniferous forests throughout their geographical area of distribution have a ground flora consisting of few but widely dispersed plant communities. The geographical situation has of course some influence on the delimitation of the plant communities; the soil vegetation of the conifer plantations of Denmark shows affinities both with the plant communities which Cajander (1909) analysed and described for the south German highland and with the plant communities of the Swedish, Finnish, and Russian coniferous forests, on which an extensive literature has been published. In Denmark it is the edaphic factors which decide to which of the vegetations of these two areas the ground flora of the coniferous forests is most closely allied.

The presence in Denmark of a ground flora differing from that of spontaneous coniferous forests is due to the fact that the coniferous trees in Denmark are forced, so to speak, to grow where they are planted, and this may be on soil where a natural competition with foliiferous trees would lead to the destruction of the conifers. This applies to the good soil; the poorest soil on which forests are planted will not, even though the forest can only be maintained by forestal care, have an essentially different soil vegetation from that known from territories covered with natural forest.

By far the greater part of the Danish conifer plantations consists of Picea exelsa. Pinus silvestris, and Pinus montana, though Abies pectinata has also a fairly wide distribution. It is only of recent years that various other coniferous trees have begun to be planted on a larger scale, and these are not included in the present study. Nor has the ground flora of the larch forests been investigated here. Whenever coniferous forest is mentioned in the sequel, indeciduous forest is always implied.

The forestal treatment of woods causes greater changes in the life conditions of the soil vegetation than occur in natural forests. Hence the vegetation does not always achieve stability, but will contain elements which are either relicts from a previous plant community or new immigrants. What plant community will dominate with a certain constellation of environmental factors will in part depend on how quickly the character plants are able to immigrate, and how long they take in attaining the development necessary for the characterisation of a plant community. This time differs widely; it is longest for the sub-shrubs and the lichens, brief for *Deschampsia flexuosa* and for mosses, which appear very quickly and form a population in places where they find favourable life conditions. Though I have as far as possible kept to the stable plant communities, there are, therefore, several cases where the phanerogamic vegetation, owing to its slow rejuvenation, has not yet attained the development which it will probably attain later under the conditions at hand.

In woods under forestal care the light conditions on uniform soil will differ, though they will be uniform over larger areas, so that better opportunites are afforded for the study of the influence of light on the ground vegetation than in natural forests, where the density of the crowns of the trees is often dependent on the condition of the soil.

None of the forests investigated stands on high moor soil, but otherwise I have sought as different soils as possible. A conspectus of the localities from which vegetation analyses are at hand appears at p. 55.

There exist but few works dealing with the vegetation of Danish coniferous forests. Warming (1916—19) gives a number of species lists from more or less purely coniferous forests and mentions some of the most conspicuous plant communities; and Bornebusch (1925) has attempted to apply Cajander's forest types mentioned below to Danish coniferous forests. Finally Olsen (1921) has investigated the succession of the vegetation in cleared coniferous forests.

Cajander's works are of fundamental importance for the modern plant-sociological investigation of coniferous forests (the most important (1909) being those on the S. German highlands and on Finland (1921)). Cajander's researches have led to the erection of a series of forest types, the chief of which are the *Cladina*, *Calluna*, *Vaccinium*, and *Myrtillus* types. An *Oxalis* type has been set up, too, but it would seem to occur under Abies pectinata only, or where there is an admixture of foliiferous trees.

From Sweden there is a work by Hesselman (1926), which describes, in connection with investigations on nitrogen and acidity, a series of analyses of the soil vegetation of conifer forests, carried out by the same method as that adopted by me.

A survey of the forest types of the Soviet Union is found in Sukatschew (1928, 1932).

The present treatise is based on a prize essay submitted to the University of Copenhagen and awarded the gold medal of the University in 1935.

I should like here to express my thanks to the Rask-Ørsted Foundation for a grant which has rendered possible the translation into English of the present work, and to Botanisk Rejsefond and Japetus Steenstrup's Legat for financial aid towards the work in the field.

To Professors Knud Jessen and C. Raunkiær I owe a debt of gratitude for much good advice during the final working up of the treatise.

Analysis of the Plant Communities.

For the analysis of the vegetation RAUNKIÆR's circling method (1909) was adopted. After a floristically and physiognomically uniform test area had been selected, 20 circles of 0.1 sq. m each were marked off along a straight line at equal distances from one another, generally 1 m. If the stump of a tree was within a circle it was skipped. The occurrence of all vascular plants and mosses, and of the chief lichens was noted for each circle, and stated in percentage occurrence in all circles from the test area. To be regarded as occurring within the circle, the plant in question must have either a basal shoot, or a basal petiole, or a perennating shoot apex within the circle.

All the chief species except *Rubus idaeus* and *Pteridium aquilinum* have such a degree of density that, where they form typical plant communities, they occur in all the circles, i. e. their frequency percentage (fr $^0/_0$) is 100. A plant is said to be a frequency dominant when its fr $^0/_0$ exceeds 80. The limit has been made so low in order to secure a margin for irregularities in the structure of the plant community.

A concept analogous to frequency is constancy (DU RIETZ 1930, p. 433, BEGER 1932, 485). While the fr $^0/_0$ conveys an idea of the distribution of the species within a test area, the constancy percentage (k $^0/_0$) is a means of expressing the variation within a plant community, the k $^0/_0$ showing in how many of all the test areas, in which the same plant community occurs, the species are present in at least one of the circles. Since 20 circles of 0.1 sq.m. each were examined in each test area, the constancy shows in how many per cent a species occurs within an area of 2 sq.m. A species is said to be constant when its k $^0/_0$ exceeds 80. A survey of k $^0/_0$ for a number of species will be found at p. 29 (Table 1).

Plant-sociological Terminology.

The nomenclature proposed by DU RIETZ (1930, p. 307 ff.) has been adopted for the designation of the plant communities. The smallest plant-sociological units into which it has proved convenient to divide the soil vegetation of conifer forests are termed sociations. A sociation is defined on p. 307 as a stable plant community of an essentially homogeneous composition of species, that is to say, at least with constant dominants in each layer; and a dominant is a species "which alone or in company with one or more almost as dominant species forms the bulk of the vegetation in its layer"[1].

[1] In my opinion, a division into layers which does not refer absolutely to the relative height of the species entering into a plant community can only serve to create confusion. In DU RIETZ's remark (1930, p. 387) that in *Loiseleuria-Cetraria nivalis* sociation an upper layer (Feldschicht, *Loiseleuria*) may lie embedded in a lower layer (Bodenschicht, *Cetraria*) it is not the height which has been decisive. It is of course of interest that the *Cetraria* layer, which is most frequently the lower one, may also be the upper one, but this is not expressed by this use of the term "layer" instead of, for instance, population, and the division into layers becomes unjustified in plant-sociology. On this principle one might with equal propriety refer *Hedera helix* and *Lonicera periclymenum* to the shrub or forest layer when they creep among the herbs of the forest-soil.

By the character species of a sociation are meant species which have formed the basis for its erection, and which enter into the name of the sociation. Hence the character species are constant dominants, but most sociations possess other constant dominants which it would be inconvenient to include in the name of the sociation.

A species is said to form a population when it constitutes an essential part of the vegetation. The term says nothing as to the importance of the species for the systematics of the plant community.

When a plant community is designated in the sequel by two species, one of which is placed in parenthesis, the two sociations are meant of which one is designated by the two species, and the other by the species not placed in parenthesis; thus *Deschampsia-(Scleropodium)* soc. means the *Deschampsia* sociation + the *Deschampsia-Scleropodium* sociation.

For the vascular plants the same systematic names have been adopted as in Raunkiær (1934). The nomenclature of the mosses accords with C. Jensen (1915, 1923) and that of the *Cladonia* species with Mølholm Hansen & Lund (1929).

The Systematic Grouping of the Plant Communities.

In the systematic grouping the principle has been adopted of disregarding the taxonomic position of the dominant species. In practice several mosses must occupy a subordinate position as character plants compared with the phanerogams (except *Deschampsia flexuosa*) owing to their occurrence in the greater part of the soil vegetation of coniferous forests. Only where these widely dispersed species form independent populations have they been used as a basis for the erection of sociations. Even though environmental factors have not been directly employed as indicators in the division of the plant communities into sociations, by the above procedure species which are closely associated with certain constellations of environmental factors within coniferous forests will primarily be used as character plants.

The figures in the vegetation tables will not show in all cases to what plant community a sociation individual belongs. It applies to the mosses especially that the deviation is often too small for the quantitative composition to be read from the frequency percentages.

The tree population does not enter into the systematics of the plant communities, but is merely treated as the creator of the environmental conditions which the trees offer the soil vegetation by their species, density, etc.

For the sake of clearness I have chosen to divide the soil vegetation of conifer forests into as few sociations as possible, and in my opinion a further subdivision would in most cases serve no purpose. However, more extensive investigations may perhaps show the justification of distinguishing for instance a *Luzula pilosa* sociation, or of dividing the *Empetrum* sociation into an *Empetrum-Hylocomium parietinum* sociation and an *Empetrum-Scleropodium* sociation.

The Nomenclature of the Soil.

For the characterisation of the upper layers of the soil which are mixed with humus I have adopted the nomenclature proposed by Hesselman (1926, p. 204 ff.). In many instances it is, however, impossible to distinguish between "råhumus" and "mår". Hence I have used the term "peat" for Hesselman's "råhumus" + "mår", and have only employed "raw humus" where it is indubitable that the humus layer deserves this designation, that is to say, where the humus layer is interwoven with fungal hyphae and roots to a felty mass (fibrous peat).

The term "surface soil" denotes the upper layer of soil admixed with humus, washed-down humous particles being, however, left out of consideration. The subsoil is the unmixed mineral soil.

Rubus idaeus grows in soil which, compared with other soils under conifers, must be designated as good. This designation is unsatisfactory from a general ecological point of view, since it only tells us that the edaphic-ecological factors are at their optimum for the greatest number of species. The facts are too complicated to be expressed numerically, even though the pH value of the soil gives us some information of its quality. To obtain some holds for a characterisation of the soil beyond what can be directly observed, a characterisation which at the same time furnishes some information of the edaphic-ecological relationship of the species entering into the soil vegetation of conifer forests, I will call such soil suitable for a species on which the species may be supposed, with a probability bordering on certainty, to be willing to form populations in some state of the remaining ecological factors. The soil, for instance of a test area covered with *Thuidium tamariscifolium*, is thus said to be suitable for *Rubus* if a change in the tree population may lead to a forest climate which will permit *Rubus* to form a stable population.

Light Measurement.

For the light measurements the method with Wiesner's hand insolator evolved and fully described by Boysen Jensen (1932) was used.

The principle of the method is that sensitive paper in order to darken to a certain standard tone requires a time corresponding to the intensity of the light. The generally accepted law that the intensity of light required for the same darkening of the photometric paper is inversely proportional to the time of exposure does not apply to the paper used. The adjusting showed that to a fourfold increase in the light intensity corresponds a darkening period 3.522 times as short. Hence to estimate the relative light intensity, "i"[1], in a forest it is necessary, instead of directly calculating the percentage of the time of exposure, to convert this into absolute light intensity (expressed in k × lux, where k is a constant characteristic of the standard tone) by means of curves constructed on the basis of the factor found, and to calculate "i" from this.

[1] "i" is used by Rübel (1928) as a term for the light percentage.

In dark forests the difference is very considerable. If for instance the period of illumination in the open is 1 % of the period of illumination in the forest, the light percentage will in reality be 0.69. To 10 % in time corresponds an i-value of 8.15.

Since it must be taken for granted that the rays important for the CO_2 assimilation determine the light minimum of a plant community, that is to say, the red yellow rays in particular, the paper was made especially sensitive to these by treatment with Rhodamin-B. But since Rhodamin-B paper, too, is somewhat sensitive to blue rays a red yellow filter was further used (filter glass 1 mm thick from Schott & Gen., Jena, F 21707 EK 50).

So as not to cut off the light the insolator was held at arm's length. The time was measured by a stop watch. The measurement over the area tested was made during even movement — walking or running — and I endeavoured to expose the insolator to the light in the sunny spots during the length of time due to them according to the area they occupy. Each measurement was repeated once or several times, and the results generally agree very well, especially for the lower i-values, nor are the deviations in relation to the light percentages very large for the lighter areas. To determine the full daylight it was necessary to take the average of several measurements, because the darkening of the photometric paper to the light standard tone employed in order that the measurements in the dark forests should not be too time-consuming, was arrived at in a very short time, in extreme cases 10 seconds, hence it was difficult to measure. The measurements in and outside the forest were made directly after one another. In dark forests, where a single measurement may take more than an hour, the full daylight was measured before and after it, and the average value used in the calculation of "i".

The light percentage in forests depends in various ways on the light conditions in the open. The light percentage falls with the decreasing height of the sun as a result of the fact that at a low height of the sun the crowns of the trees allow a smaller percentage of the sunbeams to reach the forest soil, and the sunlight constitutes 60—70 % of the total amount of light at full daylight.

If the full daylight diminishes because the sun is covered by clouds, the light percentage is higher than when the sun is uncovered.

Information as to the light percentage gathered from the literature shows that other photometric methods than that employed by me give corresponding results. On measuring diffuse light Salisbury (1916, p. 94) found an increasing light percentage in oak forests in the course of the spring until leafing occurred. Fehér (1929, p. 43) found a light percentage in a fir forest varying between 30 % and 55 % in the course of the year, with the minimum in January and the maximum in June. At p. 37 the same author has a curve of the light percentage in a pine forest where a distinct increase is seen on rainy days, that is to say, when the sun is covered with clouds.

The influence of the above-mentioned factors on the light percentage varies with the varying density and height of the trees. Hence it is understandable that no table of corrections can be made. In order to make the light measurements comparable, the determinations, with a few exceptions, were made in sunlight between 9 and 3 o'clock, but around the solstice between 8 and 4 o'clock. This arrangement of course involved the giving up of a number of measurements, but because the sunlight was particularly abundant during the two summers the investigation was in progress, it was possible to adhere to it without any great loss of i-values.

Besides insisting on a relative stability I have also demanded a uniform development of the plant community over a fairly large area, rarely less than 400 sq.m. By choosing such a large test area I obtained the most satisfactory light measurements, the intensity of the light over a small test area being too largely dependent on the momentary position of the sun. Where the investigation of environmental factors other than light intensity was of importance it was in certain cases necessary to reduce the demands in respect of the size of the test area.

Determination of the Hydrogen-Ion Concentration of the Soil.

Sampling.

In the present investigation the actual acidity only has been determined, i. e. the concentration of free hydrogen ions present in the soil extract.

Most peat plants have the greater part of their roots in the lower stratum of the peat which rests with a sharply defined limit on the mineral soil. Since acidity as an ecological factor is of course most important for the roots I have chosen to take the samples in the lower part of the peat, though only where the thickness did not exceed 8—10 cm. In places where there is not an actual peat formation the consistent application of a definite principle is more difficult. In such places the roots often penetrate far down into the subsoil, and the humus layer is more or less mixed with the subsoil. In most instances, however, there will be a layer, a few centimetres thick, of almost pure humus, and it is from this that the samples of soil have been taken for the determination of the acidity. Such a procedure renders it possible to obtain some pH values from the rhizosphere of some of the phanerogams occurring in this soil (*Oxalis*, *Asperula*, *Milium*).

From each test area three measurements were as a rule made, each comprising 3—4 mixed samples of soil. A sample was thus taken for about every second circle. The pH values from the subsoil, however, are derived from a single sample taken in all instances at a depth of 15—20 cm.

By far the greatest number of samples were measured in the fresh state on the same day that they were taken, but in some cases the measurement could not be made till later on; the samples were then dried in the air and kept in paper bags. The change in the pH caused by drying and keeping is stated by most authors to be very slight for acid soil (Arrhenius 1926, Hesselman 1926, Jenny 1926, Frank 1927, Hoss 1932).

Method of Measuring the Acidity.

In measuring the acidity the electrometric method with kinhydron was used. The apparatus employed (Betriebs-Ionometer nach Trenel) was in the shape of a box and proved excellent for work in the field. The extraction was made in flasks of a capacity of 100 c.c. They were filled three parts with soil, and the smallest possible amount of distilled water was added, only so much as was necessary to decant the c. 10 c.c. used for the measurement.

The time of extraction for the fresh samples was at least one hour, extraction longer than this proved quite unnecessary. An extraction time of 24 hours in the few experiments I made with it showed no great difference and no particular tendency; nor was this to be expected, since the samples are mostly damp at the outset. The dried samples, on the other hand, need a longer time for extraction; I used at least three hours. On preservation for some length of time in an ordinary glass there is a risk of pH undergoing a change in a basic direction (Zollitsch 1927, p. 138).

Corrections for temperature up to 18° were made according to a table fixed to the apparatus. This is of importance in measurements with kinhydron, especially for the study of the acidity requirements of the plants here considered, their deviations in pH being very small. A difference of for instance + and — 8° will cause a difference of + and —0.13 for pH 4.00.

If the second decimal in the pH value exceeded 4 it was increased to the next tenth.

In the course of the investigations the accuracy of the "Ionometer" was tested several times, and it always showed a pH value agreeing very closely with that given for the standard fluid.

The pH values obtained by this method are somewhat lower than those obtained by the colorimetric method and by the electrometric determination of the acidity of a soil filtrate; for in the pH determination of a soil suspension the physiologically active hydrogen ions loosely connected with the soil particles are measured in addition to the free ions (Pallmann & Haffter 1933).

Abbreviations and Conspectus of the Plant Communities.

The following abbreviations have been used for some frequently mentioned species:

Brach. = *Brachythecium curtum.*
Clad. = *Cladonia impexa.*
Desch. = *Deschampsia flexuosa (= Aira f.).*
Dicr. scop. = *Dicranum scoparium.*
Eur. prael. = *Eurhynchium praelongum.*
H. par. = *Hylocomium parietinum (= Pleurozium Schreberi = Hypnum S).*
H. prol. = *Hylocomium proliferum (= H. splendens).*
Loph. het. = *Lophocolea heterophylla.*

Plag. dent. = *Plagiothecium denticulatum.*
Rubus = *Rubus idaeus.*
Scl. = *Scleropodium purum* (= *Pseudoscleropodium p.*).
Ster. = *Stereodon cupressiformis var. ericetorum* (= *Hypnum c.*).
V. myrt. = *Vaccinium myrtillus* (= *Myrtillus nigra*).
V. vit. = *Vaccinium vitis-idaea.*

A survey of light percentages will be found at p. 41, of the thickness of the peat at p. 44 (Table 2), and of pH at p. 48 (Table 3 and 4).

Below we give a list of the plant communities investigated, with references to the vegetation tables and the page at which they are described.

	Table	Page
Asperula odorata—Oxalis soc.	I, 2	12
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Rubus—Brachythecium—Deschampsia soc.	I, 16—17	14
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Deschampsia—Oxalis soc.	II, 1	15
Oxalis—Thuidium soc.	III, 7—8	15
Thuidium—Polytrichum attenuatum soc.	III, 6	16
Thuidium tamariscifolium soc.	III, 1—5	16
Brachythecium curtum soc.	IV, 3—14	16
Vaccinium myrtillus soc.	V, 4—9	17
Vaccinium myrtillus—V. vitis-idaea soc.	V, 3	18
Pteridium aquilinum—V. myrtillus soc.	V, 1—2	18
Vaccinium vitis-idaea soc.	VI, 7—15	19
Empetrum nigrum soc.	VI, 1—4	20
Calluna—Empetrum soc.	VII, 2—6	20
Calluna vulgaris soc.	VII, 8—19	20
Deschampsia—Scleropodium purum soc.	VIII, 1—22	21
Deschampsia flexuosa soc.	IX, 1—11	22
Deschampsia—Galium harcynicum soc.	IX, 12—13	22
Deschampsia—Hylocomium parietinum soc.	IX, 14—17	22
Carex arenaria soc.	X, 1—11	23
Carex arenaria—Oxalis soc.	X, 12—13	23
Scleropodium purum soc.	XI, 1—19	23
Hylocomium parietinum soc.	XII, 1—33	24
Hylocomium proliferum soc.	XV, 7—9	25
Hylocomium triquetrum soc.	XV, 3—6	26
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Dicranum majus soc.	XV, 10—12	26

	Table	Page
Stereodon cupressiformis soc.	XIV, 1—19	26
Lophocolea heterophylla soc.	XVI, 1—9	27
Eurhynchium striatum soc.	IV, 1—2	27
Cladonia impexa soc.	XIII, 1—9	28

Description of the Plant Communities.

Asperula odorata—Oxalis soc.

Table I, 2.

This typical plant community of foliiferous forests only occurs very rarely under coniferous trees. It appears here on particularly damp soil under Picea exelsa, forming a zone round a ditch. The layer of moss does not cover the ground, the dominant species is *Eurhynchium striatum*. *Oxalis* here attains its most luxuriant development in the coniferous forest. The immediate vicinity bears an extremely luxuriant *Rubus*—*Brach.* soc. with *Stellaria glochidosperma*, *Milium effusum*, and some *Asperula* (Table I, 4—5).

Light intensity 9.17 %, pH 5.07. The humus layer is typical mould, the subsoil but slightly sandy.

Melica uniflora soc.

Table I, 1.

The *Melica* soc., too, is ecologically closely allied to the *Rubus*—*Brach.* soc. Well-developed specimens were only found at Sonnerup under Picea excelsa where *Melica* forms very dense growths at a higher light percentage than the surrounding *Rubus* populations. *Eurhynchium striatum* forms a dense carpet.

The humus layer takes the shape of a sharply delimited layer with a granular structure. Here *Melica* has all its roots. pH is the highest measured in peat, on the average 5.07, and it is no doubt due to the high pH that *Brach.* which forms the moss layer in the *Rubus* populations is here replaced by *E. striatum* as in the *Asperula*—*Oxalis* soc. Close to this soc.-individual there occurred a feebly developed *Asperula* soc. on peat.

Urtica dioeca soc.

Table I, 3.

Urtica enters into several *Rubus* soc. individuals and is altogether ecologically closely allied to *Rubus*. The soc. individual here described is on a level with and close to the *Rubus*—*Brach.*—*Geranium Rob.* soc., but with more light. The roots of *Urtica* are found in the humus layer which is very loose and mouldlike. The average pH is 4.27.

Rubus idaeus—Brachythecium curtum sociations.

Table I, 4—17.

These sociations were met with almost exclusively under Picea excelsa. The reason is that they only develop on soil of such a nature that Picea excelsa is considered the most profitable of the coniferous trees in a forestal respect. Table 1 gives the k $^0/_0$ of some species in the sociations. Compared with the other plant communities pH is high, viz. 4.40. From the table it will be seen that the light percentage may be as low as 4.28.

The sociations may be naturally divided into sociations with *Oxalis* and sociations with *Deschampsia*, but it will be necessary to set up a third sociation for the sociation individuals from Sonnerup, because *Oxalis* has not immigrated into this isolated wood, and because the composition of the vegetation is here otherwise somewhat different.

Rubus idaeus—Brachythecium—Oxalis soc.

Table I, 4—11.

Oxalis is vigorously developed, and *Brach.* forms a continuous carpet. *Eurhynchium praelongum*, which shows a very strong affinity to *Brach.* and is presumably never absent where *Brach.* forms a population, has a k $^0/_0$ of 88. *Mnium rostratum* here attains its most vigorous development within coniferous forests with a k $^0/_0$ of 100. *Scl.* too occurs constantly but always with a low frequency percentage.

The sociation individual richest in species is No. 4 which contains many mould plants, such as *Asperula odorata*, *Stellaria glochidosperma*, *Urtica*, *Brachypodium silvaticum*, and *Milium effusum*. In this pronouncedly hemicryptophytic community the hemicryptophyte moss *Mnium undulatum* occurs with a frequency percentage of 100. (All other mosses forming populations in coniferous forests are chamaephytes).

Where the light allows, *Milium* may form an essential part of the sociation. In No. 5, at a light percentage of 7.5, it showed distinct signs of the want of light and was almost sterile, in No. 6, at 18.3 $^0/_0$ light, it was extremely well developed.

At 4.28, the lowest light percentage, *Rubus* is stunted for want of light and does not become the frequency dominant.

The humus layer is everywhere mould-like, under *Milium* it is typical mould. *Rubus* has the greater part of its roots in this, at any rate quantitatively; the roots of all the rest of the phanerogams only rarely penetrate to the sub-soil.

Sociations were only found in older growths on somewhat clayey moraine sand and in sheltered situations. All the analyses given are derived from North Sealand, but the sociation does not seem to have any geographical limits in Denmark; it has been found for instance in Bromme plantation at Sorø and at Aunsbjerg between Viborg and Silkeborg.

Rubus idaeus—Brachythecium—Geranium Robertianum soc.

Table I, 12—15.

This sociation was only met with in Sonnerup. It differs from the preceding sociation by the absence of *Oxalis* and by the presence of *Geranium Rob.* as a dominant, in addition to some other therophytes, especially *Galium aparine* and *Stellaria media* pH is higher than in the *Rubus*—*Oxalis* sociation, and the light percentage is very low, ranging from 4.57 to 5.82.

The humus layer is of a peaty consistency. The subsoil consists of coarsely alluvial sand with a pronounced podsol profile.

Rubus idaeus—Brachythecium—Deschampsia flexuosa soc.

Table I, 16—17.

Deschampsia enters into the sociation as a character plant. However, it differs from the rest of the *Rubus* sociations by being less rich in species and by the presence of several of the species which characterise soil of less dispersion than that on which *Rubus* is usually found. These species are *Lophocolea bidentata*, *Ster.*, *H. par.*, *Galium harcynicum*, and *V. myrt.* The soil is the same as that on which the *V. myrt.* sociation may be found, but somewhat moister, which is the reason why *Dryopteris* occurs. Though physiognomically rather prominent, *Dr. dilatata* has only a low frequency percentage.

The humus layer is peaty.

Cajander mentions a plant community showing great agreement with this one from Picea excelsa and Abies pectinata forests in the South German highlands. It is regarded as a subtype of the *Myrtillus* type, bordering on the *Oxalis* subtype, but it does not contain *Oxalis*. In northern forests in Sweden and Finland *Rubus* seems to occupy a subordinate place in the soil vegetation.

Oxalis acetosella soc.

Table II, 2—11.

The *Oxalis* sociation is often developed on soil suitable for *Rubus* at a low intensity of light. It attains its best development under Abies pectinata, or where there is a growth of foliiferous trees, but *Oxalis* may form populations together with *Brach.* in pure Picea excelsa growths (6—8). In the rest of the sociation individuals under Picea excelsa leaf-bearing trees were present, in No. 10 in the form of a fairly luxuriant growth of *Sambucus nigra*; in Nos. 5 and 9 there were beeches so near by that the soil was manured by their leaves. It is hardly by chance that *Brach.* and other mosses are absent from these sociation individuals. Mosses cannot grow in situations where they are covered by broad leaves, though the leaves of *Rubus* seem to form an exception, probably because of their rapid decomposition.

In addition to *Brach.* the mosses especially represented are the three very shade-tolerant forms *Eur. prael.*, *Loph. het.*, and *Plag. dent.* *Thuidium* and *Dicranum majus* occur now and then.

The nearness of foliiferous trees diminishes the importance of the i-values as a basis for comparison with pure coniferous plant communities. The following values are from a pure population of coniferous trees; 1.73 (No. 7), 1.74 (No. 2), 4.15 (No. 3), 5.28 (No. 6), 8.20 (No. 11), 9.32 (No. 8).

The humus layer is mostly somewhat mixed with the mineral soil. Under Abies pectinata, however, it is always a typical mould layer, consisting of a layer of dark brown crumbling mould, a few centimetres thick, under a thin layer of needles. In this *Oxalis* has all its subterranean parts.

The acidity is subject to great fluctuations, varying between 3.5 and 5.6. Even within the same test area the deviation in a single instance amounts to 0.9 (No. 9), which is the greatest divergence in pH measured within a single sociation individual. *Oxalis* attains its best development at the highest pH values. A particularly high acidity is found in No. 6, where the subsoil down to at least 1 metre's depth was greasy bog soil with a pH of 3.5. The other sociations analysed were found on more or less clayey moraine deposits.

The Finnish *Oxalis*— and *Oxalis—Myrtillus* type contains leafbearing trees in greater or smaller numbers. From Germany the *Oxalis* sociation is mentioned as a subtype of the *Oxalis* type (CAJANDER 1909, p. 24). The tree population here consists mostly of Abies pectinata.

Deschampsia flexuosa—Oxalis soc.

Table II, 1.

In the *Oxalis* sociation *Desch.* is only rarely found and the specimens are feeble. On the other hand, *Oxalis* is occasionally found in *Desch.* sociations. In the sociation individual analysed *Desch.* was so weak compared with *Oxalis* and *Brach.* that it is most nearly allied to the *Oxalis* sociation. The sociation was somewhat exposed to wind and probably stable. The lower part of the peat layer was black and granular in structure, the upper part more like raw humus. Most of the roots of *Deschampsia* were in the upper part of the peat.

Oxalis—Thuidium tamariscifolium soc.

Table III, 7—8.

Thuidium, on account of its strong vegetative propagation, forms a dense carpet on the forest soil. *Brach.* and *Thuidium* are the only mosses forming populations with which *Oxalis* can successfully compete for room. In Table III, 7—8 the results of the analysis of the *Oxalis—Thuidium* sociation are given. The sociation links up with the *Oxalis* sociation individual in Table II, 3.

Apart from the fact that No. 7 was considerably richer in moss than No. 8 the sociation individuals showed great resemblances in spite of the considerable difference in the thickness and nature of the humus layer. In No. 7, under Abies pectinata, there occurred *Hylocomium loreum* and *Plagiochila asplenioides*, the latter, however, only where the soil was almost devoid of humus. *Polytrichum attenuatum* has a frequency percentage of 70, but is very poorly developed. In No. 8 under Picea excelsa the humus layer consisted of peat of a thickness of 5—12 cm. *Mnium rostratum* was the frequency dominant here.

Thuidium—Polytrichum attenuatum soc.

Table III, 6.

Of mosses *Polytrichum* alone, on account of its deviating growth form, is able to become the frequency dominant as well as the physiognomical dominant in a *Thuidium* carpet. *Polytrichum* carries its underground parts right down into the mineral soil, and multiplies by means of rejuvenation shoots from there.

Thuidium tamariscifolium soc.

Table III, 1—5.

The sociation is very pure. *Thuidium* is only present on moraine suitable for *Rubus* and *V. myrt.* and requires rather a large amount of moisture, but the light intensity in the *Thuidium* sociation is too low for phanerogams to thrive; it ranges from 0.82 to 4.24 %.

In Nos. 1 and 4 *Mnium undulatum* occurred, but only where the humus layer was thin. Its stolons are always found in the mineral soil.

Thuidium is indifferent to the acidity and the nature of the humus, it may even grow directly on mineral soil. In No. 1 *Thuidium* formed a zone round places which were covered with water in the winter. *Senecio silvaticus* was the only plant occurring in the dry depressions.

Brachythecium curtum soc.

Table IV, 3—14.

Brach. is one of the most widely occurring mosses in coniferous forests. Where it forms an independent sociation it covers the forest soil with an even but not always quite continuous carpet.

Grass does not occur in the sociation, and other phanerogams are scarce. The most frequent species are *Oxalis* and *Lactuca muralis*. As everywhere where *Brach.* forms populations there is a constant occurrence of *Eurhynchium praelongum*. *Loph. heterophylla* and *Scl.* are of common occurrence in the sociation, though generally with a low frequency percentage. Of rare occurrence as essential elements are *Mnium rostratum*, *Plag. dent.*, and *P. undulatum*; *Ster.* may become the frequency dominant, but as a rule it is poorly developed. *Thuidium* occurs fairly often.

The light intensity is low, varying between 0.96 and 6.66. The lightest sociation individual, No. 7, forms a transition to the *Oxalis* sociation.

The humus layer is thin throughout. The variations in its thickness are given in Table 2. The humus is always peat and may be developed as a pronounced raw humus abundantly interwoven with the hyphae of fungi. The sociation is fairly independent of the subsoil and acidity, but it does not occur on the driest sandy soil. It may be found homogeneously developed in places where the subsoil passes from clayey moraine sand into turf in overgrown lakes, and it also occurs on blown sand where the moraine does not lie very deep down.

The *Brach.* sociation occurs almost exclusively in fir woods, but it may also be found under Abies pectinata (No. 5).

Kujala (1926, p. 22) mentions *Brach.* as one of the most frequent and most abundant forest mosses in Finland on fresh soil in fir woods.

Vaccinium myrtillus sociations.

Table V.

The forestal treatment of the wood rarely allows *V. myrt.* to form populations in coniferous forests. The species only grows on moraine deposits, where the soil is of such a kind that the trees often give too much shade. The lowest i-value measured was 20.9. At much lower i-values it does not form populations, but it may occur in small groups or in scattered specimens in areas with a light percentage of down to about 4.

V. myrt. has the lowest pH of the phanerogams, the average being 3.73, with a minimum and a maximum of 3.4 and 4.3. Olsen (1921, p. 63) found it at pH 3.5 to 3.8.

The peat below *V. myrt.* is loose but interwoven with its numerous stolons and as a rule with the plant structure preserved. It is in great part formed by *V. myrt.* itself. *V. myrt.* has all its roots in the peat and it probably never occurs as a pioneer in mineral soil.

V. myrt. would seem to have a rather intensive generative propagation, rapidly colonising localities suitable for *V. myrt.* as soon as the light becomes favourable. In Denmark it seems to be an obligatory shade plant, but it is not dependent on the trees. Thus it will form small but stable populations in the shade of rocks and will successfully compete with *Calluna* on slopes with a northern exposure.

In other localities, for instance in the Alps, it will form dense growths above the tree line both on slopes with a northern and with a southern exposure, though the intensity of the light is there much greater than in Denmark; but in such localities *Calluna* is poorly developed and but little fit to compete with it. Hence it is most probable that it is the competition with *Calluna* which makes it appear as if *V. myrt.* cannot tolerate undiminished light in Denmark.

The *Myrtillus* type, which is a somewhat more comprehensive concept than *V. myrt.* sociations, is one of the most widely distributed of Cajander's forest types. It is particularly abundant on moraine in the southern half of Finland (Cajander 1921, p. 35) and over most of the Scandinavian peninsula.

Vaccinium myrtillus soc.

Table V, 4—9.

Desch. is constant and well developed, wherever *V. myrt.* does not occur in such dense growths that it shuts out the light. Now and then *Luzula pilosa*, *Majanthemum* and *Trientalis* are met with. Other phanerogams are rare. *Scl.* and *H. par.* form a well-developed layer of moss, though usually only one of the species is well developed in the same sociation individual. *Dicr. rugosum*, *H. prol.* and *Ster.* occur constantly but with low frequency. *Dicr. scop.* often finds good growth conditions (low pH).

Vaccinium myrtillus—Vaccinium vitis-idaea soc.

Table V, 3.

The sociation was only met with on moraine gravel in the neighbourhood of Silkeborg, and must be supposed to be rare. It only differs from the *V. myrt.* sociation by the presence of *V. vit.* In more northerly regions, on the other hand, the two *Vaccinium* species often occur together.

Pteridium aquilinum—V. myrtillus soc.

Table V, 1—2.

Well-developed sociations were only met with on soil suitable for *V. myrt.—V. vit.* near Silkeborg. *Pteridium* requires much light, 28—30 $^0/_0$ were measured, and below that i-value it occurs scattered but does not form populations.

The pH values tell us nothing about the acidity requirements of *Pteridium* since its rhizomes and roots are in the sub-soil. I have observed on several occasions that *Pteridium* develops its leaves earliest in the year in the most shady situations.

Vaccinium vitis-idaea and Empetrum nigrum sociations.

Table VI.

V. vit. and *Empetrum* are often closely allied in an ecological respect. They are both facultative shade plants which may form populations in full daylight under other edaphic conditions. In forests they only occur in part of the area where the environmental factors are favourable to them. This is connected with the great difficulty they experience in generative rejuvenation, a difficulty especially marked in places with a dense carpet of moss (Kujala 1926, p. 15 and 33), the sole situations where the species find life conditions in coniferous forests. Once they have immigrated they form dense populations by vegetative propagation. The difficulties of immigration are plainly apparent to the observer who notices one of the fairly frequent instances where one of the species forms a single luxuriant clone in a large homogeneous area. The stolons of *V. vit.* grow about 10 cm. annually (Kujala 1926, p. 14), those of *Empetrum* show a similar growth, so that a clone of, for instance, 10 m. in diameter must be at least 50 years old. Though it turns out that the plant has good growth conditions, no new individual has immigrated during this period, a long one, especially if we consider the frequent changes to which Danish forests are subject.

Empetrum requires more light than *V. vit.* and is more resistant to drought. The differences are not very great. The fact that *Empetrum* is most frequently found in forests in moister situations than *V. vit.* has nothing to do with their relative capacity to withstand moisture. For they are both found in bogs in far moister situations than in forests. The most considerable ecological difference lies in the acidity requirements of the species. As will be shown later, it is pH which determines at what degree of moisture the species occur in the forest. Expressed in pH the difference is small, *V. vit.* has an average pH of 3.83 (3.3—4.5) while that of *Empetrum* is 4.02 (3.7—4.4), and the sociations in which they are character species have pH 3.80 and 4.03 respectively.

KOTILAINEN (1928, p. 65) found the same relation between the acidity of the two species in bogs.

Vaccinium vitis-idaea soc.

Table VI, 7—15.

Phanerogams other than the character species occur but sparsely. *Carex arenaria* may become the frequency dominant and *Desch.* often occurs, but in very feeble specimens. In one instance only (No. 14), where the soil came very near to being suitable for *V. myrt.*, was it found as a frequency dominant. On the other hand, the moss carpet is always exceedingly luxuriant. It often attains a thickness of 15 cm. *H. par.* constitutes the chief part; only in one of the sociation individuals analysed was *Scl.* the physiognomical dominant. *Dicr. rugosum*, *D. scop.*, *H. prol.* and *Ster.* are constant, and *Bleph.* often occurs; but all these mosses together occupy a modest place compared with *H. par.* Lichens rarely occur. Throughout, the sociation has a very homogeneous character.

The lowest i-value for the sociation is 7.5, but at so low a light percentage it is etiolated. Here the density of the shoots is so small that in spite of even spreading it only barely attains a frequency percentage of 100. Under more favourable environmental conditions the shoots may stand very close together; their density depends exclusively on the environmental conditions, for where two or several clones adjoin, the density of shoots will be the same in their common area as in the single clone.

The peat has often a magnitude of 6—8 cm. *V. vit.* is considered one of the most peat-producing plants. It seems strange that a plant with so slow a growth and such a small leaf-fall — its leaves are bi- or triennial — should have any essential influence on the production of peat. *Carex arenaria* could with equal justice be called peat-producing. It is beyond doubt that it is the mosses which produce the peat, and as a matter of fact, it has quite the same appearance as the *H. par.*-peat.

The roots of *V. vit.* are most commonly found at the lower edge of the peat, but where this is particularly thick (e. g. No. 11), they do not go so deep. They do not penetrate into the mineral soil. In several cases I have found a layer of black plastic peat, up to 12 cm. thick, without roots, under the moss peat in younger forests on the heath; the pH values were very low in this layer (3.5—3.6—3.6). It was quite evidently the heather peat which was here preserved, whereas this is rarely demonstrable in *H. par* sociations in the same localities. It is presumably more probable that *V. vit.* finds the best life conditions in such places than that it should be able to conserve the heather peat. The heather peat is not included in the peat thicknesses given. A layer of hard pan up to 22 cm. was met with under the sociation.

The *V. vitis-idaea* soc. is found on very sandy subsoil only. In some few instances it forms colonies on moraine gravel, but its main area is the Jutland heaths. It also occurs on blown sand, principally where the moraine lies deep down (Svinkløv, Blykobbe, Tisvilde, Hornbæk).

In more northerly regions *V. vit.* is far less exclusive in its requirements than in Denmark. It is of common occurrence in all the Finnish types of coniferous forests (Ilvessalo 1922, p. 22), whereas, according to Adamson, it has a smaller edaphic-ecological amplitude in the Pennine range than *V. myrt.*

Empetrum—Vaccinium vitis-idaea soc.

Table VI, 5—6.

This sociation is most like the preceding one and forms a transition to the

Empetrum nigrum soc.

Table VI, 1—4.

Empetrum, where it forms independent populations, is associated with fairly moist sandy soil. A fact connected with this is that *Scl.* is mostly the physiognomical dominant, completely taking over the part of *H. par.* in *V. vit.* sociations. *Calluna* occurred in all the sociation individuals analysed, but otherwise the floristic composition was the same as in *V. vit.* sociations. The separate sociation individuals will be discussed in more detail in a later section (p. 33).

Calluna—Empetrum soc.

Table VII, 2—7.

Where *Empetrum* grows in company with *Calluna* its requirement of moisture is much less than where it forms independent sociations, it will even grow on the driest gravel in company with *Cladonia impexa* (No. 7).

The *Calluna—Empetrum—Clad.* sociation is highly reminiscent of the high northern "tall heath", but the latter is also found on much better soil than in Denmark (Tamm 1920, p. 169).

Calluna vulgaris soc.

Table VII, 8—19.

In Denmark *Calluna* rarely forms stable sociations in forests; it requires too much light to do so (see p. 40). By far the greater number of analyses of *Calluna* populations have as a matter of fact been made to investigate the succession and ecological relationships of the plant communities.

Nos. 2—4 and 14 are probably stable. At the low light percentage in 3 and 14 (13—14 $^0/_0$) it suffers distinctly from want of light and has to share the space with *Carex arenaria*, and at 27 $^0/_0$ also (No. 4) it does not attain as vigorous a development as in full light. It is difficult to decide which of the other sociation individuals would be preserved unchanged if the light conditions did not change.

Desch. occurs scattered, only forming populations where *Calluna* has recently immigrated after clearing (No. 18). *Dicr. scop.* and *H. par.* are constants, but the reason why *H. par.* often occurs in very small numbers is the ephemeral character of the plant community (see under Succession). *Ster.* occurs in all the sociation individuals, and mostly in abundance. *H. prol.* often occurs, and here, as usual, it is closely associated with *Scl.*

Calluna has the same pH requirements as *Empetrum*, the mean value being 4.01 (3.5—4.7) for the sociations and 4.03 (3.7—4.4) for the species.

The heath peat differs from peat formed of moss by being black and structureless. The subsoil is always podsolated, but a formation of hard pan only takes place on particularly sandy soil.

Deschampsia flexuosa sociations.

Where *Desch.* forms stable populations it is nearly always sterile. At a light percentage exceeding c. 12—15 it may, however, flower, but never as luxuriantly as where it occurs as a "ruderal plant" after clearing. Stability and fertility are inversely proportional, the ratio being quite independent of the nature of the soil.

In coniferous forests *Desch.* has perennial above-ground stolons and might thus be classed among the chamaephytes; but the apices of the shoots are protected in the winter by a layer, often very thick, of its own leaves and of moss which, biologically, acts as a layer of soil. In several places I have seen that the shoots in the winter were not only covered by the green leaves from the same year, but the withered leaves from last year, too, lay as a continuous layer over the apices of the shoots.

Desch. is the most shade-tolerant grass. It forms populations at i-values ranging from c. 7 to 100. While it may thus occur at almost all light intensities, its moisture amplitude is rather narrow. The pH variation curve for the species is given in fig. 8. As will appear, *Desch.* is closely associated with peat with a pH around 4.0. Its pH border values are 3.5 and 4.9 (165 measurements), and its dispersal is very small — though not compared with that of other peat plants. Olsen (1921, p. 79) found the same average value for the species.

Desch. always grows in a layer of peat. Only rarely do its roots penetrate to the subsoil. In thick layers of peat they do not reach the lower part of the layer. Where stable, it is a pronounced peat-producing plant.

Cajander (1909, p. 64 ff.) mentions plant communities with *Desch.* as the dominant as a sub-type of the *Myrtillus* type (Southern Germany). It contains much more *Polytrichum* than the Danish *Desch.* sociations (cp. Bornebusch 1925, p. 210). In the north *Desch.* seems to be of less importance.

Deschampsia—Scleropodium purum soc.

Table VIII.

The sociation is one of the most widely distributed in Danish coniferous forests, and occurs on nearly all kinds of subsoils. *Scl.* may be very vigorously developed, particularly in moist depressions in dunes, and *Desch.* forms a dense carpet and is almost solely prevalent among the phanerogams. *Trientalis* may be the frequency dominant, and *Oxalis* too may become a frequency dominant without being a relict.

Of constant occurrence are *H. par.* and *H. prol.* but always of low or moderate frequency, while *Lophocolea bidentata*. *Dicr. scop.*, and *Ster.* are common. *Thuidium* only occurs in sociation individuals which also harbour *Oxalis*. Lichens never occur.

The thickness of the peat is seen to vary between 2.5 and 11 cm. The peat may vary a good deal in structure. In many cases there is a distinctly preserved plant structure, in other instances the structure is granular, and both may occur within the same test area.

Deschampsia flexuosa soc.

Table IX, 1—11.

The distinction between this sociation and the preceding one is in some instances somewhat casual. *Scl.* is a constant but with low frequency. Where *Desch.* is so luxuriant that *Scl.* does not form populations for want of space or light, we are in reality concerned with a sociation corresponding completely to the typical *Desch.*—*Scl.* sociation, but under conditions where *Desch.* has such growth facilities that it supplants *Scl.* which it otherwise protects.

The chief difference in the composition of the vegetation, besides that given in the designation of the sociations, is the constant presence of *Ster.*, often as the physiognomical dominant, among the mosses. In No. 1 *Lycopodium annotinum* forms a dense population.

The i-values are on the average somewhat higher than in the *Desch.*—*Scl.* sociation, and the thickness of the peat as a rule lies 2 cm. higher. For the *Desch.*—(*Scl.*) sociation the average pH is 4.02 (3.5 to 4.9).

The sociation occurs most commonly on moraine sand suitable for *Rubus* and *V. myrt.*

Deschampsia—Galium harcynicum soc.

Table IX, 12—13.

This sociations was met with on soil suitable for *V. vit.* No. 12 is closely allied to the *Desch.* sociation, No. 13 most closely resembles the succeeding sociation. *Galium* was well developed and fertile in both sociation individuals. A sociation corresponding entirely with No. 12, but containing several non-forest plants, occurs in summer-dry green bogs between *Calluna* heath and *Carex Goodenoughii* populations on open heath (Mølholm Hansen 1932, p. 145).

Deschampsia—Hylocomium parietinum soc.

Table IX, 14—17.

Desch. is somewhat poorly developed, allowing a luxuriant growth of *H. par.*, *H. prol.*, *Dicr. rugosum*, *D. scop.* and *Ster.* No. 17 appeared two years after clearing in a forest with *H. par.* sociation and will gradually pass into *Calluna* heath, the rest of the sociation individuals are stable. The *Desch.*—*H. par.* sociation has an average pH of 3.86 (3.4—4.2). The subsoil always consists of sand.

Carex arenaria soc.

Table X, 1—11.

This sociation is very widely distributed in coastal dune plantations. In these forests *C. arenaria* attains a density rarely seen outside them, and has a diverging appearance. The leaves may attain a length exceeding 1 m., and are partly procumbent. It is mostly sterile but may flower at a light percentage of c. 12—15 and on the whole shows good agreement with *Desch.* in its relation to light. Its light minimum lies at 7—9 %, and it forms sociations in the open dunes and on the heath.

Scl. is constant in the sociation and is very luxuriant; and *H. prol.* often attains a considerable development. *Dicr. rugosum. D. scop., H. par.* and *Ster.* are nearly always present, but as a rule with low frequency. In a single instance *Empetrum* was the frequency dominant (No. 1). The sociation individuals from Sonnerup are remarkable by their content of *Brach.* and *Mnium rostratum.*

There is no reason to regard *C. arenaria* as a relict from the dune. As already mentioned, it thrives remarkably well in the forest, even in situations where it must be supposed not to have formed sociations originally.

The magnitude of the peat varies between 5 and 11 cm. and it is noteworthy that *C. arenaria* always has its stolons as well as its roots in it. Though in forests *C. arenaria* is indissolubly associated with the peat, it only occurs where the subsoil is almost pure sand.

C. arenaria has the highest pH of the moor plants forming populations, pH being 4.15 (3.7—4.8) for the species, and 4.12 (3.7—4.6) for the sociation.

Carex arenaria—Oxalis soc.

Table X, 12—13.

This peculiar composition of the vegetation may be found in situations where water from moraine deposits penetrates into overlying sandy strata (here half a metre to one metre thick). The sociation is rare but interesting by the fact that it shows how *Oxalis* can thrive on blown sand when under the influence of moraine deposits, and that this does not unfavourably influence *C. arenaria* which, unlike *Oxalis*, does not thrive on moraine. The layer of peat is 6—7 cm. thick, and all the roots are in it. *Luzula pilosa* and *Hylocomium triquetrum*, both with similar pH requirements to *Carex arenaria*, are well developed.

Scleropodium purum soc.

Table XI.

Scl. is an oceanic-boreal moss, having its south-eastern limit in the Caucasian beech region. Its oceanic character is so pronounced that even in Denmark distinct differences in its edaphic requirements may be observed. It is one of the most widely dispersed of the mosses of Danish coniferous forests, and occurs both on moraine sand and in dune forests.

The *Scl.* sociation only occurs on soil where *Desch.* or *C. arenaria* will also thrive, so that its upper light limit is dependent on the lower light limit of these species;

and since the latter is lower than that of most other phanerogams, the sociation is an almost pure moss sociation. The shade-tolerant *Luzula pilosa* is the frequency dominant in one instance. *Brach.* occurs in many of the sociation individuals, and limited to the same are *Mnium rostratum*, *Loph. heterophylla* and *Plag. dent.* The *Brach.* sociation and the *Scl.* sociation often merge, whereas the line between the *Scl.* sociation and the *H. par.* sociation is fairly distinct. *H. par.* is, however, found as a constant in the *Scl.* sociation, though mostly with low frequency. *Dicr. scop.* may become the frequency dominant, but it never becomes the physiognomical dominant. *H. prol.* and *Ster.* are constants of from low to moderate frequency.

Where *Scl.* attains its best development it forms a dense carpet with ascending or erect shoots, very similar to those of *H. par.* In other cases it creeps along the ground.

The *Scl.* sociation has nearly the same light requirements as the *Brach.* sociation.

The thickness of the peat shows that *Scl.* only occurs where the magnitude of the peat exceeds 6 cm. In accordance herewith it is only found in old forests, often in younger growths of the second generation, because dark forest soil is here combined with a thick layer of peat. Where *Scl.* is luxuriant and forms the chief part of the peat itself, the latter is loose and somewhat felt-like. In other instances it is like raw humus and often interwoven with the roots of trees.

pH for *Scl.* sociations is low. It averages 3.82 (3.4—4.4), whereas pH is considerably higher for the species, viz. 4.01 (3.4—4.8).

Hylocomium parietinum soc.

Table XII.

The *H. par.* sociation is beyond comparison that which occupies the largest area of all the plant communities of coniferous forests. There is no doubt, however, that it will become rarer when the large areas with Pinus montana of the first generation on the heath, which is its chief domain, are replaced by the more shelter- and shade-giving Picea excelsa.

H. par. occurs on all kinds of soil except that suited for *Rubus* (there only on the rotten stumps of trees), but it only forms populations on soil suitable for *V. vit.* or still drier soil.

Comparison with the k $^0/_0$ for the *H. par.* and *V. vit—(Empetrum)* sociation shows extremely good agreement. *Clad.*, however, forms an exception, being found in the *H. par.* sociation only. Actually the moss populations in the two plant communities are exactly similar, but the agreement in the k $^0/_0$ is somewhat misleading, because *Scl.* may form a population in the *V. vit.* sociation without it being found necessary to divide it into two sociations on that account. In the *H. par.* sociation *Scl.* is rare and of low frequency. The composition of the species is extremely uniform, with *H. par.* as the absolute physiognomical dominant and *Dicr. rugosum*, *D. scop.*, *H. prol.* and *Ster.* as constants. *Dicr. rugosum* may be almost solely prevalent in small spots. The moss carpet is often 20 cm. thick. *Desch.* has a k $^0/_0$ of 64, but is of low frequency and always very slender.

The uniform development of the *H. par.* sociation is due to its great influence on the surface soil owing to its rapid growth and lively vegetative propagation. KUJALA (1926, p. 40) found an annual augmentation of 10—13 mm., but the rate of growth is doubtless very variable under different conditions (see also the discussion of the production of peat at p. 46).

The light percentage in the *H. par.* sociations is highly variable. On rare occasions it has been found to be 3.46, but at such low intensities of light it grows slowly and will only with difficulty be able to compete with the more shade-tolerant *Stereodon.* The *H. par.* sociation may be found in full light (plate II).

The peat under the *H. par.* sociation is loose and felt-like and is for the most part formed of the character species. The average thickness of the peat mostly lies between 4 and 7 cm. The pH of the peat ranges around 3.87 within such narrow limits that in 22 out of 100 sociation individuals it will lie within an interval of 0.1 around the mean value. The lower and upper limits of pH are 3.4 and 4.3. The pH amplitude for the species is, as was to be expected, somewhat wider than for the *H. par.* sociation with a regular distribution around pH 3.85 (fig. 8).

Hylocomium proliferum soc.

Table XV, 7—9.

The *H. proliferum* sociation has exactly the same qualitative composition as the *Scl.* sociation, but differs from it in the fact that *H. prol.* with *H. par.* are physiognomical dominants.

Scl. and *H. prol.* show great biological similarities and seem to alternate in different climates. In coniferous forests the *H. prol.* population is much better developed in Finland and in the Scandinavian peninsula than in Denmark. As far south as Småland the luxuriance of *H. prol.* is striking. KUJALA (1926, p. 30) designates *H. prol.* as the most important forest moss next to *H. par.*, while the same author in his very comprehensive studies of Finland's forest moss vegetation does not find *Scleropodium* at all.

H. prol. is a pronounced acidiphile, the average for the species being 3.80, which is considerably below that of *Scleropodium.* But a comparison of the sociations of the two species shows no distinct difference in the acidity.

A comparison of the k $^0/_0$ of the two species (Table 1) furnishes good information as to their relative relation to moisture. It is seen that *H. prol.* has the highest k $^0/_0$ in the *Clad.*, *H. par.* and *V. vit.—(Empetrum)* sociations, whereas *Scl.* is most frequent in the *Desch.* populations. Thus *H. prol.* is more tolerant of drought than *Scl.* This was immediately seen in No. 8. The soil had here been ploughed, and there was a very regular distribution with pure *H. prol.—H. par.* on the ridges and a very great admixture of *Scleropodium* in the furrows. Strictly, this sociation individual is a mosaic of two sociations.

The *H. prol.* sociation has a somewhat higher light minimum than the *Scl.* sociation. It also occurs at a somewhat higher light percentage than the latter, in places where *Deschampsia* cannot immigrate owing to a lack of water — which is never the case in the *Scl.* sociation.

H. prol. mostly occurs on soil suitable for *V. myrt.* and *V. vit.* but may also be met with on sand where these species would hardly grow. It seems here to be dependent on the leaves falling from foliiferous trees, at any rate a very few birches scattered among the conifers will be able to change a pure *H. par.* sociation into a *H. prol.* sociation, which was the very thing that happened in No. 7. The phenomenon may be observed very frequently, for instance in Tisvilde.

Hylocomium triquetrum soc.

Table XV, 3—6.

This sociation only occurs under special conditions in coniferous forests, viz. in situations where the peat, owing to a calciferous subsoil or for other reasons, has a particularly high pH. Thus it is of common occurrence in Svinkløv, where the *H. parietinum* sociation was to be expected, and it forms a zone round limestone quarries. In Sonnerup, too, it dominates in several places over its most common accompanying mosses *H. par.*, *H. prol.*, and *Scl.* Scattered birches have a very favourable effect on *H. triquetrum* (the leaves of foliiferous trees increase the pH).

Luzula pilosa—H. triquetrum soc.

Table XV, 1—2.

The examples are derived from the vicinity of the *Carex arenaria—Oxalis* sociation and under similar conditions, but the sociation has probably appeared as a result of birches in the neighbourhood.

Dicranum majus soc.

Table XV, 10—12.

The sociation has been found on soil suitable for *V. vit.* and *V. myrt.* near Silkeborg, and in Grib Forest it occurs at the top of slopes bearing *Thuidium* sociation at a lower level.

The two other common *Dicranum* species do not form sociations. *Dicranum scoparium* occurs in most sociations and is as a rule equally distributed over the test area. It has not nearly the same power of vegetative reproduction as *D. majus*, but *D. scop.* is indifferent to light and very resistant to drought. Its pH is the lowest that has been measured, averaging 3.71.

D. rugosum resembles *Calluna* and *Empetrum* in its relation to absolute moisture. It is a constant in the dry *Cladonia* sociation and occurs among *Sphagnum* in bogs. Its light requirements are slightly in excess of those of the *H. par.* sociation.

Stereodon cupressiformis soc.

Table XIV.

The *Stereodon* sociation occurs on soil both slightly drier and slightly moister than that of the *H. par.* sociation. In many instances the composition of the species differs only quantitatively in the two sociations, but the difference is so considerable that there can hardly ever be any doubt to which sociation a plant community belongs. *Stereodon* forms a continuous carpet and where the sociation is best developed has an ascending growth; at a lower intensity of light it creeps along the forest ground. It is always the variety *ericetorum*, by some authors regarded as a separate species, which forms sociations.

The reason why *Stereodon* is able to resist the competition of *H. par.* is that it is more tolerant of shade and requires less moisture than the latter. The sociation has been found at a light intensity of 1 %, but at such a low intensity of light it grows slowly and will, particularly in old growths, become covered with needles. At 2—3 % its growth is so vigorous that it may rise above the fallen needles. Where the soil is very dry, the *Stereodon* sociations may be stable at high values of i, the highest measured being 20.7.

Lophocolea heterophylla sociations

Table XVI, and

Eurhynchium striatum soc.

Table IV, 1—2.

Table XVI gives the results of the analyses of some sociation individuals on very dark forest soil, which all contain *Loph. het. Plagiothecium denticulatum* var. *curvifolium* may form populations at as faint an illumination as somewhat below 2 %, at a lower light intensity all the mosses are attached to prominent objects, especially to roots and fallen branches.

The lowest of all i-values found was 0.37 (No. 4). At this low light intensity *Lophocolea heterophylla*, *Plagiothecium denticulatum*, and *Stereodon* still occur.

Haberlandt (1886, p. 476) observed that the rhizoids of *Eur. praelongum* penetrate into fallen beech leaves and produce haustoria-like lobed formations. Hence he conjectures that it is a semi-saprophyte. Another of the species most tolerant of shade, *Loph. het.*, is invariably associated with fresh or decaying parts of plants. As far as I know, no investigations are available on its nutrition, but there can hardly be any doubt that it is a semi-saprophyte. In the course of a very few years it may in very dark forests form a pale green coating on the end surfaces of splinters from the felling of trees or on stumps of trees, a rate of growth which no other moss ever attains at a similar light intensity. *Loph. het.* most frequently occurs in dark forests. It can, however, thrive at more light, but is very susceptible to drought. Thus it has been found at 15 % on splinters soaked with water.

In very dark localities with a high pH *Eur. striatum* was in one or two instances found to be the dominant moss. One case was under young Picea excelsa of the first generation on marly sand in Nørlund plantation and the other was on moraine clay under old Abies pectinata in Rø plantation. In both places *Eur. striatum* was scattered and accompanied by *Eur. prael.* and *Plag. dent.*

Cladonia impexa soc.

Table XIII.

Cladonia impexa forms a continuous carpet, mostly with *Cladonia rangiferina* tufts interspersed. Physiognomically the mosses play an insignificant part, but the following mosses will nearly always be found:

Bleph., *Dicranum rugosum* and *D. scop.*, *H. par.* and *Ster. Desch.* may occur. It is very slender, but often fertile.

Cladonia is found on the same kind of soil as *H. par.*, but its slow growth makes it incapable of competing with it, so it is confined to places too dry for *H. par.* Otherwise the species is quite independent of the absolute moisture. According to Mølholm Hansen and M. Lund (1929, p. 27) it occurs wherever there is a possibility of lichen vegetation.

The *Cladonia* sociation has been found at i-values as low as c. 10, but the measurements are from the insolated slopes of dunes, so the values are somewhat too low. The sociation has no upper light limit.

pH is very low, the average value being 3.72 (3.4—4.3). The peat is as a rule thin. Such low pH values will not be found anywhere else in peat of so slight a thickness, whereas it may occasionally be found in the lower part of a thick layer of peat.

The list of lichens in the Table is not complete.

The plant communities described in Table XVII belong to the rarer kinds hence they will not be discussed in detail. They are of interest by the fact that they form members in ecological series, so they will be mentioned in subsequent sections.

The Distribution of the Vegetation on different Soils.

In the following we shall give a series of typical examples of the ecological factors influencing the distribution of the vegetation in the separate instances. Localities have been chosen which, as far as can be judged, show agreement in respect of as many environmental factors as possible, while one factor or rather, since the environmental factors usually constitute a more or less indissoluble complex, a complex of factors, varies. Thus, for instance, an increase in the intensity of the light will involve greater desiccation, and the moisture conditions of the soil decisively affect its acidity, a state of dependence which cannot be explained exclusively by the effect of the species associated with certain degrees of moisture.

The figures merely give an outline of the variations in the environmental factors and the plant communities to which they give rise, some attention having, however, been paid to the relative extension within the area of the plant communities.

Dune and Level Heath.

The ground vegetation in coniferous forests on dunes and level heath has many points of resemblance, but the dunes bear a more variable vegetation, because moraine

Table 1. Constancy percentage of some species in some of the plant communities.

	Rubus—Brach. sociations Tab. I	Oxalix acetosella sociation Tab. II	Brach. curtum sociation Tab. IV	Vacc. myrt. sociations Tab. V	Vacc. v.-i.—(Empetr). sociations Tab. VI	Calluna sociations Tab. VII	Desch.—Scl. sociation Tab. VIII	Desch. sociation Tab. IX	Carex arenaria sociation Tab. X	Scleropodium sociation Tab. XI	Hyl. parietinum sociation Tab. XII	Stereodon sociation Tab. XIV	Cladonia imp. sociation Tab. XIII
Number of sociation individuals	14	10	12	9	11	19	22	11	11	19	33	19	9
Oxalis acetosella	57	100	33	0	0	0	32	9	0	0	0	0	0
Deschampsia flexuosa	64	30	0	100	64	69	100	100	64	58	64	58	44
Blepharozia ciliaris	0	0	0	0	55	26	14	0	0	0	39	11	89
Brachythecium curtum	100	80	100	22	9	11	32	45	36	63	9	22	0
Dicranum rugosum	0	0	0	78	91	58	14	18	55	16	88	37	89
— scoparium	14	40	67	78	100	95	77	45	45	100	91	100	100
Eurhynchium praelongum	79	70	83	11	0	0	5	0	18	16	0	11	0
Hylocomium parietinum	21	40	50	89	100	89	82	82	55	89	100	100	89
— proliferum	29	10	75	78	91	53	86	64	73	95	94	74	33
— triquetrum...............	21	10	16	11	9	11	32	27	27	32	27	26	0
Lophocolea heterophylla	29	90	100	33	0	5	5	27	0	47	6	22	0
Mnium rostratum	86	40	50	11	0	0	5	0	27	21	0	0	0
Plagiothecium denticulatum	36	80	58	44	9	0	14	55	0	47	0	21	0
Scleropodium purum............	93	70	92	89	27	42	100	91	100	100	24	47	0
Stereodon cupressiformis	21	60	42	100	91	100	50	100	55	89	94	100	100
Thuidium tamariscifolium	21	50	42	0	0	0	18	0	0	0	0	0	0
Cladonia impexa	0	0	0	0	0	26	0	0	0	0	42	32	100

Gams (1932, p. 332) gives a list of affinities between mosses and vascular plants (the Alps, but partly also Danish species).

deposits often lie near the surface, and under such conditions that they may influence the moisture of the surface (Hornbæk, Tisvilde, Blykobbe, Svinkløv). These are the woods that show the greatest floristic resemblance to the N. Scandinavian forests because of the presence of *Pirola* species, *Chimaphila* species, *Linnaea*, *Listera cordata*, *Goodyera repens*, and a luxuriant growth of *Ctenium crista-castrensis*. Common to dune and heath according to the increasing degree of moisture is the succession *Clad.* sociation, *Ster.* sociation, *H. par.* sociation, (or *V. vit.* sociation), *Desch.* sociations, (or *Carex arenaria* sociation on dunes). *Deschampsia*, however, is much better developed on dune than on heath; on the heath it usually occurs in company with *H. par.*, on dune with *Scl.* The *Scl.* sociation, which is very frequent in dune forests, only occurs on the heath in old fir woods with a well-developed layer of peat.

Example 1.

Locality: Frederikshaab Plantation (level heath). The subsoil consists of coarse sand with stones, the finer heath sand being blown away. The tree population consists of 70 year old Pinus montana with open and low growth. At a light percentage of c. 30 there is *Clad.* sociation (Table XIII, 5), and if the light intensity increases essentially, the *Clad.* sociation cedes its place to a lichen plant community in which *Cladonia rangiformis* occupies a prominent place. Under the trees, where the largest amount of needles is found and where there is least desiccation by the sun, there occur small *H. par.* populations, now and again with *Empetrum*.

Example 2.

Very close upon the preceding one, but the sand is but little blown away or not at all. Among 40 year old Picea excelsa of the first generation *Ster.* forms populations at 3.08 % of light (Table XIV, 18). In slightly lighter situations, at 3.46 %, *H. par.* is well developed (Table XII, 14). This is the lowest i-value found for the *H. par.* sociation. In a growth about 40 years old in the immediate vicinity, where the soil must be supposed to be the same, the *Desch.—H. par.* sociation occurs at 10.9 % of light (Table IX, 16). Below the light minimum of *Deschampsia* the *H. par.* sociation (XII, 15) appears, and at high i-values, as a result of the desiccation, the *H. par.* sociation recurs, followed by the *Ster.* sociation and the *Clad.* sociation.

Hence, with increasing intensity of light, we have: *Ster.* soc.—*H. par.* soc.—*Desch.-H. par.* soc.—*H. par.* soc.—*Ster.* soc.—*Clad.* soc.

Example 3.

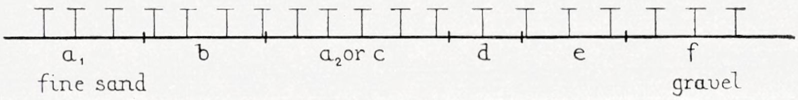

Fig. 1. *a* = *V. vit.* soc. (Table VI, 14 and 12), *b* = *Desch.-H. par.* soc, (Table IX, 14). *c* = *H. par.* soc. (Table XII, 4). *d* = *Ster.* soc. *e* = *Clad.* soc. (Table XIII, 1). *f* = *Calluna-Empetrum-Clad.* soc. (Table VII, 7).

The locality (Sandheden) is situated 4 km. to the east of Silkeborg immediately to the north of the high road to Aarhus. The soil is a gently sloping deposition cone with a gradual transition from gravel to fine sand, which is adjacent to moraine deposits. The Pinus silvestris population is 40—50 years old and of the first generation; over f, however, it is 20 years old. The light is everywhere the optimum for all the sociations concerned except f. f is in process of passing into the a pure *Clad.* sociation, in the more open spots the dwarf shrubs have died. Under the older Pinus silvestris, at the top of the cone, a *Clad.* sociation is to be seen, abutting on the *Ster.* sociation, which forms transitions to the *H. par.* sociation. This contains *V. vit.* clones. *V. vit.* is associated with a greater thickness of the peat and a higher frequency of *H. prol.* Where the sand is finest, the *Desch.—H. par.* sociation makes its appearance likewise the *V. vit.* sociation, with an uncommonly large admixture of *Desch.* and a little *V. myrt.*

On the moraine slope this series is continued in the *V. myrt.* sociation.

This example comprises all the most important plant communities from the heath, and they will be found in the same succession whether the differences in dryness, as in this case, are due to the porosity of the soil or to the effects of the wind or the sun.

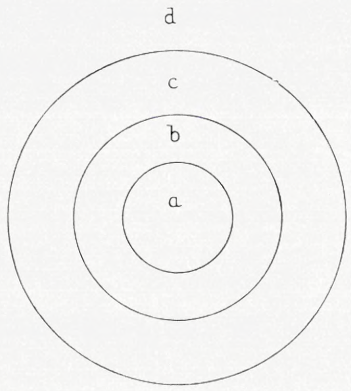

Fig. 2. *a* = *Desch.—Galium harcynicum—H. par.* soc. (Table IX, 13) pH 4.13. *b* = *V. vit.—Empetrum* soc. (Table VI, 5) pH 4,07. *c* = *V. vit.* soc. (Table VI, 10) pH 3,90 (lower peat 3.6). *d* = *H. par.* soc. (Table XII, 7) pH 3.87.

Example 4.

Locality: Bredlund Plantation (level heath). The growth consists of 30—40 year old Pinus montana of the first generation. The light intensity ranges from 15 to 20 % and is thus the optimum for all four sociations. Fig. 2 shows diagramatically the distribution of the sociations according to the height above the ground-water level. The differences in height are very small, but distinctly demonstrable. At the lowest level, where also *Molinia coerulea* occurs, the *Desch.—G. harcynicum—H. par.* sociation is met with. Then follow the *Empetrum—V. vit.* sociation and the *V. vit.* sociation. Below the layer of peat in which the roots are found, and which has retained the plant structure, both these sociations have a 6—8 cm. thick layer of black, greasy peat, which, however, does not seem to limit the *V. vit* sociation for the benefit of *H. par.* sociation, the highest lying sociation. A layer of hard pan, 4—7 cm. thick, is present everywhere.

Example 5.

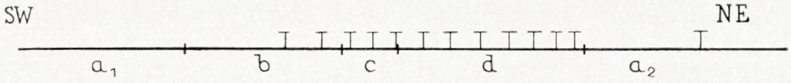

Fig. 3. *a* = *Calluna-Empetrum* soc. (Table VII, 5). *b* = *Clad.* soc. (Table XIII, 9). *c* = *Ster.* soc. *d* = *H. par.* soc. (Table XII, 1).

The tree population is c. 40 year old Pinus silvestris of the first generation on a level terrain of blown sand at Dueodde. The original vegetation is a *Calluna—Empetrum* sociation very poor in species, which does not differ much from the one here analysed (a_2) in which there are scattered trees. To the south-west of the forest and some distance into it there is a zone with a *Clad.* sociation which is bounded on the south-west by the original vegetation, and in the interior of the forest, at 30—35 % light, there is a narrow zone with a *Ster.* sociation, which forms a transition to a *H. par.* sociation or an *Empetrum* sociation (Table VI, 4), harbouring some *Calluna* and a luxuriant moss population. Although the intensity of the illumination is far above the minimum for *Empetrum*, *Empetrum* will disappear gradually as *Calluna* dies, and it will hardly immigrate here again. To the north-east the *Calluna—Empetrum* sociation extends right up to the edge of the forest.

The reason why the *Clad.* sociation occurs in the south-western part of the forest is to be found in an interaction of two factors. The ground-water level has been lowered as a result of the afforestation, and the place is exposed to the wind. In sheltered situations farther inside the forest the *H. par.* sociation is found at a similar ground-water level and outside the north-eastern part, where there is shelter, the original vegetation can be maintained, in spite of the lowered ground-water level.

In other places at Dueodde as well as in other dune forests the *Carex arenaria* sociation (Table X, 4) will be found in depressions of the dunes, surrounded by the *H. par.* sociation. In the locality here analysed the percentage of illumination is 11.3 %, so that the *Empetrum* sociation will probably be excluded for want of light.

Example 6.

The test areas are on dunes in the Blaabjerg Plantation. The dune is steep and with about the same slope towards the north-east and the south-west. The tree population consists of open Pinus montana, and the light intensity is 20—30 % (measured horizontally). On the side exposed to the sun and the wind there occurs a *Clad.* sociation which, as the dune becomes less sloping, passes into a *H. par.* sociation. On the upper part of the north-eastern slope there is a well-developed *Ster.* sociation with a thick layer of peat. This is an exception. *Desch.* is frequency dominant here, but it is very slender. A little lower, in more sheltered situations, *Desch.* becomes more vigorous and occurs in company with *Scl. Desch.—Scl.* here passes into a pure *Scl.* sociation when the light falls below the minimum for *Deschampsia*, but in some places the zonation *Desch.—Scl.* soc. *H. par.* soc. will be found, when *Deschampsia* is excluded owing to lack of light.

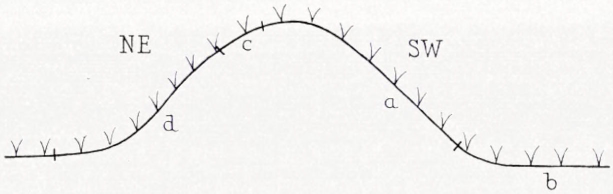

Fig. 4. *a* = *Clad.* soc. (Table XIII, 6). *b* = *H. par.* soc. (Table XII, 5). *c* = *Ster.* soc. (Table XIV, 12). *d* = *Desch.—Scl.* soc. (Table VIII, 1).

On less steep dunes the *Desch.—Scl.* sociation is replaced by a *H. par.* sociation, and this is a very common distribution of the vegetation on dunes. The following is an example from the inner sands of Frederikshaab Plantation; on the southern slope occurs a *Clad.* sociation (Table XIII, 3) and on the northern slope an *H. par.* sociation (Table XII, 11).

Example 7.

The example is derived from Hornbæk Plantation. The subsoil is blown sand deposited in a more or less deep layer over moraine deposits. The figure shows relief conditions and the relative thickness of the blown sand. At the top, in a fir wood with 3.18 % illumination occurs the *Scl.* sociation with *Luzula pilosa* as the frequency dominant. Here and there are found smaller *H. par.* sociation individuals. A little above the foot of the slope where there are scattered specimens of Pinus silvestris the *Empetrum* sociation appears, with a very luxuriant population of *Scl.*, and at the lowest level occurs a *H. par.* sociation or a *V. vit.* sociation with *H. par.*, but no *Empetrum*. As will appear from several examples, *Scl.* and *H. par.* are sufficiently good indicators of moisture to show that the moisture is greatest in the *Empetrum* sociation. Here, then, we have *Empetrum* as a "well plant", while *V. vit.* only occurs

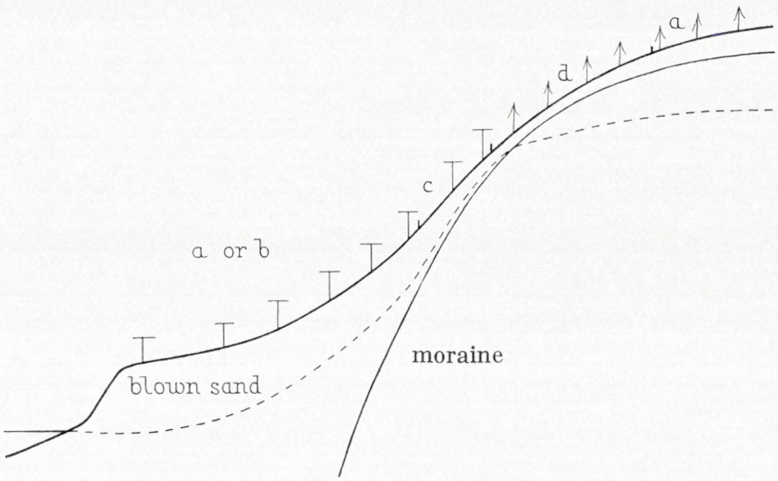

Fig. 5. Diagram showing the moisture conditions in Exemple 7. The moraine is overlain by a layer of blown sand. The stipled line denotes the probable position of the ground-water level (partly after SUKATSCHEW 1932, p. 202). *a* = *H. par.* soc. (Table XII, 22, the lowest lying *H. par.* sociation individual). *b* = *V. vit.* soc., *c* = *Empetrum* soc. (Table VI, 3), *d* = *Scl.* soc. (Table XI, 18).

in the driest area. Since *Empetrum* is more resistant to drought than *V. vit.*, the degree of moisture can only be regarded as a factor influencing the distribution of the vegetation as far as the mosses are concerned.

In Tisvilde Plantation, too, *Empetrum* sociation may be observed in several places in the eastern part at the foot of the slope facing the sea. Such a pronounced lime and well plant as *Equisetum hiemale* forms populations here in some few places and furnishes conclusive evidence of the influence of the ground-water. Below the *Equisetum hiemale* zone occurs the *Empetrum* sociation (Table VI, 2), which passes into the *Calluna* sociation (Table VII, 13). Still further removed from the moraine hill there are beginnings of a *Cladonia* sociation, which in more shaded situations passes into the *H. par.* sociation (Table XII, 16). On the moraine hill the aforementioned *Carex arenaria—Oxalis* sociation appears, besides the same plant communities as those mentioned for Hornbæk.

Example 8.

Locality: Rønne Plantation. Light $^0/_0$ 10.5. The *H. par.* sociation (Table XII, 31, both *Scl.* and *Desch.* are frequency dominants, but very feeble), occurs at high levels somewhat lower down appears a very pure *Desch.—Scl.* sociation (Table VIII, 5).

Example 9.

Locality: Tisvilde Plantation. The subsoil is blown sand over moraine deposits, and the light intensity is 5—6 $^0/_0$, i. e. below the minimum for *Desch.* At the lowest level there occurs a *Scl.* sociation rich in *Luzula pilosa* (Table XI, 19). A little higher up there is a *H. par.* sociation with an abundance of *H. prol.* (Table XII, 24). At a still higher level and at a higher light intensity a purer *H. par.* sociation (Table XII, 6) appears. Under scattered young firs there is a very luxuriant growth of *Scl.* and *H. prol.*, corresponding entirely to the occurrence of *H. par.* under pine in the *Clad.* sociation in Frederikshaab Plantation (Example 1).

Moraine.

The three moraine areas most thouroughly investigated are the neighbourhood of Silkeborg, Almindingen, and Grib Forest. Round Silkeborg the moraine contains stones and gravel, in Almindingen it consists of nearly pure sand, and in Grib Forest it is more or less clayey. The moraine hills around Silkeborg are suitable for *V. vit.*—*V. myrt.*, *Rubus* only occurs below round the lakes, the *H. par.* sociation appears on insolated slopes of hills or such as are exposed to the wind. Almindingen, to which Gjøding Plantation may be added, is suitable for *V. myrt.*, and *Rubus* only forms populations in the *Rubus*—*Brach.*—*Desch.* sociation which characterise moist soil suitable for *V. myrt.* The *H. par.* sociation is not stable. The third area, Grib Forest with surrounding forests (Tokkekøb Hegn, Store Dyrehave, Rudeskov, to which may be added Rø Plantation), is suitable for *V. myrt.* and *Rubus.*

Example 10.

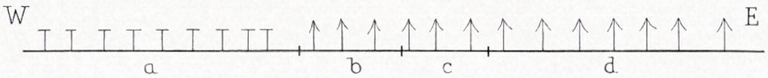

Fig. 6. *a* = *Calluna* soc. (Table VII, 12). *b* = *Ster.* soc. *c* = *Desch.*—*Scl.* soc. (Table VIII, 14). *d* = *Scl.* soc. (Table XI, 12).

Locality: Moraine hill near Silkeborg. To the west, on the original *Calluna* sociation, there is a 10 year old population of Pinus silvestris, two to three metres high, which only affords slight shelter to the forest ground vegetation in an adjacent growth of Picea excelsa, about 70 years old. On the outskirts of the Picea excelsa growth there occurs a *Ster.* sociation interrupted now and again by fragments of a *Desch.*—*H. par.* sociation. Further in, where there is more shelter in the forest, there occurs *Desch.*—*Scl.* sociation, but where the side light has no influence it is too dark for *Desch.* and we get a *Scl.* sociation (cp. Dueodde, Example 5).

Example 11.

Table IX, 7 shows a *Desch.* sociation individual containing *Molinia coerulea* and *V. myrt.* The light $^0/_0$ is 22 and thus the optimum for the three species. The surface of the soil is slightly broken and the vegetation is distributed according to increasing height in *Molinia* sociation, *Desch.* sociation, and *V. myrt.* sociation. Only where the ground is so low (near Bastemose, where swamping of the coniferous forest has been found) that the ground-water is near the surface, can *Desch.* form a stable population where the light is strong enough for *V. myrt.* However, it may persist several years after clearing (Table VIII, 21).

Over fairly large stretches, in light pine forest, on the previous Højlyng, there occurs a *Desch. caespitosa* sociation with *Oxalis* (Table XVII, 6). The sociation is rather uniformly developed, but in moist situations it may pass into a very pure *Carex hirta* sociation (Table XVII, 7). At the same level as these two sociations *Thuidium* forms populations in dark growths of fir, often in the shape of belts round spots covered with water in the winter.

In Almindingen the distribution of the most common vegetation according to the illumination is as follows: In the darkest situations a moss sociation rich in *Ster.* or *Plag. dent.* (Tables XIV, 3 and XVI 5—7); then follow the *Desch.—(Scl.)* sociation (Table IX, 5) and the *V. myrt.* sociation (Table V).

Example 12.

Table IX, 3 represents a *Desch.* sociation individual situated in the windy outskirts of Tokkekøb Hegn. *Rubus* sociations rich in species (Table I, 4—5, 8) occur in sheltered situations within the forest. A quite similar relation prevails between Table IX, 2 and Table XVII, 1—2 from Rø. *Desch.* is exceedingly vigorous here. While *Desch.* will only thrive in sheltered situations on the heath (when the ground-water does not exert its influence), and is fairly indifferent to wind on soil suitable for *V. myrt.*, the influence of wind is an essential condition if *Desch.* is to be able to colonise soil with a marked disposition for *Rubus.*

If the intensity of the light falls below the minimum for *Rubus*, *Brach.* will be left as the only species forming populations (in some instances, however, *Thuidium* will form sociations). At the same time the formation of mould ceases. That this is the reason why *Oxalis* disappears together with *Rubus* is rendered probable by the following example: A *Brach.* sociation individual (Table IV, 8) is intersected by a ditch, and only around this does an *Oxalis* sociation occur (Table II, 7). A formation of mould takes place at the ditch, while peat is produced in the *Brach.* sociation. This zonation is very common, and in pure coniferous forests *Oxalis* almost only forms sociations under such extreme conditions (and in young growths, which have not yet had time to form peat). It never attains the luxuriance which it has under *Rubus.*

Example 13.

A similar zonation to that mentioned, for instance, in Example 5, may be found at full light in the granite terrain of Bornholm. The soil consists of humous substances and weathered granite. It is black and amorphous with few mineral particles interspersed. Where the layer of soil is thinnest there occurs a *Clad.* sociation with the same composition as that of the forest; thus both *Bleph.*, *Ster.*, *Cladonia* and *Dicr. scop.* will as a rule be found. If the layer of soil is a little thicker, a pure *H. par.*

sociation will appear, which passes into a *Desch.* or a *Calluna* sociation. With a still greater thickness of the soil, a waste land vegetation rich in species appears.

Small but typically developed sociations occur in the same succession as was mentioned above around insolated stones, even if the layer of soil has a uniform thickness. Plate II shows a case where *Cladonia impexa*, *H. par.* and *Deschampsia—Calluna* are seen to form fragments of zones round denuded crags.

Succession of the Vegetation.

For a species to form a stable population it is not sufficient that the environment is favourable. Conditions must be such that the often considerable changes in the environmental factors (including the biotic factors) which accompany the immigration of the species, are no greater than that the environment is still within the ecological amplitude of the species. If, for instance, *Desch.* immigrates in large amounts into a *H. par.* sociation on dry soil, the result will be a deterioration of the environmental conditions for *H. par.*, *H. par.*, however, conditions the moisture which enabled *Desch.* to immigrate, and thus *Desch.* lays the foundation of its own destruction. Here and there conditions are such that a constant balance can be maintained (*Desch.—H. par.* soc.), but usually the two species will form separate populations.

When a species has carried the change too far, the result will be that its vitality is reduced, and thus the effect will be diminished. If this does not happen simultaneously with an improvement in the environmental conditions for a competing species, so that the latter will take its place *(Ster.—H. par)*, the species itself will be able to regulate the environmental conditions in such a way that it forms a stable population. As examples of this may be mentioned *H. par.* and probably *Calluna*, which both exercise a great influence on the soil.

In the soil vegetation of conifer forests the balance between the reversible factors (particularly the thickness of the peat and its acidity) and the vegetation will in most instances be quickly established, while an irreversible process such as the washing away of calcarious soil with the resulting increase in acidity and the size of the grains will take place too slowly for the course of the mutual interaction of the various soil vegetations and the degree of washing to be observable in our conifer plantations.

We shall here give some examples of the course of the succession upon afforestation of areas covered with *Calluna*, since it is most frequently on such that conifer forests are planted.

Example a.

In the sociation individual described in Table VII, 7 the original *Calluna—Empetrum—Clad.* sociation is passing into a *Clad.* sociation, as is usually the case in the driest places where *Calluna* forms populations.

Example b.

The example is derived from Søgaard Plantation on the central heath of Jutland. The original vegetation is given in Table VII, 1 (10 circles). It is seen to be a *Calluna*—

Empetrum heath with a scattered occurrence of *Arctostaphylos uva-ursi*, *V. vit.* and *Molinia coerulea*; *H. par.* and *Ster.* are dominant mosses. Under a layer of black peat, 2—7 cm. thick, there are 20—25 cm. bleached sand and 5—15 cm. hard pan.

The first result of planting with Pinus montana is a more vigorous growth of *Calluna*, which thrives exceedingly well as long as the trees afford shelter without giving very much shade (e. g. Table VII, 8, where the trees are planted in close rows with wide interspaces between the rows). The rest of the phanerogams are not able to grow at the same rate, and gradually as the trees give more shade they will, therefore, die for want of light. *Empetrum*, however, forms an exception. Table VII, 6 shows the vegetation under 11 year old Pinus montana. The light intensity is 12.7 $^0/_0$, but the light is somewhat irregularly dispersed under the low trees. *Calluna* is rapidly declining, being now found almost only in the spots of light, and it is followed by *Empetrum*. Under the trees there is an even luxuriant carpet of *Ster.*, and the absence of *H. par.* is noted. In an adjacent growth, five years older, with the same light conditions, *Calluna* is half dead with long etiolated shoots. It cannot be decided with certainty whether *Empetrum* has also grown here originally, but at any rate it is the rule that *Empetrum* disappears at this stage. The vegetation approaches a pure *Ster.* sociation, nor is *H. par.* present in noticeable quantity. It might be thought that *H. par.*, in contrast with the more shade-tolerant *Ster.*, had been ousted by the shade and had not had time to immigrate after the dying down of *Calluna*, but the next example will show that this is not the case. The decisive factor here is the moisture associated with the thickness of the peat.

The heather peat decomposes rapidly, and simultaneously a fresh layer of peat is formed of needles and *Ster.*, but this formation takes place more slowly than the decomposition of the original peat. In the examples mentioned here the heather peat is hardly demonstrable any longer, and the new layer of peat has not yet attained a thickness of three cm.; and at such a slight thickness of the peat *H. par.* has never been found on the heath. The peat may long keep its slight thickness which on this soil is absolutely essential for *Ster.* to be able to compete with *H. par.* if there is the optimum illumination for both species. In some few instances, however, the *Ster.* soc. was found at a somewhat greater thickness of the peat (Table XIV, 7 and 16). In very dry places the thickness of peat essential to *H. par.* will never be attained, we have then a stable *Ster.* sociation (e. g. Table XIV, 11, which is adjacent to a *Clad.* sociation).

After its disappearance *V. vit.* will not immigrate again until the peat has reached the thickness typical of *H. par.*; and — as mentioned when we discussed the vegetation at Dueodde (p. 31) — *Empetrum* will only come back again together with *Calluna*.

The succession *Ster.*—*H. par.*—*V. vit.* will be found in all the moisture zones of the heath, from *Calluna*—*Arctostaphylos* and at any rate to *Carex Goodenoughii*. These zones depend on the height above ground-water level, which in the place here mentioned hardly has any influence on the distribution of the vegetation, since planting here has made the ground-water sink.

I do not know the details of the succession when coniferous forest is planted on cleared oak scrub with *V. myrt.*, but from the *H. par.* stage there is at any rate no difference to be seen in younger growths either in the vegetation or in its succession. This applies to oak scrub adjoining heath (Søgaard Plantation).

Example c.

The locality lies in the southern part of Almindingen. The original vegetation is a *Calluna* sociation, differing in the main from the one mentioned under b by the absence of lichens, *V. vit.*, and *Empetrum*. The sub-soil consists of fine moraine sand with the admixture of some clay, and the heather peat is 2—6 cm. thick. On the sociation individual represented in Table VII, 19 there is six-year-old Pinus silvestris but the ground vegetation does not differ from the vegetation in the open. *Molinia coerulea* does not enter into the circles, but it is present. The great resemblance to the heath in example b is due to *Calluna*, which acts very largely as an "edificator" by securing good conditions for several species. The resemblance may be more striking than the examples show, but the difference in the soil is manifested both in a deviating vegetation in spots where *Calluna* does not occur, and it is also particularly marked after planting. As on the heath, so here, there is in some parts a competition between *Calluna* and oak.

Table VII, 10 shows the vegetation of a fifteen-year-old growth at 18 $^0/_0$ light. *Calluna* is still the frequency dominant but the growth is open. A considerable advance of *H. par.* at the expense of *Ster.* is already noticeable, a change, of which the frequency only gives a slight idea. The thickness of the peat given here is for heather peat; a new layer of peat has not been formed yet.

Table XII, 32—33 gives the vegetation in an adjoining 30—35 year old Pinus silvestris and Picea excelsa growth with a *H. par.* sociation. No light measurements are available, but the light $^0/_0$ lies above the minimum for *Desch.* In No. 32 there is still a little heather, and the peat has the black colour of the heather peat. The thickness is only 2—3 cm., the lowest observed under the *H. par.* sociation., and this is not by chance. The greater capacity of the subsoil to retain the water here replaces the greater thickness of the peat which is essential on the heath for the colonisation of *H. par.*

That the pH of the subsoil should have any influence on the difference in the succession is excluded, for at Almindingen the pH is considerably above the upper limit of pH for *H. par.*, being near its optimum in Søgaard Plantation. A slighter thickness of the peat would, therefore, be more likely to favour *H. par.* on the heath than on moraine sand.

The *H. par.* sociation in Almindingen is even less stable than *Ster.* on the heath, and like the latter when ousted by *H. par.*, it does not reappear when it has been superseded by *Desch.* or *V. myrt.*

In some few places on comparatively dispersed soil *H. par.* is superseded by *Molinia coerulea*. The fact that *Molinia* can form a population in such localities, but not on the heath where it was found before afforestation, requires further explanation. On the heath the ground-water is of the greatest significance for the water supply of plants which, like *Molinia*, cannot grow on the highly acid peat. The evaporation from the trees will, however, cause a lowering of the ground-water level (RAMANN, 1911, p. 454), so that the ground flora is limited to the buffer-free rainfall. On more dispersed soil the rain is retained by the mineral soil, and a lowering of the ground-water level will not, therefore, have such a revolutionary effect on the water supply of the surface, the effect being cancelled by the reduction in evaporation which the trees cause by affording shelter and shade.

Example d.

In Grib Forest, where the soil is more fine-grained than in the previous examples, it has been observed that, after planting, a *Calluna* sociation will pass directly into a *Desch.* sociation (Table VII, 18, which, however, still contains some *Calluna*). The material was here too small for the succession to be accounted for in detail.

The succession after clearing has not been investigated. We shall merely offer a few remarks on the behaviour of *Desh.* on different soils. After extensive clearing of forest with *H. par.* sociation in Søgaard Plantation, there will in the same year only be few *Desch.* individuals which are fertile, and they will probably be relicts. The next summer, one and half years after the clearing, *Desch.* forms a dense flowering carpet (Table IX, 17), even if it did not form a population in the forest before the clearing. *Calluna* will very quickly immigrate. On soil suitable for *V. myrt. Desch.* will appear after the same lapse of time, and may be preserved here for several years. Thus MÜLLER (1887, p. 49) mentions a ten-year-old *Desch.* population on soil cleared of beeches in Grib Forest. OLSEN (1921, p. 87) gives an example of how *Desh.* does not immigrate until 4—5 years after clearing, the soil being only then sufficiently acid for it. This is the case on soil suitable for *Rubus*.

The Dependence of the Vegetation on the Intensity of the Light.

Numerous investigations are available on the depression of the various rays of light in the forest, but the results are so conflicting that it is difficult to say with certainty what rays reach the forest ground in the relatively largest amount. WIESNER (1907) could not demonstrate any difference in the spectral composition of the light by measurements with normal photographic paper and paper treated with Rhodamin-B at light intensities exceeding 0.12 $^0/_0$. LUNDEGÅRDH (1923, p. 419 and 1925, p. 75) finds the blue rays most reduced, and DAXER (1934) arrives at the opposite result. In dense fir growths, where the blue rays constitute 0.12 $^0/_0$ of the blue rays in the open, KLUGH (1925) found the red rays reduced to 0.005 $^0/_0$ of the red rays in the open, i. e. a very considerable reduction of the red rays.

By electrometric measurements in which they used filters of different colours ATKINS & POOLE (1931) arrived at the same result as LUNDEGÅRDH. The light in forests is said to be very poor in blue rays, equalling sunlight in orange red, and much richer in deep red than the light of the sky and sunlight. This result is probably correct, for the filters used in most of the light determinations with photometric paper permitted the action of rays with a shorter wave breadth than that of orange red.

The great difficulties connected with giving equivalent expressions to the results obtained by the different methods render problematic the value of a comparison with the results of the various authors. Thus Lindquist gives i-values for *Vaccinium myrtillus* sociation as low as 2 in beech forest, while I have not found this deciduous species forming sociations at i-values below 20 in coniferous forest.

The upper light limit of a plant community is often determined by the lower light limit of another plant community. Hence it is in some degree dependent on the soil on which a plant community occurs what its light limits will be.

In open forests the desiccating effect of the sun will affect the distribution of the vegetation. This is plainly evident on sloping ground. If a terrain in the geographical latitude of Denmark inclines 34° towards the north, the rays of the sun will never reach it at all in the winter months, and at the summer solstice the highest angle of incidence will be 23° at noon. On a southern slope with the same inclination the angle of incidence of the sun's rays will be up to 68° at the equinox, and at the summer solstice the rays of the sun will even fall vertically on the surface of the soil. Though dunes have not so large an inclination, and trees somewhat counterbalance the desiccating action of the sun at different degrees of exposure, it is clear that the direction of the inclination must be of great importance as a plant-distributing factor. The i-values afford no information as to those effects of the sun which are dependent on the exposure, since they are measured horizontally.

In the eastern, dry regions of Europe *Calluna* occurs in denser forests than further west (Ramann 1911, p. 472), and according to Rubner (1921, p. 333) it has this in common with numerous other plants. Rubner has observed that many plants only occurring outside forests in western Germany are forest plants in eastern Germany, and he thinks the reason is that the sky during the summer months is much oftener cloudless in the eastern than in the western part of Germany, so that the plants, in spite of the shade of the trees, receive an adequate amount of light. This explanation agrees with the results of Wiesner's enquiry into the light requirements of *Betula nana* and other species (1907, p. 155). He found that they required the highest relative light intensity in their most northerly situations. It is probably due to the above-mentioned facts that it has been possible to erect a *Calluna* type in Finland, whereas in Denmark it is difficult to distinguish it from the *Vac. vit.* type (Bornebusch 1925, p. 209), and it is probably also the reason why *Arctostaphylos uva-ursi* does not appear at all as a forest plant in Denmark.

There are of course conifer growths still darker than those whose ground vegetation is described in Tables III, IV, and XVI (down to 0.37 $^0/_0$ light) (mentioned at p. 27), though probably none are so dark that the want of light entirely prevents moss vegetation; but the plentiful supply of needles in connection with the slow growth of the mosses limits the latter to projecting points where the needles do not remain. Hence older growths, where the surface has become even and the supply of needles is large, are often more sterile than younger growths at the same intensity of light, and Abies pectinata with its flatter needles will be more liable to check the growth of mosses than Picea excelsa.

Below we give a list of the lowest i-values found in a number of plant communities.

Vaccinium myrtillus soc.	21
Empetrum nigrum soc.	15
Cladonia impexa soc.	10
Vaccinium vitis-idaea soc.	7.5
Deschampsia flexuosa soc.	6.8
Carex arenaria soc.	6.2
Rubus idaeus soc.	4.3
Hylocomium parietinum soc.	3.5
Oxalis acetosella soc.	1.5
Scleropodium purum soc.	1.2
Brachythecium curtum soc.	1.0
Stereodon cupressiformis soc.	0.9
Thuidium tamariscifolium soc.	0.8

All moss sociations with the exception of the *H. par.* sociation which requires most light, have an upper light limit. The *Ster.* sociation may with increasing light $^0/_0$ be superseded by the *Brach.* sociation, but usually the moss sociations are replaced by phanerogam sociations. The sociation most tolerant of shade, the *Oxalis* sociation, which can exist at a light percentage as low as 2, is of slight or no importance in that respect, for it only occurs on soil suitable for *Brach.*, and the light minimum of the *Brach.* sociation almost coincides with that of the *Oxalis* sociation. The two last-mentioned sociations will as a rule be superseded by a *Rubus—Brach.—Oxalis* sociation, which may occur at a light percentage as low as 5—6.

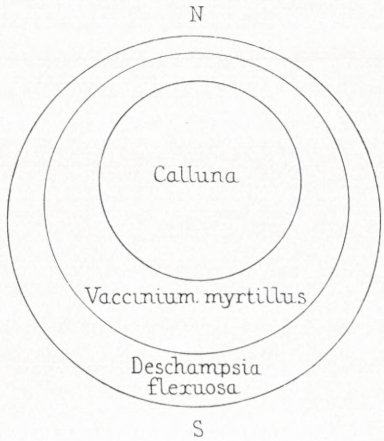

Fig. 7. Zonation of *Calluna*, *Vaccinium myrtillus*, and *Deschampsia flexuosa* according to decreasing light intensity in a glade.

Deschampsia will often be replaced by *V. myrt.* at 20 $^0/_0$ light or somewhat below, but under other circumstances it may form populations at 100 $^0/_0$. At about 10 $^0/_0$ light *V. vit.* can colonise areas with a *H. par.* sociation. In contrast with the *V. myrt.* sociation, it has no upper light limit (see p. 17). Both species will most frequently be superseded by *Calluna* at a high light intensity. Fig. 7 gives a diagram of the zonation in a glade in a low growth of Abies pectinata (3—4 m.) of the first generation in a scattered birch growth with heather. In the middle we still find the *Calluna* sociation; in a zone surrounding it *V. myrt.*; and at the edge of the glade *Desch.* The only effect of the trees is from the shade they afford.

When the light percentage exceeds 15—20 the desiccation caused by the sun will most affect the distribution of the vegetation on sandy soil; grasses with a predilection for light and other plants will immigrate onto clayey soil, especially *Anthoxanthum odoratum*, *Holcus lanatus*, *Agrostis stolonifera*, and *Desch. caespitosa* (see Table XVII).

The Carbon Dioxide Concentration of the Forest Air.

In connection with the light we will discuss the CO_2 tension of the forest air. For there cannot be any doubt that the differing CO_2 conditions in forests are of great importance for the plants. They may be compared with that of light where light affects the distribution of plants because it is at the minimum of CO_2 assimilation.

In the open air Ebermayer (1878) found 0.04 $^0/_0$ CO_2; in a closed fir and beech forest 0.08 $^0/_0$ at a height of 2 m.; and 0.15 $^0/_0$ in the humus cover; that is to say, an increasing CO_2 tension with decreasing height. Russel and Appleyard (1915) always find a higher CO_2 concentration in soil air than in the atmosphere. Lundegårdh (1921, p. 86 and 1925, p. 363) measured 0.08 $^0/_0$ in a *Oxalis* population in an alder and beech forest, and Fehér (1929, e. g. p. 37) measured a CO_2 amount of c. 1 mg per litre at a height of 0.30 m. in a pine forest, which corresponds to a volume percentage of c. 0.07.

Lundegårdh found that the CO_2 curve for *Oxalis* ascends with increasing CO_2 tension, and Daxer (1934), in assimilation experiments on *Oxalis* on forest soil, found that the assimilation varied with the CO_2 concentration of the forest air.

No investigations are available on the dependence of the assimilation on the CO_2 tension in mosses, but the high CO_2 tension in the moss carpet must be supposed to be of importance for its growth at low intensities of light. Under a dense *Rubus—Oxalis* population at, for instance, 8 $^0/_0$ of light, "i" must be exceedingly low, lower than the i-value required for the *Brach.* sociation to attain a similar vigorous development as the *Brach.* population under *Rubus—Oxalis* (2—3 $^0/_0$). When the *Rubus* population is near the outskirts of a wood, where the wind may act as a ventilator, the soil will as a rule be found devoid of both *Oxalis* and *Brachythecium* (which can only be explained by desiccation in the case of *Oxalis*), even if these occur under the same edaphic conditions further in.

As Lundegårdh (1925) points out, the increase of the CO_2 tension with decreasing height to a certain degree compensates for the decrease in the same direction of the light intensity.

The Influence of the Species of Tree on the Ground Vegetation.

According to Cajander (1909, p. 17), the similarity of the vegetation under different species of trees is fairly marked. Ilvessalo (1922, p. 34) finds greater similarity within pine and birch than within the latter and fir, and Bornebusch (1925, pp. 211 and 214) arrives at a similar result. For the more luxuriant types of forest he finds the greatest agreement in the vegetation under foliiferous trees and pine, less under pine and fir.

This does not agree with my experience in cases where the light conditions under pine and fir are uniform, or in cases where the tree population is so dense that the form and nature of the leaf, besides the differences in illumination, according as the trees are deciduous or evergreen, may affect the ground vegetation.

Under different foliiferous trees there may occur differences in the vegetation which are due to the nature of the leaves. In Grib Forest, in an *Oxalis* sociation under beech, I have observed a regular zonation of *Mercurialis perennis* around interspersed oaks. It is improbable that the differences in the light conditions which are due to the later leafing of the oak are of any importance, for the same zonation was found both in the interior of the forest and at much higher intensities of light on the outskirts. These conditions agree with the fact that beech is much more liable to form peat than oak (Müller 1887).

The difference in the soil vegetation under Picea excelsa, Pinus silvestris, and Pinus montana may in all cases be traced to the differing influence of these trees on the forest climate, especially the light conditions, as well as to the circumstance that these trees are planted on different soils. Where the species form growths of the same density on similar soil, it has been impossible to show any difference in the soil vegetation (see e. g. Table I, 13—14, where the tree populations are so dense that their waste materials may possibly exercise a specific influence on the vegetation).

For Abies pectinata other conditions prevail, and the reason is that its fallen needles are changed into mould quicker than those of the other conifers on the same soil. In places where Abies pectinata forms peat, the ground vegetation will not be any different from that on peat under the other conifers. On more fine-grained soil, where Abies pectinata does not form peat, a ground flora will appear which deviates from that of the other conifers, for the latter nearly always form peat if their needles are not mixed with the leaves of foliiferous trees or of *Rubus*. In Almindingen, Rø, and Rude Forest the *Oxalis* sociation only occurs under Abies pectinata, often with a moss vegetation rich in species (Tables II, 11 and III, 7) which is absent in *Oxalis* sociations under foliiferous trees. On soil suitable for *V. myrt. Oxalis* will be found under closed beech growths just as well as under Abies pectinata, but perhaps with *Anemone nemorosa* and *Asperula odorata* interspersed (cp. Bornebusch 1925, p. 211).

In a beech growth with a light percentage of 3.95, which was adjacent to a growth of firs with a *Rubus—Oxalis* sociation (Table I, 5, Tokkekøb) with 7.50 $^0/_0$ light, *Anemone nemorosa* was found to be the physiognomical dominant. *Oxalis* was sparsely and evenly developed, and *Milium effusum*, *Stellaria glochidosperma*, and *Asperula* etc. were present, but not *Rubus* and *Brach*. Here the light conditions are of importance, for *Rubus* cannot grow in the shade of the beech, and *Anemone* will not thrive in the evergreen fir forest. But even where there is a slight admixture of foliiferous trees in a coniferous forest their effects will be felt, on dry soil especially by the much more luxuriant growth of *Hylocomium triquetrum* and *H. proliferum* to which they give rise.

The Dependence of the Vegetation on the Moisture and the Thickness of the Peat.

Table 2 gives a general view of the thickness of the peat for some of the chief plant communities. The figures denote the number of occurrences within peat thickness classes of 1 cm. The values used are the mean values of the highest and lowest thicknesses of the peat found when the samples of soil were taken for the determination of acidity. Neither the green nor the dead layers of moss, which were fairly distinct from the peat proper, were included.

Table 2. The thickness of peat from a number of plant communities.

	Thickness of the peat (cm.)													
	1—1.5	2—2.5	3—3.5	4—4.5	5—5.5	6—6.5	7—7.5	8—8.5	9—9.5	10—10.5	11—11.5	12—12.5	13—13.5	Total
Scleropodium purum soc.	..	..	..	..	..	2	6	4	2	1	1	..	1	17
Brachythecium curtum soc.	1	2	2	1	3	1	..	..	..	..	..	..	..	10
Carex arenaria soc.	..	..	..	..	4	3	3	..	..	..	1	..	..	11
Vaccinium myrtillus soc.	..	..	1	1	2	4	1	..	..	..	..	..	..	9
Vaccinium vitis-idaea (Empetrum) soc.	..	..	..	1	1	4	4	..	..	..	1	..	..	11
Deschampsia-Scleropodium soc.	..	1	4	3	2	4	1	1	1	1	1	..	..	19
Deschampsia flexuosa soc.	..	..	1	..	2	3	3	..	1	1	..	..	..	11
Hylocomium parietinum soc.	..	1	3	8	5	6	6	..	..	1	..	..	..	30
Stereodon cupressiformis soc.	..	..	4	6	3	4	1	..	..	..	..	..	..	18
Cladonia impexa soc.	1	1	1	2	1	3	..	..	..	..	..	..	..	9

Of the first members in the moisture series *Clad.* soc., *Ster.* soc., *H. par.* soc. (to which *V. vit.* belongs), the driest have the smallest peat thickness. The thickness of the peat under the *Desch.—Scl.* sociation and the *Carex arenaria* sociation varies very much. The magnitude of the peat becomes less in the *Desch.—Scl.* sociation and in the *Carex arenaria* sociation after these have invaded an area with a *Scl.* sociation. The peat under *V. myrt.* sociations is comparatively thin, its thickness varying from 4 to 7 cm.

The most striking example of how the thickness of the peat may influence the distribution of the vegetation, and not only be a consequence of the differing capacity of the species to produce peat, is afforded by the *Scl.* and the *Brach.* sociations. Both sociations are often found on the same kind of soil, and their light requirements are almost identical. The peat is derived from the waste products of the trees. As already mentioned, *Brach.* does not produce peat, and *Scl.*, which at a stronger light is just as productive of peat as *H. par.*, often, at the low light $^0/_0$ of the *Scl.* sociation, has too slow a growth to have any influence of consequence on the formation of peat. The pH of the sociations differs somewhat, but *Scl.* occurs in other sociations at the same pH as the *Brach.* sociation, and *Brach.* is almost indifferent as regards pH. The average difference in the thickness of the peat is c. 4 cm. The reason why there is a very sharp limit at 6 cm. is that the character species do not form pure sociations where the thickness of the peat is about 6 cm., but a mosaic which is difficult to analyse.

The reason why the thickness of the peat is such an important factor in the distribution of the plants is in the first place that the peat, with its large capacity for retaining water, serves to regulate the moisture. But for some surface mosses, among these *Brach.*, the fir peat must be supposed to lack certain nutrient substances; it is of importance therefore, that, when the thickness of the peat is slight, the moss and the subsoil should be in close contact with each other. As far as can be judged, the moisture is greater in the *Brach.* sociation individuals on turf than in the *Scl.* sociation individuals with the highest degree of moisture.

While in other parts of the country the *Scl.* sociation only occurs on blown sand when the sand forms a layer not excessively thick over moraine deposits, this sociation is very widely distributed in Blaabjerg and Oxbøl plantations. The growth of *Scl.* on dry soil must be explained by the climatic conditions, and probably especially by the comparatively cool and moist summer with frequent sea-fogs. The rainfall on the southwestern coast of Jutland is no greater than in central Jutland. The figures given for Houstrup and Aal are 675 and 745 mm. respectively; for Høllund Søgaard near Frederikshaab Plantation, where *Scl.* does not occur in the dune terrain, the figure is 758 mm.

The thickness of the peat in the *Desch.*—*Scl.* sociation is less than that of the *Scl.* sociation, half of the peat thickness of the sociation individuals investigated lying below the minimum for the *Scl.* sociation. The reason why *Scl.* can still grow here is that *Desch.* protects the moss layer from desiccation (RAUNKIÆR 1922, PALLMANN & HAFFTER 1933) and thus makes up for the effect of the slighter thickness of the peat. Where the *Desch.* population, as is often the case with the *Desch.* sociation, is dependent on the desiccating action of the wind, *Scl.* has been replaced by *Ster.* which is more tolerant of drought; and it likewise depends on how much a *V. myrt.* sociation individual is exposed to the wind whether the moss population is made up of *H. par.* or *Scl.*

Since it turns out that the thickness of the peat may be of importance for the distribution of the plants, the factors which affect the formation of peat are the actual plant-distributing factors. The climate is of some importance in Denmark, but it plays a subordinate part compared with that of the soil. A large amount of rain and a low temperature will favour the formation of peat. If we compare the humus layer under a growth of Abies pectinata of almost the same denseness and age in Sonnerup (Table XI, 8, light $^0/_0$ 6.71) and Almindingen (Table III, 7, light $^0/_0$ 8.26), we shall find that in Sonnerup it consists of a layer of peat 8—12 cm. deep, in Almindingen of a layer of mould a few centimetres deep. Abies pectinata does not form peat anywhere in Almindingen, and Picea excelsa only a thin layer (the *Scl.* sociation does not occur in Almindingen), whereas everywhere in Sonnerup Plantation there is an unusually vigorous formation of peat with a forest ground vegetation usually occurring on rather moist soil. Outside the plantation there is a dry vegetation typical of sandy fields. The difference in the climate in these two places is great compared with the climatic fluctuations within the area investigated, but the climate in Almindingen is best suited for the formation of peat. There is an average rainfall of 635 mm., and the average temperature is 7.1 (at the High School). In Sonnerup the corresponding figures are 509 and 7.9 (Odden). Hence the decisive difference is in the soil. In Almindingen this is fine moraine sand, at Sonnerup alluvial sand containing gravel, stones, and mollusk shells; but the ground-water level is high enough for the trees to benefit by it. Since draughtiness in forests with less porous soil may lead to the formation of peat (see p. 53), one might receive the impression that desiccation is a main condition for the formation of peat, whether or not this takes place by the water leaking away or evaporating. But since the possibilities of peat formation increase with increasing rainfall, one arrives at the conclusion that peat formation is in the first place dependent on the waste products of the plants being washed away. The reason why there is usually but a slight formation of peat on dry soil is that the vegetation is too sparse to supply the necessary waste material.

The capacity of the species for forming peat differs greatly. Where there is no soil vegetation there will always be peat under Picea excelsa and pine, and where there is a luxuriant growth of moss on dry soil, the production of peat is more rapid than where it is prevented by want of light, though in such places there is a more abundant supply of needles. In other words, in such cases the mosses supply the major part of the raw material for the formation of peat.

Rubus does not produce peat, on the contrary, it prevents the production of peat in fir woods. Species which will always form peat where they occur in stable plant communities are *Calluna*, *V. myrt.*, and *Desch.* For these species, which can grow on a subsoil whose pH is far beyond their pH amplitude, it is a life condition to be able to produce peat. *Carex arenaria* and *Brach.* do not produce peat, and *V. vit.* and *Empetrum* are probably only in slight degree productive of peat. The rather thick layer of peat in which one will always find these phanerogams, which mostly occur in open forests where the waste products of the trees are small, is chiefly derived from the moss vegetation.

Within a single *H. par.* sociation individual there will often occur a mosaic of moss cushions 20—25 cm. thick with a thin layer of peat underneath, and a moss layer a few centimetres thick underlain by a thicker layer of peat. The most natural explanation of this is that it is a consequence of an unstable equilibrium between the rate of growth of *H. par.* and the environmental factors produced by its growth. *H. par.* is one of the principal peat-producers of the conifer forests, and is thus able to augment the moisture in so far as this process is dependent on an increasing thickness of the peat. But *H. par.* has very specific moisture requirements, hence it will attain a very luxuriant growth under temporarily favourable conditions. Only after the lapse of some years will this cause so great an increase in the addition of humus that the production of new peat exceeds the decomposition of the peat, the moisture increasing to such a degree that the growth will be checked.

Scl. probably behaves in the same way as *H. par.*, while *Ster.*, by adding to the thickness of its peat from another cause lowers its own life conditions, for by so doing it establishes good possibilities of existence for *H. par.* against which it cannot hold its own in the competition for space.

The dependence on the thickness of the peat seen in the *H. par.* sociation is an example of how the effect of a great porosity of the subsoil can be counterbalanced by a great thickness of the peat. On the coarse-grained soil in Sonnerup, *H. par.* (and other plants) are found at the greatest thickness of the peat, and conversely, the thickness of the peat is least on more dispersed soil (Almindingen, though here it is labile, see example c, p. 38).

The succession of the dwarf shrubs according to their ability to tolerate drought is as follows:

Calluna—Empetrum, *V. vit.*, *V. myrt.* These species are recorded from the high moor, hence they are fairly indifferent as regards the absolute moisture. From the order of the species we may already suspect a connection between the degree of xeromorphism and the ability to resist drought, the least xerophilous, *V. myrt.*, being the least xeromorphous. The facts become plainer if we consider other highmoor plants which are even less resistent to drought, for instance the *Drosera* species. These are invariably associated with a very moist substratum, and in accordance herewith their structure is hygromorphic.

Clad. and *Dicr. rugosum* behave exactly like the dwarf shrubs as regards moisture; most other species have a rather narrow moisture range, narrowest for *H. par.* and *Scl.*

None of the vascular plants which form extensive growths on the soil of coniferous forests are specific to these forests. On the other hand, the mosses *Brachythecium curtum* and *Ctenium crista-castrensis* only occur in coniferous forests. Both species are distributed throughout Denmark, but only *Brachythecium* forms populations over large areas. All the common species are circumpolar. Only *Scleropodium purum* and *Plagiothecium undulatum* are pronounced oceanic species.

The Dependence of the Vegetation on the Acidity of the Soil.

After Olsen (1921) has shown how largely acidity acts as a plant-distributing factor, and gradually as the technique has made acidity one of the most easily accessible of the chemical ecological factors, it has become the rule that an acidity investigation should form part of all more extensive ecological works. A survey of the results gained in this field in recent years will be found for instance in Hoss (1932, with a full list of the literature).

Nevertheless it is in many cases difficult to compare the results gained, partly because the samples have been taken with different objects in view, partly because

Table 3. Distribution of pH values from plant communities in which the species are frequency dominants (%).

pH	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	n	M
Rubus idaeus	..	..	..	4	0	11	0	15	7	4	22	4	7	7	7	7	0	0	4	..	..	..	..	..	27	4.29
Luzula pilosa	..	..	..	..	..	6	6	6	18	35	12	6	6	0	0	6	..	..	..	..	..	..	..	..	17	4.21
Oxalis acetosella	..	..	1	4	3	3	11	11	15	8	14	4	4	3	1	5	1	4	1	3	1	1	0	1	74	4.21
Hylocomium triquetrum	..	..	..	..	..	8	8	8	25	17	8	8	4	8	4	..	..	..	..	..	..	..	..	..	24	4.19
Brachythecium curtum	..	..	3	11	3	11	5	18	8	3	8	1	7	3	4	5	4	1	1	3	..	..	..	..	73	4.17
Carex arenaria	..	..	..	..	5	5	11	15	13	18	11	13	4	4	0	2	..	..	..	..	..	..	..	..	55	4.15
Calluna vulgaris	..	..	..	..	6	9	27	12	18	21	6	3	..	..	..	..	..	..	..	..	..	..	..	..	34	4.03
Empetrum nigrum	..	..	..	..	15	4	15	19	22	19	4	4	..	..	..	..	..	..	..	..	..	..	..	..	27	4.02
Deschampsia flexuosa	..	1	4	5	9	10	13	14	13	11	7	4	2	2	2	1	1	..	..	..	..	..	..	..	165	4.01
Scleropodium purum	..	1	2	6	13	13	12	9	12	11	8	5	1	3	2	2	..	..	..	..	..	..	..	..	174	4.01
Stereodon cupressiformis	0	3	5	8	14	18	15	12	11	7	4	2	1	0	0	..	..	..	..	..	..	..	..	..	204	3.89
Hylocomium parietinum	1	3	6	9	13	19	16	13	9	6	3	1	0	..	..	..	..	..	..	..	..	..	..	..	225	3.85
Vaccinium vitis-idaea	9	0	9	6	9	16	16	22	0	3	3	3	3	..	..	..	..	..	..	..	..	..	..	..	32	3.83
Hylocomium proliferum	6	6	10	6	17	8	8	17	8	10	0	2	..	..	..	..	..	..	..	..	..	..	..	..	48	3.80
Vaccinium myrtillus	..	8	16	16	16	16	16	4	4	0	4	..	..	..	..	..	..	..	..	..	..	..	..	..	25	3.73
Cladonia impexa	..	7	17	13	23	27	3	0	7	0	3	..	..	..	..	..	..	..	..	..	..	..	..	..	30	3.72
Dicranum scoparium	5	7	14	14	10	29	14	2	0	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	42	3.71

Table 4. Distribution of pH values from the plant communities (%).

pH	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	n	M
Rubus-Brach. soc.	..	..	..	2	0	7	5	15	7	2	15	2	5	5	7	7	5	7	2	5	..	..	..	..	41	4.40
Oxalis soc.	..	..	4	8	4	0	8	12	12	8	8	0	4	4	0	8	4	4	4	0	4	0	0	4	25	4.32
Carex arenaria soc.	..	..	..	..	8	5	8	14	16	22	8	14	3	3	..	..	..	..	..	..	..	..	..	..	37	4.12
Thuidium soc.	..	6	0	6	6	24	18	0	12	6	6	6	0	0	0	0	0	0	6	6	..	..	..	..	17	4.10
Empetrum soc.	..	..	..	..	18	0	18	18	18	9	9	9	..	..	..	..	..	..	..	..	..	..	..	..	11	4.03
Brach. curtum soc.	..	..	..	10	19	13	10	16	3	3	3	6	6	0	6	3	..	..	..	..	..	..	..	..	31	4.02
Desch.-(Scleropodium) soc.	..	..	3	4	11	9	12	12	10	11	12	7	1	1	2	1	1	..	..	..	..	..	..	..	89	4.02
Calluna soc.	..	..	2	7	2	9	23	12	16	16	7	2	0	0	2	..	..	..	..	..	..	..	..	..	43	4.01
Stereodon soc.	..	6	4	10	14	8	20	14	6	8	8	2	..	..	..	..	..	..	..	..	..	..	..	..	51	3.89
H. parietinum soc.	..	1	3	8	12	25	19	16	11	3	3	..	..	..	..	..	..	..	..	..	..	..	..	..	80	3.87
Desch.-H. par. soc.	..	8	8	15	8	8	8	8	23	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	3.86
Scleropodium soc.	..	4	4	14	20	22	10	6	4	10	2	2	..	..	..	..	..	..	..	..	..	..	..	..	49	3.82
Vaccinium vitis-id. soc.	13	0	13	8	4	22	13	17	0	0	4	4	4	..	..	..	..	..	..	..	..	..	..	..	24	3.80
Vaccinium myrtillus soc.	..	8	16	16	16	16	16	4	4	0	4	..	..	..	..	..	..	..	..	..	..	..	..	..	25	3.73
Cladonia impexa soc.	..	7	17	13	23	27	3	0	7	0	3	..	..	..	..	..	..	..	..	..	..	..	..	..	30	3.72

Table 5. Distribution of observed pH values in sociations with Deschampsia flexuosa, Hylocomium parietinum, and Stereodon cupressiformis respectively as frequency dominants, as compared with the calculated distribution.

pH	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9
Deschampsia																	
y observed (%) .	..	1.2	4.2	5.5	9.1	10.3	13.3	13.9	13.3	10.9	7.3	4.2	1.8	1.8	1.8	0.6	0.6
y calculated (%)	..	1.7	3.2	5.4	8.1	10.8	13.0	**13.7**	13.0	10.8	8.1	5.4	3.2	1.7	0.8	0.3	0.1
Difference.......	..	÷0.5	+1.0	+0.1	+1.0	÷0.5	+0.3	+0.2	+0.3	+0.1	÷0.8	÷1.2	÷1.4	+0.1	+1.0	+0.3	+0.5
Hylocomium																	
y observed (%).	1.3	3.1	5.8	8.9	12.9	19.1	16.4	12.9	8.9	6.2	2.7	1.3	0.4	..	..	..	..
y calculated (%)	1.0	2.5	5.4	9.6	14.1	**17.1**	**17.1**	14.1	9.6	5.4	2.5	1.0	0.3	..	..	..	..
Difference.......	+0.3	+0.6	+0.4	÷0.7	÷1.2	+2.0	÷0.7	÷1.2	÷0.7	+0.8	+0.2	+0.3	+0.1	..	..	..	..
Stereodon																	
y observed (%).	0.5	2.5	4.9	8.3	13.7	17.6	14.7	12.3	10.8	6.9	4.4	2.0	1.0	0	0.5	..	..
y calculated (%)	0.8	2.0	4.2	7.6	11.6	14.9	**16.2**	14.9	11.6	7.6	4.2	2.0	0.8	0.3	0.1	..	..
Difference.......	÷0.3	+0.5	+0.7	+0.7	+2.1	+2.7	÷1.5	÷2.6	÷0.8	÷0.7	+0.2	0	+0.2	÷0.3	+0.4	..	..

Table 6. Constants of the pH variation curve for Deschampsia flexuosa, Stereodon cupressiformis, Hylocomium parietinum, and H. par. soc. at 18° C.

	Desch.	Ster.	H. par.	H. par. soc.
Number of determinations (n)	165	204	225	80
Mean value (M ± m).........	4.01 ± 0.02	3.89 ± 0.02	3.85 ± 0.02	3.87 ± 0.02
Standard deviation (s) 0.1 in pH as unit	2.92	2.46	2.30	1.80
Parameter (h)...............	0.24	0.29	0.31	0.39
Most probable frequency in a pH interval of 0.1 about the mean value in % (x = 0)..	13.7	16.2	17.5	22.0

the results will differ somewhat according as the colorimetric or the electrometric method is adopted. Kotilainen (1927), by adopting a special electrometric method, finds very low values. However, the relation between the pH of the species often shows good agreement.

Olsen (1921) has first shown that pH values from the same species or plant community may range round a mean value in conformity to law, and Jenny (1926) has shown that the pH values may be regarded as links in the statistic chain which is described by Galton's equation of variation. As to the application of the latter to measurements of pH, see Jenny 1926, or Frey 1932.

Tables 3 and 4 show that equal intervals in the hydrogen ion concentration expressed in pH are of equal biological importance, that is to say, for the same species or plant community. Thus it is quite permissible to compute the average pH values according to the usual rules, i. e. by adding the pH values and dividing the sum by the number of determinations. This method is allowable neither for the frequency percentage nor for the light percentage.

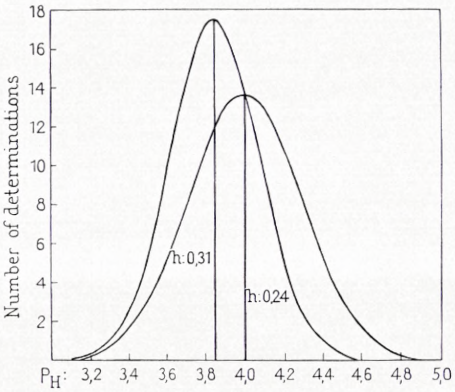

Fig. 8. pH variation curve for *Hylocomium parietinum* (h 0.31) and *Deschampsia flexuosa* (h 0.24).

A large number of pH measurements are necessary for these calculations, lest experimental errors, irregularities in the taking of the samples or the like should have a disturbing influence on the result.

The curve of the variation of pH has been computed for *H. par.*, *Ster.*, and *Desch.* In calculating the theoretical pH curve for *H. par.*, x-values of + and — 0.5, + and — 1.5 etc., from the mean value (pH 3.85) have been used in order to render comparable the observed and calculated values of y.

Table 5 will show the good agreement between the observed and the calculated values of y. The deviations are smallest for *H. par.* which always grows on a fairly thick and well delimited layer of peat, largest for *Ster.* which often grows on so thin a layer of peat that it is difficult to avoid taking up some of the subsoil, so that some of the values will be a little too high.

The pH curve for *H. par.* and *Desch.* is shown in fig. 8. The value of h is very high for all three species, that is to say, the species have a narrow range of pH. Table 6 gives some pH data for the two species, as also for *Ster.* and the *H. par.* sociation (the pH curve not calculated). The h value for *Desch.* is 0.24; somewhat higher for *Ster.* and *H. par.*, viz. 0.29 and 0.31 respectively; and highest for the *H. par.* sociation, 0.39. For comparison we may state that Jenny (1926) finds the following values of h: *Carex curvula* 0.20 (pH 4.98) and for the *C. curvula* sociation 0.28 (pH 4.82) (corresponding to *H. par.* and the *H. par.* sociation); for *Elyna myosuroides* 0.15; and for *Carex firma* 0.36 (pH 7.19). Not only peat plants but also a typical calciphilous plant such as *C. firma* show the same conformity to law in their distribution in regard to pH.

Table 3 gives the distribution of the most frequently occurring species in pH classes of 0.1 arranged according to decreasing mean value of pH. The figures give the percentage of all pH values from plant communities in which the frequency percentage of the species exceeds 80. Further the number of pH measurements (n) is given and the mean value (M) has been calculated.

In conifer forests pH is not sufficiently high to furnish any information as to the behaviour in regard to acidity of *Rubus* and *Oxalis*, which will both grow in mould. Hence I will especially deal with the acidity requirements of the peat plants. Several of the plants which are obligatory peat plants in conifer forests may, however, occur as pioneers on mineral soil without any layer of humus *(Carex arenaria, Calluna, Empetrum, Desch.)*. *Luzula* shows the highest pH, averaging 4.21, and *Dicr. scop.* the lowest, averaging 3.71, the greatest difference in the average values thus being 0.50.

For most species of peat plants there is a great probability that the mean value will correspond closely to the pH value most characteristic of the species. There is often a distinct maximum with a gradual and fairly regular decrease to both sides. If the values were not characteristic of the species a more abrupt fall might be expected towards the low pH values, which on the whole are rarer, than towards the more frequent higher ones, at any rate for species with a particularly low pH. It is true that this is the case for some species, though not more so than would be explainable if some of the subsoil, which in this connection is of no importance for the plants, had been included in the sample of soil.

Hesselman (1926, p. 212) gives an average difference in the pH of the F layer and the H layer of minus 0.18—0.22 in conifer forests rich in mosses. In some cases, when the layers of peat have been especially thick, I have, besides determining pH as usual, measured the pH of the upper layer of peat and often found values exceeding by 0.1 the pH of the lower layer. The pH values for the mosses (with the exception of *Polytrichum*) will thus be a little too low.

The values found must likewise be supposed to represent approximately the whole pH amplitude of the species. A larger number of measurements will of course somewhat enlarge the amplitude and doubtless without essentially altering the mean value. pH values much lower than those found do not occur, and wherever pH is higher than that found to be characteristic of a species, that species will be replaced by others. *Brach.* for instance, will be superseded by *Eurhynchium striatum*, the pH of which rises to about 4.8, though there is no competition for room, and *Desch.* will, with a higher pH, be replaced by *Molinia*, *Desch. caespitosa*, *Holcus lanatus* or other species.

There can be no doubt, however, that competition with other species will in some cases determine the pH amplitude of a species. This is no doubt the case with *Cladonia impexa* which cannot hold its own in the competition for space with those species of the conifer forest with which it is most closely associated ecologically *(H. par., Ster.)*, if the external conditions are but tolerably favourable to the latter. The figures show that there is an increase in the pH $^0/_0$ up to 3.8 followed by a great decrease at the pH maximum for *H. par.* (3.85). The mean value of pH presumably corresponds to its occurrence on mineral soil in coniferous forests, but where *H. par.* is excluded owing to other ecological conditions (great moisture), *Clad.* has a much larger ecological amplitude, which must be assumed to include the pH amplitude also.

The pH values from the rhizosphere of the peat plants where they appear as pioneers on sandy soil will as a rule prove to be higher than those found to be characteristic here. As an example I may mention that under dense *Carex arenaria* populations on open dune I have found pH to be 4.5 (Sonnerup), 4.8, and 5.1 (Dueodde). Pure sand has a higher pH. It is very doubtful, however, whether these values are those found round the roots. Pure sand contains very little buffer, so that even a very slight influence from the roots (CO_2) will be able to cause an alteration in their immediate vicinity (cp. Olsen 1921, pp. 112 and 131). It will then generally be the pH of the sand rather than the pH of importance for the roots which the investigator measures. Jenny (1926) finds the same pH under *Carex curvula* on peat and where it is a pioneer on granite.

In peat, on the other hand, only strong influences will cause a change in the acidity, so that the pH values for peat, at any rate, represent those to be found around the roots where the plants grow in peat, but they must be supposed to be generally valid.

Table 4 gives a similar view of the pH of the plant communities. In most cases one or several character species will be frequency dominants, but to some of the species this does not always apply, as for instance *Rubus*, *Thuidium*, and *Calluna*.

The horizontal variation within the separate sociation individuals is often about 0.1—0.2. The difference is least in typical moor, somewhat greater in mould, but it is so great compared with the difference in the pH of the sociations, that the statistic treatment of the material is necessary to demonstrate a possible characteristic acidity for the sociations.

In most cases the pH values of the species and of the plant community of which it is the character plant coincide. The *Rubus—Brach.* sociation has, however, a higher mean value (4.40) than the two character species. The reason is that we have here included the values of some *Rubus* sociation individuals where *Rubus* is not the frequency dominant. The *Brach.* sociation has a pH 0.15 lower than the species, for where *Brach.* forms populations without *Rubus* in pure conifer woods the humus layer is always peat.

The slight difference in pH shown by the peat species as well as the peat plant communities does not mean that the acidity of the peat is an indifferent environmental factor. However, one would hardly venture to ascribe any great importance to the pH figures, if it did not turn out that the difference in the mean values entirely corresponds to the natural conditions. Thus we find *Hylocomium triquetrum* where there is an influx of ground water, where there is an admixture of foliiferous trees, or where there is a supply of lime — all factors which raise pH. Nor can it be by chance that *Dicr. scop.* which is often the frequency dominant in most of the plant communities of the coniferous forests, has the lowest average pH.

As already mentioned, the dying off of *Calluna* in *Calluna—Empetrum* sociations will invariably mean that *Empetrum*, too, disappears, if the ground water level is low. The reason must be that *Calluna* forms the main part of the peat in which the species grow, and the pH of the peat is c. 4.0, which is the optimum value not only for *Calluna* but also for *Empetrum*. *Empetrum* is not itself able to maintain its pH level. Otherwise where the ground water comes to the rescue. In example 7 (p. 32) we have described the interrelation of *Empetrum* and *V. vit.* at the foot of moraine hills. *Empetrum* is only present where the ground water has any influence, *V. vit.* only where it has no influence. This quite agrees with the relation of the two species to pH. Where the ground water makes the peat less acid, *Empetrum* occurs, and on soil which only receives water in the form of rainfall *H. par.* and *V. vit.* are able to obtain the low pH which is necessary to their existence. It would seem natural to infer that *Calluna* can form a population below *Empetrum* because it has a greater influence on the soil in a way favourable to itself, but the zonation was only observed in the place mentioned.

Example 4 (p. 31) shows an analogous case which is perhaps better because the moss population is the same in all the sociations.

The *Calluna* may play the same part as the ground water as a factor in plant distribution.

It will be seen, then, that even among the extremely acidiphilous forest and bog plants there may be differences in the distribution which are exclusively due to the difference of acidity.

In the high moor, where other biotic factors than those active in forests on mineral ground make the stagnant surface water acid in the extreme, similar conditions prevail for the pH of the dwarf shrubs (Kotilainen 1927) and we arrive at the conclusion, therefore, that acidity is the most important edaphic plant distributing factor for these species, which are eurytrophic as regards moisture (see p. 47).

For most other peat plants it holds good that their requirements of acidity are just as specific while their moisture amplitude is considerably smaller, so that in most cases it will be difficult to decide whether the acidity or the moisture corresponding to a certain acidity is the most important environmental factor.

As a dune forest plant *Carex arenaria* has much in common with *Empetrum*, they may even form populations together (Table X, 1), and in accordance with its higher pH *Carex arenaria* is even more dependent on the ground water than *Empetrum*. Hence it always grows in company with *Scl.* It is improbable that moisture should be the decisive factor, for after planting *Carex arenaria* disappears from sandy soil where the ground water has no influence. Owing to the planting the sand receives materials (needles, moss) which make it highly acid. Only where this acidity is diminished by the ground water can *C. arenaria* grow. A (not excessive) influence of the ground water will secure a luxuriant growth of the peat-forming moss *Scl.*, which is the reason why *C. arenaria* in forests always grows in a thick layer of peat.

The most probable explanation of why *Desch.* requires exposure to the wind on soil suitable for *Rubus* seems to me to be as follows. When in a fir forest *Rubus* is ousted by shade, and the needles are no longer mixed with its leaves, the fir will always form peat. *Rubus* and the other mesophilous plants which accompany it will not, however, tolerate exposure to the wind, so that there will be a possibility that pH will come within the pH amplitude of *Desch.* Once *Desch.* has immigrated, it will continue the formation of peat up to a thickness rarely found under the *Brach.* sociation.

Rubus is almost indifferent to pH. The reason why it has the highest average value is that it most frequently grows on soil mixed with clay which is not as much washed out as the more porous soil. In Bromme Plantation where *Rubus* forms sociations of quite the same composition as for instance in Grib Forest, the soil is more sandy than otherwise found under *Rubus*, but the trees have been planted on arable land (cp. Table XVII, 8, where the tree population is Pinus silvestris of the first generation on arable).

The influence of the light on the pH of the surface soil depends on the vegetation it supports. This is most distinctly seen in forests suitable for *V. myrt.* In dark forests the ground is sterile or covered by a carpet of moss *(Ster., Plag. dent.)*, in both cases pH is about 3.8. If the light is strong enough for *Desch.* to immigrate, pH will rise to 4.0, only to fall again to 3.7—3.8 when the light allows *V. myrt.* to immigrate. In full light or slight shade there will again be a rise in pH about 4.0, when *Calluna* has superseded *V. myrt.* If *Calluna* does not immigrate, but for instance *Anthoxanthum*, there will be a further rise in pH because this species forms no peat.

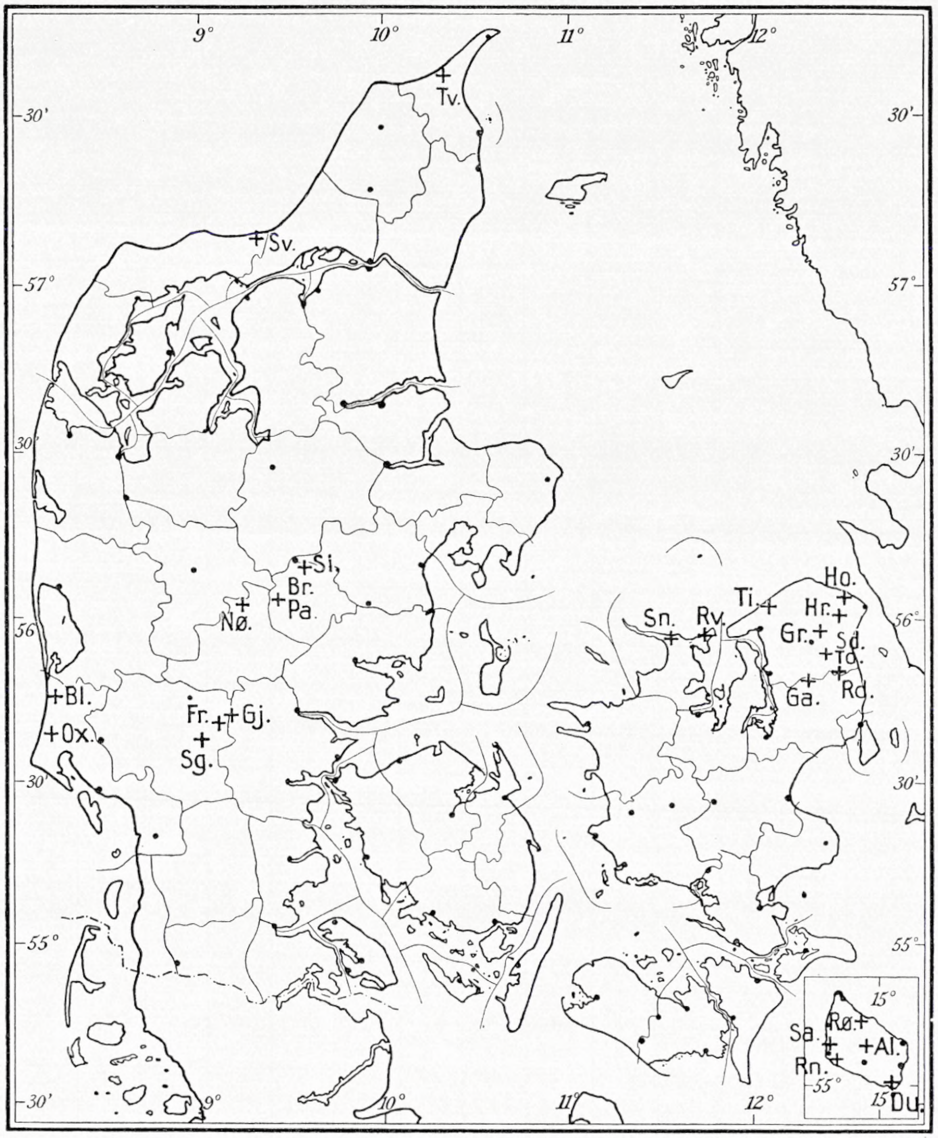

Fig. 9. Map of localities investigated.

List of Abbreviations of the Names of Localities:

Al.: Almindingen. Bl.: Blaabjærg plantage. Br.: Bredlund plantage. Du.: Dueodde. Fr.: Frederikshaab plantage. Ga.: Ganløse Ore. Gj.: Gjøding plantage. Gr.: Grib skov. Ho.: Hornbæk plantage. Hr.: Horserød hegn. Nø.: Nørlund plantage. Ox.: Oxbøl plantage. Pa.: Palsgaard plantage. Rd.: Rudeskov. Rn.: Rønne plantage. Rv.: Rørvig plantage. Rø: Rø plantage. Sa.: Sandflugtskoven (Blykobbe plantage). Sd.: Store Dyrehave. Sg.: Søgaard plantage (Høllund). Si.: Silkeborg. Sn.: Sonnerup plantage. Sv.: Svinkløv plantage. Ti.: Tisvilde hegn. To.: Tokkekøb hegn. Tv.: Tversted plantage.

The following Abbreviations for the Conifers have been used in the Tables:

P. exl.: Picea exelsa (= P. abies). P. can.: Picea canadensis (= P. alba). P. sit.: Picea sitkaënsis. P. sil.: Pinus silvestris. P. mon.: Pinus montana. P. aus.: Pinus austriaca (= P. nigra). A. pec.: Abies pectinata (= A. alba).

The fr$^{0}/_{0}$ of the trees refer to cotyledonous plants.

1 as index to the age of the tree population means of the first generation.

2 means of the second or a later generation.

Table I. Rubus idaeus sociations.

	Melica uniflora soc.	Asperula odorata soc.	Urtica dioeca soc.	Rubus—Brachythecium—Oxalis sociation								Rubus—Brachythecium—Geranium Robertianum soc.				Rubus—Brach.—Deschampsia flexuosa soc.	
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Locality	Sn.	To.	Sn.	To.	To.	Gr.	Gr.	To.	Sd.	Rd.	Rd.	Sn.	Sn.	Sn.	Sn.	Gj.	Al.
Picea abies	..	..	..	..	..	..	..	..	..	..	..	20	20	..	..	45	..
Sambucus nigra	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Sorbus aucuparia	..	..	..	..	..	..	..	..	..	..	..	..	20	..	..	..	..
Rubus fruticosus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
— idaeus	35	25	10	95	100	100	95	70	95	100	80	55	65	100	65	100	100
Vaccinium myrtillus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	..
Anemone nemorosa	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..
Arenaria trinervia	5	..	10	5	30	10	5	..	5	5	5	65	30	..	25	..	..
Asperula odorata	..	100	..	60	15	..	..	..	25	..	5	..	..	..	..	..	..
Campanula rotundifolia	..	..	..	..	..	..	..	..	..	..	..	10	15	15	..	..	..
Chamaenerium angustif.	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	50	..
Dryopteris dilatata	..	5	..	..	5	..	..	..	..	..	..	..	..	..	..	35	15
Epilobium montanum	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..
Equisetum arvense	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..
— silvaticum	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Fragaria vesca	..	..	..	..	..	..	..	..	5	..	..	5	..	..	..	..	..
Galeopsis tetrahit	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..
Galium aparine	..	5	5	20	10	..	..	..	..	..	..	90	35	50	15	..	..
— harcynicum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	40	..
— uliginosum	..	..	..	..	..	5	10	..	..	..	..	..	..	..	..	..	..
Geranium Robertianum	35	..	45	10	..	..	..	..	5	..	..	85	95	70	95	..	..
Hypericum perforatum	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..
Lactuca muralis	..	55	20	..	..	..	..	15	35	15	..	35	90	15	45	5	..
Lampsana communis	..	..	..	..	..	..	..	..	..	..	..	20	..	..	..	..	..
Majanthemum bifolium	..	..	..	..	..	..	..	15	..	15	..	..	..	..	..	..	..
Oxalis acetosella	..	100	..	100	100	100	100	95	100	95	100	..	..	..	..	..	..
Potentilla erecta	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Stellaria glochidosperma	..	75	..	80	45	..	..	..	..	..	..	..	..	..	..	..	..
— vulgaris	..	..	..	..	..	..	..	..	..	..	..	60	80	5	5	..	..
Urtica dioeca	..	..	100	90	20	..	..	..	25	..	..	..	10	30	85	..	..
Veronica chamaedrys	..	..	..	..	..	..	..	..	..	..	..	10	25	..	25	..	..
— officinale	..	..	..	..	..	..	..	..	..	..	..	25	5	40	..	..	5
Viola Riviniana	..	..	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..
— tricolor	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Anthoxanthum odoratum	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..
Brachypodium silvaticum	..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..
Carex arenaria	..	..	..	..	..	..	..	..	..	..	..	..	..	35	5	..	..
Dactylis glomerata	..	..	..	10	..	..	..	..	5	..	5	..	5	40	..	..	..
Deschampsia caespitosa	..	..	..	..	5	..	..	..	5	..	..	..	..	..	..	..	..
— flexuosa	..	..	..	..	..	..	..	10	..	5	5	55	15	30	40	100	100

Table I (continued).

	Melica uniflora soc.	Asperula odorata soc.	Urtica dioeca soc.	Rubus—Brachythecium—Oxalis sociation								Rubus—Brachythecium—Geranium Robertianum soc.				Rubus—Brach.—Deschampsia flexuosa soc.	
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Locality	Sn.	To.	Sn.	To.	To.	Gr.	Gr.	To.	Sd.	Rd.	Rd.	Sn.	Sn.	Sn.	Sn.	Gj.	Al.
Holcus lanatus	..	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..
Juncus supinus	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..
Luzula pilosa	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Melica uniflora	100	..	5	5	..	..	..	..	..	..	5	..	..	..	5	..	..
Milium effusum	..	20	..	70	90	100	30	5	..	..	..	..	..	5	..	..	..
Poa nemoralis	..	5	..	25	5	..	..	..	..	..	..	25	..	..	..	..	..
Brachythecium curtum	..	5	55	100	100	100	100	90	95	100	100	75	100	85	100	100	100
Catharinaea undulata	..	..	..	..	..	..	10	..	5	..	..	..	..	..	..	..	..
Dicranum scoparium	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	10	..
Eurhynchium praelongum	5	..	..	95	..	25	35	25	45	15	10	..	35	5	35	10	..
— striatum	100	85	..	10	75	..	10	..	..	..	..	..	..	..	..	..	..
Hylocomium parietinum	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	15	20
— proliferum	..	..	..	..	..	..	..	..	..	..	..	35	10	..	5	..	10
— squarrosum	..	..	..	..	..	..	..	..	10	..	..	..	..	..	20	..	5
— triquetrum	..	..	..	..	..	..	..	..	..	..	..	5	35	..	10	..	..
Lophocolea bidentata	5	..	..	5	..	..	..	..	..	..	5	..	..	..	5	100	80
— heterophylla	..	..	..	..	30	..	5	..	5	..	35	10	..	..	..	..	..
Mnium hornum	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..
— rostratum	25	..	..	35	90	30	55	70	65	75	40	35	25	15	90	..	..
— undulatum	..	55	..	100	65	..	..	25	50	..	..	..	..	..	..	..	..
Plagiothecium denticulatum	..	5	..	..	..	5	10	..	10	5	40	..	..	..	..	90	..
— repens	..	..	..	..	..	..	..	..	..	5	20	..	..	..	..	..	..
— silvaticum	..	..	..	..	..	..	..	..	..	..	20	..	..	..	..	..	..
— undulatum	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..
Polytrichum attenuatum	..	..	..	..	..	..	5	10	..	..	5	..	..	..	..	5	..
Rhodobryum roseum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..
Scleropodium purum	60	..	..	30	15	40	15	20	25	..	10	55	65	5	70	40	5
Stereodon cupressiformis	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	55	20
Thuidium tamariscifolium	..	..	..	..	..	..	..	..	5	5	15	..	..	..	..	..	..
Light % (i)	9.52	9.17	13.6	14.2	7.50	18.3	12.2	9.09	14.0	5.08	4.28	4.76	4.76	5.82	4.57	9.34	11.8
pH of the surface soil	4.9	5.0	4.2	4.3	4.7	4.0	4.0	3.9	4.1	3.6	3.9	4.7	4.8	4.6	4.9	3.8	4.5
- - - — -	5.0	5.0	4.3	4.3	4.8	4.3	4.1	4.0	4.2	3.8	4.0	5.0	5.0	4.7	4.9	4.0	4.5
- - - — -	5.3	5.2	4.3	4.4	4.8	4.3	4.3	..	4.3	3.8	4.1	5.0	5.2	5.1	5.2	4.0	4.6
pH of the subsoil	4.7*	..	4.3	..	..	..	..	3.7	..	3.8	3.9	..	..	..	..	..	..
Thickn. of the surf. soil (cm.)	2-7	0-5	5-7	2-4	1-4	4-7	2-8	4-5	3-6	3-10	0-3	4-5	3-5	1-6	1-5	5-9	1-2
Subsoil	gravel	sandy clay	gravel	sandy clay	sandy clay	sandy clay	sandy clay	clayey sand	sand	clayey sand	clayey sand	gravel	gravel	gravel	gravel	clayey sand	clayey sand
Species of tree	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	A. pec.	P. exl.	P. exl.	P. sil.	P. exl.	P. exl.	P. sil.
Age of tree	50	60	50	60	60	70	70	70	70	65	100	50	50	60	50	70	50

* In a depth of 30 cm. pH: 5.4.

Table II. Oxalis acetosella sociations.

	Desch.-Oxalis	Oxalis sociation									
No.	1	2	3	4	5	6	7	8	9	10	11
Locality	Gr.	Rd.	Rø	Al.	Ho.	To.	Ga.	Gr.	Si.	Rn.	Al.
Abies alba	..	..	..	10	..	..	..	..	..	..	..
Sambucus nigra	..	..	..	..	5	..	..	..	..	..	..
Sorbus aucuparia	5	..	..	..	5	..	..	..	5	..	..
Lonicera periclymenum	..	..	..	..	..	..	..	..	5	..	..
Rubus fruticosus	..	..	..	..	..	..	..	..	..	10	..
— idaeus	15	..	..	..	10	..	..	10	55	5	5
Calluna vulgaris	..	..	..	..	..	..	..	..	5	..	..
Vaccinium myrtillus	..	..	..	..	..	..	..	..	5	..	..
Arenaria trinervia	..	..	..	..	..	..	..	5	..	..	..
Dryopteris dilatata	..	5	..	..	..	..	..	..	..	..	..
Galium harcynicum	..	..	..	..	..	..	..	15	..	..	..
Geranium Robertianum	..	..	..	..	..	..	..	..	..	40	..
Lactuca muralis	..	..	..	..	..	10	..	..	..	..	..
Melampyrum vulgatum	10	..	..	..	..	..	..	..	30	..	..
Oxalis acetosella	95	95	100	100	100	100	100	95	100	100	100
Potentilla erecta	..	..	..	..	..	..	..	..	..	..	5
Sanicula europaea	..	..	..	..	..	..	..	..	..	25	..
Senecio silvaticus	..	..	..	..	..	..	..	..	..	..	15
Stellaria holostea	..	..	..	..	..	..	..	..	..	..	5
Urtica dioeca	..	..	..	..	..	..	5	..	..	5	..
Viola silvestris	..	..	..	..	..	..	..	..	..	45	..
Carex pilulifera	5	..	..	..	..	..	..	..	..	..	15
Deschampsia flexuosa	100	..	..	..	..	..	..	10	5	..	5
Luzula pilosa	65	..	..	10	..	..	..	..	20	..	85
Melica uniflora	..	..	..	..	..	..	..	..	5	..	..
Brachythecium curtum	100	10	45	30	..	100	90	100	..	5	45
Catharinaea undulata	..	..	..	..	..	..	..	..	..	..	5
Ceratodon purpureus	..	..	..	..	..	..	..	..	..	..	5
Dicranum majus	50	..	5	..	..	..	..	5	..	..	55
— scoparium	..	..	..	10	10	5	..	..	..	..	10
Eurhynchium praelongum	10	..	15	10	10	5	35	40	..	..	35
— striatum	..	..	..	..	..	..	..	..	..	..	5
Hylocomium loreum	..	..	..	..	..	..	..	..	..	..	30
— parietinum	50	5	..	..	..	5	..	15	..	..	10
— proliferum	15	..	..	..	..	15	..	..	..	..	..
— triquetrum	..	..	..	..	..	5	..	..	..	..	..
Lophocolea bidentata	5	..	..	..	..	..	..	..	..	..	..
— heterophylla	..	40	45	75	80	5	100	15	..	5	40
Mnium hornum	5	..	..	..	..	..	..	5	..	..	30
— rostratum	10	10	20	..	5	..	..	5	..	..	..
— undulatum	..	..	10	5	..	..	..	..	..	..	..

Table II (continued).

	Desch.-Oxalis	Oxalis sociation									
No.	1	2	3	4	5	6	7	8	9	10	11
Locality	Gr.	Rd.	Rø	Al.	Ho.	To.	Ga.	Gr.	Si.	Rn.	Al.
Plagiochila asplenioides	..	..	..	..	..	..	..	..	..	..	15
Plagiothecium denticulatum	15	15	30	65	30	..	25	10	..	10	70
— undulatum	..	..	..	..	..	..	..	..	..	..	5
Polytrichum attenuatum	5	..	..	..	..	..	..	..	..	..	..
Scleropodium purum	15	..	5	5	25	5	15	70	..	5	..
Stereodon cupressiformis	5	..	5	25	5	..	..	5	5	..	60
Thuidium tamariscifolium	15	20	40	..	..	..	10	..	..	10	30
Light % (i)	7.20	1.74	4.15	1.45	..	5.28	1.73	9.32	10.8	3.10	8.20
pH of the surface soil	3.9	3.7	4.9	4.6	4.1	3.5	3.9	4.0	4.2	5.3	4.3
- - - — -	4.0	3.9	5.0	4.8	4.1	3.6	4.1	4.0	5.1	5.6	4.8
- - - — -	4.1	4.0	..	..	4.3	3.6	4.5	4.2	..	..	..
pH of the subsoil	..	..	..	5.0	..	3.5	..	..	4.9	5.5	5.4
Thickness of the surface soil (cm)	4-7	1-4	0-2	2-3	5-7	..	2-6	4-7	2-4	2-4	1-4
Subsoil	clayey sand	sandy clay	clayey sand	sand	sand	turf	clayey sand	clayey sand	clayey sand	sandy clay	clayey sand
Species of tree	P. exl.	A. pec.	A. pec.	A. pec.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	A. pec.
Age of tree	55	80	50[2]	40[2]	65	70	80	70	60	80	60

Table III. Thuidium tamariscifolium sociations.

	Thuidium sociation					Th.-Polytr. attenuat. soc.	Oxalis—Thuidium soc.	
No.	1	2	3	4	5	6	7	8
Locality	Al.	Rø	Hr.	Rø	Gr.	Gr.	Al.	Gr.
Sorbus aucuparia	5	..	..	..	..	..	..	..
Picea abies	..	..	..	..	10	25	..	10
Rubus idaeus	..	..	..	..	..	5	..	..
Vaccinium myrtillus	5	..	..	..	..	..	10	..
Anemone nemorosa	..	..	..	40	..	..	..	..
Dryopteris dilatate	..	..	..	..	..	10	..	5
Oxalis acetosella	..	..	..	..	..	10	100	100

Table III (continued).

	Thuidium sociation					Th.-Polytr. attenuat. soc.	Oxalis—Thuidium soc.	
No.	1	2	3	4	5	6	7	8
Locality	Al.	Rø	Hr.	Rø	Gr.	Gr.	Al.	Gr.
Agrostis stolonifera	..	..	..	..	..	..	5	..
Carex hirta	..	..	..	..	..	..	5	..
— pilulifera	..	..	..	..	30	20	5	15
Deschampsia flexuosa	..	..	..	..	..	..	5	10
Luzula pilosa	..	..	..	..	..	..	5	..
Brachythecium curtum	10	..	..	..	5	5	5	35
Dicranum majus	..	..	..	..	35	75	35	15
— scoparium	5	..	..	..	..	..	5	5
Eurhynchium praelongum	15	..	..	..	..	..	40	..
— striatum	10	..	..	..	..	..	50	15
Hylocomium loreum	..	..	..	..	..	10	40	..
— parietinum	10	..	..	..	25	10	..	20
— proliferum	10	..	..	..	10	5	..	25
— squarrosum	..	..	5	..	..	..	..	..
— triquetrum	10	..	..	65	10	..	..	..
Lophocolea heterophylla	45	5	20	..	..	10	55	..
Mnium hornum	..	..	5	..	..	..	5	5
— rostratum	..	..	..	..	..	..	..	90
— undulatum	25	..	..	50	..	..	5	..
Plagiochila asplenioides	..	..	..	..	..	..	55	..
Plagiothecium denticulatum	..	5	..	5	..	10	35	10
— undulatum	5	..	..	..	..	..	..	..
Polytrichum attenuatum	..	5	..	..	5	100	70	..
Scleropodium purum	50	25	..	..	25	..	30	40
Stereodon cupressiformis	45	..	..	..	..	..	10	..
Thuidium tamariscifolium	80	100	50	100	100	100	90	100
Light $^0/_0$ (i)	2.50	0.82	1.39	0.91	4.24	4.78	8.26	7.73
pH of the humus layer	4.0	3.4	3.9	5.1	3.8	3.6	4.3	4.1
- - - — —	..	3.8	..	5.2	3.8	3.7	4.5	4.1
- - - — —	..	3.8	..	..	3.9	3.9	..	4.2
pH of the subsoil	4.7	..	..	5.4	..	..	..	..
Thickness of the humus layer (cm.)	0-8	4-8	7-8	0	5-10	4-7	0-2	5-12
Subsoil	sand	clayey sand	sand	sandy clay	clayey sand	clayey sand	clayey sand	clayey sand
Species of tree	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	A. pec.	P. exl.
Age of tree	50	70	35[1]	60	60	55	70	80

Table IV. Brachythecium curtum sociation.

	Eurhynch. striatum soc.		Brachythecium curtum sociation											
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Locality	Nø.	Rø	Gr.	Al.	Rø	To.	Sd.	Ga.	Sn.	Ti.	Ti.	Rø	Gr.	Si
Abies alba	..	..	..	..	..	5	..	..	..	..	..	..	..	..
Picea abies	..	..	..	..	..	5	..	..	5	90	..	40	..	..
Rubus idaeus	..	..	..	..	..	..	5	..	..	..	..	..	..	..
Vaccinium myrtillus	..	..	..	..	..	..	..	..	..	..	..	..	5	..
Arenaria trinervia	..	..	..	..	..	..	10	..	..	..	..	..	..	..
Asperula odorata	..	..	..	..	..	..	..	..	15	..	..	..	..	..
Lactuca muralis	..	..	..	..	5	10	25	..	40	..	..	..	..	..
Oxalis acetosella	..	..	..	..	..	30	85	5	5	..	..	..	..	..
Stellaria media	..	..	..	..	..	..	5	..	..	..	..	..	..	..
Veronica officinalis	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Viola silvestris	..	..	..	..	..	..	5	..	..	..	..	..	..	..
Brachythecium curtum	..	..	100	80	95	100	90	100	100	100	80	95	100	45
Dicranum scoparium	5	..	20	20	..	15	..	..	..	55	40	80	40	10
Eurhynchium praelongum	15	20	60	5	40	35	..	35	30	15	5	..	20	50
— striatum	70	20	..	..	..	..	..	..	..	..	..	..	..	10
Hylocomium parietinum	5	..	5	15	..	5	..	..	..	15	..	20	..	10
— proliferum	5	..	..	15	..	5	..	5	70	20	40	20	5	30
— triquetrum	..	..	..	..	..	5	..	..	65	..	..	..	..	..
Lophocolea heterophylla	..	75	25	20	100	30	10	15	25	45	55	70	35	25
Mnium hornum	..	..	..	..	..	5	..	..	..	..	..	10	..	..
— rostratum	..	..	..	..	..	..	95	20	65	75	50	..	..	35
— undulatum	..	10	..	..	..	..	..	..	..	..	..	..	..	..
Pylaisia polyantha	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Plagiothecium denticulatum	45	20	20	15	55	..	5	..	..	..	..	100	65	5
— repens	..	25	..	..	..	5	..	..	..	..	..	..	..	..
— silvatica	..	..	..	..	..	35	..	..	..	..	..	..	..	..
— undulatum	..	..	..	5	..	..	..	..	..	..	5	..	100	..
Scleropodium purum	..	..	70	20	..	5	65	20	55	35	60	20	10	35
Stereodon cupressiformis	20	..	..	40	..	..	..	..	..	35	95	95	..	60
Thuidium tamariscifolium	..	15	..	60	..	..	..	30	5	..	..	20	15	..
Light % (i)	0.41	0.60	4.28	∴	5.45	2.80	6.66	1.69	3.33	0.96	..	1.09	4.09	3.24
pH of the peat	4.8	4.7	3.6	3.9	4.5	3.6	3.7	3.7	4.5	3.7	3.8	4.0	3.7	4.3
- - - —	4.8	5.2	3.8	4.0	4.7	3.6	3.8	3.8	4.8	3.9	3.9	4.0	3.7	4.4
- - - —	4.9	..	4.0	4.2	..	..	..	4.0	4.9	..	..	4.1	3.7	4.4
pH of the subsoil	..	5.7	..	..	5.4	3.6	4.3	..	..	4.7	4.4	..	..	5.1
Thickness of the peat (cm.)	1-3	0-4	4-8	1-4	0-2	..	4-7	1-4	3-5	4-6	2-5	3-7	..	2-4
Subsoil	sand	sandy clay	turf		clayey sand	turf	clayey sand	sand	gravel	sand	sand	sandy clay	turf	stony sand
Species of tree	P. exl.	A.pec.	P. exl.	P. exl.	A.pec.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.
Age of tree	20[1]	80	40[2]	40[1]	60	70	70	..	50[1]	40-70	20[2]	70[2]	40	40[1]

Table V. Vaccinium myrtillus sociations.

	Pteridium—V. myrt. soc.		V. myrt. V. v.-i. soc.	Vaccinium myrtillus sociation					
No.	1	2	3	4	5	6	7	8	9
Locality	Si.	Si.	Si.	Al.	Si.	Al.	Si.	Al.	Al.
Calluna vulgaris	..	..	20	10	..	..	..	10	..
Vaccinium myrtillus	100	100	100	100	100	100	100	100	100
— vitis-idaea	5	35	100	..	..	..	..	..	..
Galium harcynicum	..	5	..	..	..	..	..	..	..
Majanthemum bifolium	..	..	..	25	..	..	..	..	..
Potentilla erecta	..	..	..	15	..	..	..	..	..
Pteridium aquilinum	65	75	..	..	..	..	..	..	..
Trientalis europaea	..	90	80	..	..	..	..	..	..
Deschampsia flexuosa	5	100	100	100	65	80	60	95	50
Luzula pilosa	..	75	70	..	..	..	..	15	..
Molinia coerulea	5	..	..	5	..	..	..	..	..
Brachythecium curtum	..	..	..	..	..	..	..	15	20
Dicranum rugosum	5	10	15	5	10	20	5	..	..
— scoparium	..	20	25	45	..	90	80	95	10
Eurhynchium praelongum	..	..	..	..	..	..	..	..	5
Hylocomium loreum	..	..	..	..	..	..	5	..	..
— parietinum	..	10	80	35	100	85	100	95	5
— proliferum	15	..	30	30	90	55	10	45	..
— squarrosum	..	..	..	15	..	10	..	..	..
— triquetrum	..	..	..	..	5	..	..	..	..
Lophocolea bidentata	..	10	15	90	..	100	..	20	25
— heterophylla	..	..	5	..	..	15	..	..	25
Mnium rostratum	..	..	..	..	..	..	..	..	15
Plagiothecium denticulatum	..	..	..	5	..	25	..	55	80
— undulatum	..	..	5	5	..	..	5	..	..
Polytrichum attenuatum	5	..	..	..	..	..	..	10	..
Rhodobryum roseum	..	..	..	..	..	..	..	..	5
Scleropodium purum	40	100	100	100	25	30	..	45	20
Stereodon cupressiformis	95	10	5	5	5	95	100	10	80
Light % (i)	30.9	28.3	31.5	23.0	24.0	20.9	27.1	23.9	39.6
pH of the peat	3.4	3.8	3.9	3.4	3.7	3.5	3.5	3.8	4.1
- - - —	3.6	3.8	3.9	3.5	3.7	3.6	3.7	3.9	4.3
- - - —	3.6	3.9	4.0	3.5	3.7	3.6	3.8	..	..
pH of the subsoil	..	..	..	..	..	..	..	4.5	5.4
Thickness of the peat (cm.)	6-8	4-7	5-7	4-8	5-8	4-8	4-7	2-6	2-5
Subsoil	stony sand	stony sand	sand	sand	sand	sand	stony sand	clayey sand	stony sand
Species of tree	P. sil.	P. sil.	P. sil.	P. exl.	P. sil.	P. exl.	P. sil.	A. pec.	P. sil.
Age of tree	65	75	75	70	40[2]	70	45	18[1]	70

Table VI. Vaccinium vitis-idaea and Empetrum sociations.

	Empetrum soc.				Emp.— V. vit. soc.		Vaccinium vitis-idaea sociation								
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Locality	Sa.	Ti.	Ho.	Du.	Br.	Sg.	Sg.	Sg.	Sg.	Br.	Si.	Si.	Sv.	Si.	Sa.
Picea abies	..	..	..	..	..	..	..	..	..	..	45	..	..	..	..
Pinus silvestris	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..
Sorbus aucuparia	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..
Juniperus communis	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..
Calluna vulgaris	5	35	15	45	..	5	..	5	..	..	..	..	..	..	..
Empetrum nigrum	100	100	100	100	100	90	25	5	5	..	..	5	20	..	..
Erica tetralix	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..
Vaccinium myrtillus	..	..	..	..	..	..	..	..	..	..	..	..	15	10	..
— vitis-idaea	..	..	..	..	100	100	100	100	100	100	100	100	95	100	100
Galium harcynicum	..	..	..	..	..	..	..	..	..	..	..	..	..	15	..
Goodyera repens	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..
Polypodium vulgare	..	..	5	..	..	..	..	..	..	..	..	..	..	..	15
Potentilla erecta	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..
Trientalis europaea	..	..	..	..	..	..	..	..	..	..	..	..	10	45	..
Carex arenaria	..	15	..	5	..	..	..	..	..	..	..	..	100	..	25
— pilulifera	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Deschampsia flexuosa	100	..	85	..	..	15	20	30	50	..	..	35	..	100	20
Luzula pilosa	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Blepharozia ciliaris	..	..	..	..	15	25	..	5	20	15	..	..	20	..	..
Brachythecium curtum	45	..	..	..	..	..	..	..	..	..	..	..	..	35	..
Ctenium crista-castrensis	..	..	..	5	5	..	10	..	..	..	..	..	..	..	..
Dicranum rugosum	10	20	10	35	15	70	20	15	25	15	15	10	..	5	20
— scoparium	5	20	15	45	75	55	35	35	55	50	90	45	10	25	30
Hylocomium loreum	..	..	..	..	..	..	..	..	..	..	20	..	..	..	..
— parietinum	90	60	90	100	100	100	100	95	100	100	100	100	60	50	85
— proliferum	100	40	90	25	35	20	20	..	10	5	95	90	60	35	25
— squarrosum	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..
— triquetrum	..	..	..	..	..	..	..	..	..	..	..	..	50	..	..
Lophocolea bidentata	..	..	..	..	..	..	..	5	..	..	..	..	30	35	..
Plagiothecium denticulatum	..	..	..	..	..	..	..	..	..	..	..	..	..	25	..
Polytrichum attenuatum	..	..	..	..	..	..	..	..	..	..	..	..	..	35	..
Scleropodium purum	100	100	95	..	..	..	..	..	..	..	..	..	45	10	95
Stereodon cupressiformis	5	10	25	95	90	25	60	100	45	45	100	80	85	85	..
Light $^0/_0$ (i)	14.8	..	18.2	34.4	16.9	25.0	17.0	19.5	14.5	15.2	7.50	37.0	26.5	36.7	41.2
pH of the peat	4.1	4.0	3.7	3.7	4.0	3.7	3.6	3.5	3.8	3.8	3.3	3.3	4.0	3.7	4.3
- - - —	4.2	4.3	4.0	3.9	4.0	3.7	3.8	3.8	3.8	4.0	3.3	3.5	4.0	3.9	4.4
- - - —	4.4	..	4.1	3.9	4.2	..	3.9	3.9	..	..	3.5	3.6	4.5	4.0	..
pH of the subsoil (everywhere sand)	..	..	..	..	..	..	..	..	4.6	..	3.2	..	..	..	5.4
Thickness of the peat (cm.)	6-10	4-6	4-8	5-7	7-8	6-9	4-8	5-8	6-8	6-8	8-15	4-7	2-6	3-9	4-9
Species of tree	P. sil.	P. sil.	P. sil.	P. sil.	P. mon.	P. mon.	P. mon.	P. mon.	P. mon.	P. mon.	P. exl.	P. sil.	P. sil.	P. sil.	P. sil.
Age of tree	45[2]	70	70	40[1]	30[1]	40[1]	40[1]	30[1]	35[1]	35[1]	55	45[1]	30[1]	45[1]	80

Table VII. Calluna vulgaris sociations.

	Heath	Calluna—Empetrum soc.					Calluna-Empetr.-Cladonia soc.	Calluna sociation												
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Locality	Sg.	Sa.	Rv.	Ti.	Du.	Sg.	Si.	Sg.	Sn.	Al.	Si.	Si.	Ti.	Rv.	Si.	Sg.	Sn.	Gr.	Al.
Rubus idaeus	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	20	..
Arctostaphylos uva-ursi	40	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calluna vulgaris	100	95	100	100	95	55	80	100	100	100	100	100	100	100	55	60	90	65	100
Empetrum nigrum	100	85	95	60	100	75	65	35	5	..	..	..	..	15	..	..	..	..	..
Erica tetralix	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Myrica gale	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vaccinium vitis-idaea	70	..	..	..	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..
Galium harcynicum	..	..	..	..	..	..	..	..	..	..	..	15	..	..	5	..	..	5	..
Polypodium vulgare	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	10
Potentilla erecta	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Trientalis europaea	..	..	..	..	..	..	..	..	..	..	..	15	5	..	15	..	..	..	..
Carex arenaria	..	20	60	..	..	..	..	..	85	..	..	..	5	95	10	5	100	..	..
— pilulifera	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..
Deschampsia flexuosa	10	10	..	10	..	..	..	..	70	20	20	90	10	..	30	5	100	100	15
Luzula pilosa	..	..	..	15	..	..	..	..	..	..	..	..	15	..	..	..	..	5	..
Molinia coerulea	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Scirpus caespitosus	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Blepharozia ciliaris	..	..	..	..	..	..	15	..	20	75	5	..	..	..	..	..	..	..	90
Brachythecium curtum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	..	5	..	..
Ctenium crista-castrensis	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dicranum rugosum	20	70	65	60	..	..	5	10	15	..	30	15	30	30	..	..	..	..	..
— scoparium	20	35	15	10	10	15	5	10	75	30	25	40	..	20	10	10	40	50	90
Hylocomium parietinum	100	95	100	100	90	..	5	15	80	95	100	100	95	85	55	10	..	65	80
— proliferum	..	50	85	85	..	..	..	..	..	5	..	75	45	40	..	5	5	15	..
— triquetrum	..	..	5	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Leucobryum glaucum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..
Lophocolea bidentata	..	..	30	..	..	..	..	..	..	..	..	..	..	5	5	..	..	..	..
— heterophylla	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..
Polytrichum attenuatum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..
— juniperinum	10	..	..	..	..	..	..	20	..	10	..	5	..	..	15	..	..	..	..
— piliferum	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..
Scleropodium purum	..	85	45	35	..	..	..	..	..	..	..	5	20	25	10	..	..	5	..
Stereodon cupressiformis	100	65	95	100	100	100	65	100	100	70	95	100	70	100	90	100	85	95	100
Cladonia impexa	70	..	..	..	..	5	100	40	..	..	..	..	10	..	..	..	..	..	..
— rangiferina	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— sp.	..	..	..	..	..	..	5	..	..	..	..	..	..	..	5	..	..	..	..

Table VII (continued).

	Heath	Calluna—Empetrum soc.					Calluna-Empetr.-Cladonia soc.	Calluna sociation											
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Locality	Sg.	Sa.	Rv.	Ti.	Du.	Sg.	Si.	Sg.	Sn.	Al.	Si.	Si.	Ti.	Rv.	Si.	Sg.	Sn.	Gr.	Al.
Light $^0/_0$ (i)	100	16.0	13.8	27.0	65.0	12.7	60	43.4	52.2	18.1	67.3	14.3	..	13.6	8.52	11.4	7.9	11.5	70
pH of the peat	3.7	4.1	3.8	4.1	4.1	3.6	3.5	4.0	4.0	4.2	3.8	3.7	4.0	3.9	4.3	3.9	3.8	3.6	4.2
- - - —	..	4.2	3.9	..	4.1	3.6	3.7	4.1	4.1	4.2	3.9	3.9	4.0	3.9	4.7	..	4.2	4.0	4.3
- - - —	..	4.2	3.9	..	..	..	..	..	4.4	4.3	3.9	3.9	..	3.9	..	..	4.2	4.1	..
pH of the subsoil	..	..	..	..	..	..	..	4.3	..	..	..	..	..	..	5.2	4.1	..	..	5.2
Thickness of the peat (cm.)	2-7	3-5	4-6	5-8	2-4	1-2	0-3	1-5	..	2-5	2-6	4-8	5-6	4-6	1-3	2-3	8-10	..	2-6
Subsoil	sand	sand	sand	sand	sand	sand	gravel	sand	sand	clayey sand	sand	gravel	sand	sand	stony sand	sand	gravel	clayey sand	clayey sand
Species of tree	..	P. sil.	P. aus.	P. sil.	P. sil.	P. mon.	P. sil	P. mon.	P. sil.	P. sil.	P. sil.	P. sil.	P. sil.	P. aus.	P. mon.	P. mon.	P. sil.	P. sil.	P. sil.
Ages of tree	..	60	60	65	10-40	11[1]	20[1]	27[1]	25[1]	15[1]	8[1]	10[1]	75	60	9[1]	16[1]	13[1]	16[2]	6[1]

Table VIII. Deschampsia flexuosa—

No.	1	2	3	4	5	6	7	8
Locality	Bl.	Ti.	Sa.	Ho.	Rn.	Rn.	Rn.	Sn.
Sorbus aucuparia	..	..	..	..	..	5	..	..
Lonicera periclymenum	..	..	65	..	..	20	..	..
Rubus fruticosus	..	..	15	..	..	10	..	..
— idaeus	..	..	..	..	..	..	..	10
Calluna vulgaris	..	..	..	..	..	..	20	5
Vaccinium myrtillus	..	..	..	..	..	..	..	..
— vitis-idaea	..	..	5	..	..	..	..	..
Dryopteris dilatata	..	..	..	..	..	..	..	..
Campanula rotundifolia	..	..	..	..	..	..	..	..
Convallaria majalis	..	..	25	..	..	..	..	..
Galium harcynicum	..	..	..	..	..	..	..	..
— verum	..	..	..	..	..	..	5	..
Goodyera repens	..	25	..	..	..	..	..	..
Hieracium umbellatum	..	..	..	..	5	..	..	..
Lactuca muralis	..	10	..	..	..	..	..	65
Majanthemum bifolium	..	..	..	..	..	..	..	..
Melampyrum vulgatum	..	..	..	20	..	..	..	..
Oxalis acetosella	..	..	20	..	..	..	..	..
Polypodium vulgare	..	..	5	..	..	..	..	..
Potentilla erecta	..	..	..	..	..	..	..	..
Pteridium aquilinum	..	..	..	..	..	..	..	..
Senecio silvaticus	..	..	..	..	..	..	..	..
Trientalis europaea	65	15	..	..	..	..	..	..
Agrostis stolonifera	..	..	..	..	..	..	..	..
— tenuis	..	..	..	..	..	..	..	..
Anthoxanthum odoratum	..	..	..	..	..	..	20	..
Avena elatior	..	..	..	..	..	..	..	..
Carex arenaria	..	..	90	..	..	20	..	35
— hirsuta	..	..	..	..	..	..	..	..
— panicea	..	..	..	..	..	..	..	..
— pilulifera	..	..	..	..	..	..	..	..
Dactylis glomerata	..	..	..	..	..	..	..	..
Deschampsia flexuosa	100	95	95	100	100	100	100	100
Holcus lanatus	..	..	..	..	..	..	..	..
Luzula congesta	..	..	..	..	..	..	..	..
— pilosa	..	35	..	75	..	10	..	..
Poa pratensis	..	..	..	..	..	..	..	..
Blepharozia ciliaris	10	..	..	..	..	..	..	..
Brachythecium curtum	..	..	..	..	15	..	..	..
Ctenium crista-castrensis	..	..	5	5	..	..	..	..
Dicranum majus	..	..	..	..	..	..	..	..
— rugosum	..	..	5	..	..	5	..	5
— scoparium	10	5	5	5	5	15	5	45

Scleropodium purum sociation.

9	10	11	12	13	14	15	16	17	18	19	20	21	22
Tv.	Ox.	Bl.	Al.	Ho.	Si.	Fr.	Si.	Al.	To.	Gr.	Gr.	Al.	Sn.
..	..	..	..	..	..	..	10	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	5	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	5	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	5	..	..
5	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	85	..	..	..	..	5	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	10
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	25	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	15	..	..	..	..	5	45	5	60	90	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	5	..
..	..	..	..	..	..	..	..	..	5	..	..	..	..
..	..	..	..	..	..	5	..	..	..	..	..	..	..
..	..	65	..	..	..	15	..	..	..	..	95	5	..
25	..	..	..	..	..	..	..	..	..	..	..	..	15
..	..	..	..	..	..	..	..	..	..	..	..	5	..
..	..	..	..	..	..	..	..	..	..	..	..	60	10
..	..	..	..	..	..	..	..	..	..	..	..	..	5
90	35	..	..	..	..	..	..	..	..	..	..	..	10
..	..	..	..	..	..	..	..	..	..	..	..	..	15
..	..	..	..	..	..	..	..	..	..	..	..	..	5
..	5	..	5	..	..	..	..	5	..	5	..	5	..
..	..	..	..	..	..	..	..	..	..	..	..	..	15
100	100	100	100	100	95	100	100	100	100	100	100	100	100
..	..	..	..	..	..	..	..	..	..	..	..	..	5
..	..	..	..	..	..	..	..	..	..	..	..	10	..
..	..	..	..	10	..	..	..	10	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	60
..	5	10	..	..	..	..	..	..	..	..	..	..	..
10	..	..	..	..	5	30	..	10	20	..	40	..	..
..	..	..	5	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	35	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
5	5	30	..	15	..	10	..	45	15	10	15	..	..

Table VIII

No.	1	2	3	4	5	6	7	8
Locality	Bl.	Ti.	Sa.	Ho.	Rn.	Rn.	Rn.	Sn.
Eurhynchium praelongum	..	..	..	..	..	..	..	..
Hylocomium loreum	..	..	..	..	..	..	..	..
— parietinum	15	..	60	5	5	35	..	10
— proliferum	25	10	65	30	..	15	10	5
— squarrosum	..	..	..	..	..	..	..	..
— triquetrum	10	25	..	40	..	..	..	5
Lophocolea bidentata	..	5	..	..	..	..	..	5
— heterophylla	..	..	..	..	..	..	..	..
Mnium rostratum	..	..	..	..	..	..	..	..
Plagiothecium denticulatum	..	..	..	..	..	..	..	..
— silvaticum	..	..	..	..	..	..	..	..
— undulatum	..	..	..	..	..	..	..	..
Polytrichum attenuatum	..	..	..	..	..	..	..	..
Scleropodium purum	100	100	100	100	100	100	100	95
Stereodon cupressiformis	100	..	..	..	5	..	..	45
Thuidium tamariscifolium	..	..	..	..	..	..	..	..
Light $^0/_0$ (i)	..	..	..	6.82	7.16	16.7	21.8	24.4
pH of the peat	3.5	3.9	4.3	3.8	4.2	4.1	4.7	3.8
- - - —	3.6	4.0	4.3	3.8	4.2	4.3	4.9	3.8
- - - —	3.7	..	4.4	3.8	4.3	4.3	..	3.9
pH of the subsoil	..	4.6	..	..	5.2	..	..	..
Thickness of the peat (cm.)	6-9	7-10	4-9	4-7	2-5	2-5	2-4	..
Subsoil	sand	sand	sand	sand	sand	sand	gravel	gravel
Species of tree	P. mon.	P. exl.	P. sil.	P. exl.	P. sil.	P. sil.	P. sil.	P. sil.
Age of tree	45[1]	50[2]	80	70	70	70	80	75

(continued).

9	10	11	12	13	14	15	16	17	18	19	20	21	22
Tv.	Ox.	Bl.	Al.	Ho.	Si.	Fr.	Si.	Al.	To.	Gr.	Gr.	Al.	Sn.
..	..	..	..	..	..	..	..	..	..	..	15	..	..
..	..	..	..	..	..	..	..	..	..	..	10	..	..
50	10	70	5	5	40	5	60	30	..	20	5	5	..
75	30	35	65	..	10	10	40	5	15	45	60	..	15
..	..	..	15	..	..	..	..	5	..	..	..	25	35
10	..	5	..	..	..	..	..	..	..	..	25	..	..
55	45	80	45	10	..	..	85	5	20	5	50	20	..
..	..	..	10	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	45	..	..
..	..	..	10	..	5	5	..	..	..	..	..	..	..
..	..	..	..	..	..	..	5	..	..	..	..	..	..
..	..	..	..	..	5	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	5	10	..	..
70	100	85	95	95	95	100	85	100	90	100	100	90	100
15	25	95	..	30	90	..	60	15	..	40	..	..	..
..	..	..	..	..	..	..	..	5	..	10	5	5	..
17.7	9.32	21.4	..	..	6.75	10.4	8.30	12.3	..	9.17	12.7	28.2	41.1
4.3	3.5	3.7	4.4	3.9	4.1	4.0	3.6	4.1	3.8	3.7*	3.6	4.3	4.0
4.6	3.7	3.7	4.7	3.9	4.2	4.2	3.8	4.3	3.9	3.9	3.7	4.4	4.0
4.8	..	3.7	..	3.9	..	4.2	3.8	..	..	4.0	3.7	..	4.2
..	..	4.3	5.0	..	..	..	..	4.6	3.7	..	..	5.5	..
5-8	3-8	6-7	1-6	..	4-8	2-6	3-5	3-5	..	8-14	8-13	1-4	7-11
sand	sand	sand	sand	sand	gravel	stony sand	sand	clayey sand	clayey sand	clayey sand	clayey sand	stony sand	gravel
P. mon. 40[1]	P. mon. 50[1]	P. mon. 45	P. exl. 80	P. exl. 70	P. exl. 70	P. exl. 120	P. mon. 15[1]	P. exl. 15[1]	P. exl. 70	P. exl. 60	P. exl. 80	P. sil. 70	P. sil. 80

* Upper peat pH 3.9.

Table IX. Deschampsia flexuosa sociations.

	Deschampsia flexuosa sociation											Desch.—Galium harcynicum soc.		Deschampsia—Hylocomium parietinum soc.			
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Locality	Rø	Rø	To.	Gj.	Al.	Ti.	Al.	Ox.	Sn.	Sn.	Gr.	Si.	Br.	Si.	Si.	Fr.	Sg.
Picea abies	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..
Populus tremula	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..
Sorbus aucuparia	..	..	..	..	..	..	..	5	..	..	..	20	..	..	35	..	..
Lonicera periclymenum	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rubus fruticosus	..	5	..	..	..	..	..	..	..	..	..	20	..	..	..	..	..
— idaeus	25	..	..	10	..	..	..	..	..	..	55	..	..	..	..	..	..
Calluna vulgaris	5	..	..	..	..	5	..	..	20	..	10	10	..	5	..	5	10
Vaccinium myrtillus	..	..	..	..	5	..	25	..	..	..	..	5	..	15	..	..	..
— vitis-idaea	..	..	..	..	..	..	..	..	..	..	..	5	35	..	..	5	..
Arenaria trinervia	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..
Dryopteris dilatata	..	..	..	..	..	..	..	25	..	..	..	..	..	..	..	..	..
Galium harcynicum	..	..	..	..	..	..	..	..	..	..	..	100	100	..	10	5	..
Hieracium sp.	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Lactuca muralis	..	..	10	..	..	5	..	..	..	..	..	..	..	..	..	..	..
Lycopodium annotinum	100	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Melampyrum vulgatum	..	..	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..
Oxalis acetosella	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Polypodium vulgare	..	..	..	..	..	..	..	20	..	..	..	..	..	..	..	..	..
Potentilla erecta	..	..	..	..	..	..	30	..	..	..	..	..	..	..	..	..	..
Senecio silvaticus	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..
Trientalis europaea	..	..	..	..	..	..	..	30	..	..	5	..	..	..	..	..	25
Veronica officinalis	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..
Agrostis tenuis	..	..	..	..	..	..	..	..	..	..	50	..	..	..	..	..	..
Anthoxanthum odorat.	..	..	..	..	..	..	20	..	..	..	..	..	..	..	..	..	..
Carex pilulifera	5	..	..	..	5	..	..	..	..	..	10	..	..	..	..	..	15
Dactylis glomerata	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Deschampsia caespitosa	..	..	5	..	..	..	5	..	..	..	5	..	..	..	..	..	..
— flexuosa	100	100	100	100	100	100	100	95	100	100	100	100	100	100	90	100	95
Festuca rubra	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Holcus lanatus	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..	..
Luzula congesta	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— pilosa	5	5	10	5	75	90	..	..	..	..	..	..	..	..	..	..	..
Melica uniflora	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Molinia coerulea	..	..	..	..	..	..	25	..	..	..	..	..	10	..	..	..	..
Sieglingia decumbens	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..
Blepharozia ciliaris	..	..	..	..	..	..	..	..	..	..	..	..	20	..	30	25	..
Brachythecium curtum	..	..	40	20	..	20	5	..	..	10	..	25	..	..	..	10	..
Ceratodon purpureus	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..

Table IX (continued).

	Deschampsia flexuosa sociation											Desch.—Galium harcynicum soc.		Deschampsia—Hylocomium parietinum soc.			
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Locality	Rø	Rø	To.	Gj.	Al.	Ti.	Al.	Ox.	Sn.	Sn.	Gr.	Si.	Br.	Si.	Si.	Fr.	Sg.
Dicranella heteromalla	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..
Dicranum rugosum	..	..	..	..	..	5	..	..	10	..	..	..	..	40	15	5	10
— scoparium	..	..	..	..	35	10	..	..	35	15	65	..	30	35	30	85	10
Hylocomium loreum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..
— parietinum	20	5	..	70	..	75	20	5	35	10	20	25	95	100	95	95	100
— proliferum	..	5	..	75	5	25	15	5	..	5	..	..	..	30	65	35	5
— squarrosum	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..
— triquetrum	..	..	..	..	..	10	5	..	..	20	..	..	..	..	..	..	..
Lophocolea bidentata	85	20	..	60	..	100	10	45	..	..	10	..	..	90	40	5	..
— heterophylla	..	..	25	25	5	..	..	..	..	..	..	..	..	..	..	..	..
Plagiothecium denticul.	5	5	5	15	25	..	5	..	..	..	..	5	..	..	..	..	..
— undulatum	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..
Polytrichum attenuatum	..	5	..	..	..	..	..	..	..	..	40	..	..	15	..	..	..
Scleropodium purum	45	50	45	35	50	20	20	50	5	..	25	20	..	20	10	..	..
Stereodon cupressif.	85	20	60	75	15	50	20	90	100	55	80	60	90	85	95	80	95
Light % (i)	26.9	32.7	12.9	8.77	11.4	..	22.3	..	15.6	18.2	..	17.6	21.1	20.0	7.83	10.9	70
pH of the peat	4.0	4.0	4.0	4.2	3.5	4.0	4.1*	3.7	3.7	4.0**	3.9	3.7	4.0	3.4	3.8	3.6	4.1
- - - —	4.1	4.1	4.0	4.3	3.7	4.1	4.4	3.8	3.9	4.2	3.9	3.8	4.2	3.5	3.9	3.7	4.1
- - - —	..	4.4	4.2	4.3	..	4.3	4.5	4.1	4.2	4.4	4.1	4.2	4.2	3.6	4.1	..	..
pH of the subsoil	4.4	4.3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4.1
Thickness of the peat (cm.)	6-9	3-7	6-7	5-10	5-8	6-9	2-4	5-7	4-6	8-12	6-12	4-9	7-9	3-8	2-6	1-4	5-6
Subsoil	clayey sand	clayey sand	clayey sand	clayey sand	clayey sand	sand	clayey sand	sand	sand	sand	clayey sand	sand	sand	sand	sand	sand	sand
Species of tree	P. sil.	P. sil.	P. exl.	P. exl.	P. exl.	P. exl.	P. sil.	P. mon.	P. aus.	P. exl.	P. exl.	P. sil.	P. mon.	P. sil.	P. mon.	P. mon.	P. mon.
Age of tree	80	80	50	70	40	60	90	50	45		6[2]	45	35[1]	40[1]	30	40	50

* under Molina pH 4.7. ** upper peat pH 4.3.

Table X. Carex arenaria sociations.

	Carex arenaria sociation											C. arenaria—Oxalis soc.	
No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality	Sa.	Ti.	Sa.	Du.	Rv.	Ti.	Rv.	Sn.	Sn.	Sn.	Sn.	Ti.	Ti.
Sorbus aucuparia	..	5	..	..	..	..	..	..	..	..	..	..	5
Rubus idaeus	..	..	..	..	..	..	..	..	20	..	..	..	..
Calluna vulgaris	..	15	..	10	5	..	..	..	..	..	..	..	..
Empetrum nigrum	95	..	25	20	..	..	..	..	..	..	..	..	..
Arenaria trinervia	..	..	..	..	..	..	..	..	55	20	..	..	..
Campanula rotundif.	..	..	..	..	..	..	..	..	..	..	10	..	..
Galium aparine	..	..	..	..	..	..	..	..	..	40	..	..	..
Geranium Robertianum	..	..	..	..	..	..	..	..	40	70	..	..	..
Lactuca muralis	..	..	..	..	..	..	..	85	5	..	..	..	..
Luzula pilosa	..	..	..	..	..	..	..	..	..	..	..	85	70
Oxalis acetosella	..	..	..	..	..	..	..	..	..	..	..	100	100
Polypodium vulgare	..	..	..	..	..	..	..	..	10	..	..	..	..
Anthoxanthum odoratum	..	..	..	..	..	..	..	..	..	..	20	..	..
Carex arenaria	100	100	100	100	100	100	100	100	100	100	100	100	100
Dactylis glomerata	..	..	..	..	..	..	..	..	10	10	..	..	5
Deschampsia flexuosa	10	35	40	..	..	..	..	70	70	95	65	50	60
Holcus lanatus	..	..	..	..	..	..	..	..	..	35	5	..	..
Poa pratensis	..	..	..	..	..	..	..	..	..	..	25	..	..
Brachythecium curtum	..	15	..	..	..	..	..	40	65	10	..	20	15
Ctenium crista-castrensis	..	..	..	5	..	..	..	..	..	..	..	..	..
Dicranum rugosum	..	25	20	30	15	30	20	..	..	..	..	..	..
— scoparium	..	40	..	30	30	15	..	5	..	..	..	25	..
Eurhynchium praelongum	..	..	..	..	..	..	..	..	15	5	..	..	..
Hylocomium parietinum	..	40	70	85	65	10	90	..	..	..	..	95	..
— proliferum	20	15	70	85	45	90	95	..	..	5	..	80	5
— squarrosum	..	..	..	..	..	..	..	..	5	..	..	..	..
— triquetrum	..	..	..	..	..	..	20	..	15	20	..	95	85
Lophocolea bidentata	..	15	..	..	5	..	..	..	5	60	..	10	..
Mnium rostratum	..	..	..	..	..	..	..	..	20	35	20	..	..
Rhodobryum roseum	..	..	..	..	..	..	..	..	..	5	5	..	..
Scleropodium purum	100	100	100	95	90	100	45	30	95	95	25	75	95
Stereodon cupressiformis	..	35	..	10	100	..	25	85	..	..	10	85	45
Light $^0/_0$ (i)	25.7	16.2	24.2	11.3	8.14	8.84	9.22	11.9	6.24	10.0	22.7	..	..
pH of the peat	4.0	3.7	3.7	3.9	4.1	3.7	4.2	4.0	4.1	4.0	4.4	4.1	4.2
- - - —	4.1	3.9	3.8	4.0	4.3	3.8	4.2	4.1	4.3	4.1	4.4	4.2	4.4
- - - —	4.2	..	3.9	4.0	4.3	..	4.2	4.2	4.4	4.2	4.4	4.5	4.6
Thickness of the peat (cm.)	10-12	6-8	6-8	4-6	4-7	6-8	4-7	5-7	4-7	6-7	4-8	6-8	5-7
Species of tree	P. sil.	P. sil.	P. sil.	P. sil.	P. aus.	P. exl.	P. aus.	P. aus.	P. sil.	P. exl.	P. exl.	P. sil.	P. sil.
Age of tree	60^2	13^2	60^2	40^1	60^1	100	60^1	50	65	45	65	50^2	50^2

The subsoil is in every place sand.

Table XI. Scleropodium purum sociation.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Locality	Sa.	Gr.	Sa.	Sa.	Sa.	Rv.	Rv.	Sn.	Si.	Si.	Pa.	Si.	Sa.	Sa.	Sg.	Si.	Bl.	Ho.	Ti.
Picea abies	..	..	..	..	..	..	5	80	..	..	..	..	..	..	..	..	..	20	25
Sorbus aucuparia	..	..	..	..	10	..	..	..	..	..	..	..	..	5	..	..	..	5	..
Calluna vulgaris	..	..	..	..	..	..	..	..	..	..	5	5	..	..	..	..	..	..	..
Vaccinium myrtillus	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..
Galium harcynicum	..	..	..	..	..	..	..	..	..	..	15	5	..	..	..	..	..	..	..
Lactuca muralis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15
Melampyrum vulgatum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	..
Trientalis europaea	..	..	..	..	..	..	..	..	..	..	30	..	..	..	..	..	30	..	..
Carex arenaria	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	30	..	..
Deschampsia flexuosa	..	5	5	..	..	..	..	5	..	10	..	20	5	15	..	5	5	10	5
Luzula pilosa	..	..	..	5	..	..	..	..	..	..	35	..	5	..	..	..	..	95	45
Brachythecium curtum	90	80	65	45	65	50	25	30	5	..	..	..	..	5	10	..	..	..	15
Ctenium crista-castr.	30	..	5	..	..	..	5	..	5	..	..	..	..	..	..	..	..	30	..
Dicranum rugosum	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	5	5	..
— scoparium	95	10	95	75	95	60	65	50	70	5	40	15	100	20	5	35	10	55	10
Eurhynchium prael.	..	5	..	5	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..
Hylocomium pariet.	60	5	60	15	90	45	40	20	50	95	75	15	100	..	..	25	10	30	15
— proliferum	25	35	35	5	10	20	10	60	45	90	90	25	5	5	10	5	..	30	30
— triquetrum	..	..	..	..	..	60	..	20	..	..	10	..	10	..	..	..	..	15	5
Lophocolea bidentata	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— heterophylla	5	50	..	50	20	65	..	90	..	..	..	..	10	85	..	15	..	..	..
Mnium rostratum	..	..	..	..	10	40	5	35	..	..	..	..	..	..	..	..	..	..	..
Plagiothecium dent.	75	35	50	75	35	15	..	..	..	..	..	..	45	10	..	15	..	..	..
Polytrichum attenuat.	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..
Rhodobryum roseum	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Scleropodium purum	100	100	100	90	95	100	100	100	95	90	100	95	90	100	100	100	100	100	100
Stereodon cupressif.	35	25	100	65	45	60	55	50	60	60	45	90	15	10	85	95	95	..	..
Light $^0/_0$ (i)	5.85	7.39	1.19	..	2.16	4.25	6.48	6.71	5.08	10.0	4.15	5.72	..	2.24	4.24	7.31	..	3.18	5.19
pH of the peat	3.8	3.5	3.8	3.6	3.6	3.7	4.2	3.7	3.4	3.4	4.0	3.7	3.7	3.8	3.7	3.6	3.6	4.2	4.1
- - - —	3.8	3.7	4.0	3.8	3.9	3.8	4.2	3.8	3.5	3.6	4.1	3.9	3.8	3.9	3.7	3.6	3.7	4.2	..
- - - —	..	3.7	..	..	3.9	3.9	4.4	3.8	3.6	3.7	4.3	..	..	4.0	3.8	..	3.8	4.2	..
Thickness of the peat (cm.)	7-11	6-8	8-10	11-15	7-9	6-9	6-8	8-12	4-8	5-9	7-10	4-8	..	7-9	5-10	..	5-9	10-12	7-9
Subsoil	sand	sand	sand	sand	sand	sand	sand	gravel	sand	clayey sand	clayey sand	gravel	sand	sand	sand	clayey sand	sand	sand	sand
Species of tree	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	A. pec.	P. exl.	A. pec.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. sil.	P. exl.	P. exl.	P. mon.	P. exl.	P. exl.
Age of tree	45^2	60	35^2	35^2	35^2	45^2	55^1	70	60	45^2	80	70	35^2	20^2	65^1	45^2	45^1	70	100

No. 2: upper peat pH 3.7.

Table XII. Hylocomium

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality	Du.	Ti.	Sv.	Si.	Bl.	Ti.	Br.	Nø.	Nø.	Fr.	Fr.	Fr.	Sg.
Picea abies	..	..	..	..	..	..	..	..	..	..	..	..	..
Calluna vulgaris	..	..	..	5	..	..	..	..	..	..	..	..	..
Empetrum nigrum	..	..	..	..	10	..	..	..	..	..	..	..	5
Vaccinium myrtillus	..	..	..	..	..	..	..	..	..	..	..	..	..
— vitis-idaea	..	..	..	..	..	..	..	..	..	..	..	..	..
Potentilla erecta	..	..	..	..	..	..	..	..	..	..	..	..	..
Scorzonera humilis	..	..	..	..	..	..	..	..	..	..	..	..	..
Carex arenaria	35	30	15	..	70	10	..	..	..	..	..	..	..
Deschampsia flexuosa	..	10	..	30	5	10	..	..	..	15	55	45	..
Festuca ovina	..	..	..	..	..	..	..	..	..	..	..	..	..
Luzula pilosa	..	..	..	..	..	15	..	..	..	..	..	..	..
Molinia coerulea	..	..	..	..	..	..	..	..	..	..	..	..	..
Sieglingia decumbens	..	..	..	..	..	..	..	..	..	..	..	..	..
Blepharozia ciliaris	..	..	..	..	10	..	20	70	15	..	80	5	5
Brachythecium curtum	..	..	..	..	..	..	..	..	..	..	..	..	..
Cephaloziella sp.	..	..	..	..	..	..	..	..	..	..	..	..	..
Ctenium crista-castrensis	..	..	..	..	..	..	..	..	..	..	..	..	..
Dicranum majus	..	..	..	..	..	..	..	..	..	..	..	..	..
— rugosum	10	50	5	20	5	65	25	30	40	20	20	10	15
— scoparium	60	..	..	60	40	40	30	40	95	30	55	70	55
Hylocomium loreum	..	..	..	..	..	..	..	..	..	..	..	10	..
— parietinum	100	100	100	100	100	100	100	100	100	100	100	100	100
— proliferum	20	40	20	10	5	15	15	10	45	30	20	25	5
— triquetrum	..	10	20	..	..	..	..	..	15	..	..	..	..
Lophocolea bidentata	..	..	..	..	..	..	..	..	..	..	..	..	..
— heterophylla	..	..	..	..	..	..	..	..	..	..	..	5	..
Plagiothecium undulatum	..	..	..	..	..	..	..	..	..	..	..	..	..
Rhodobryum roseum	..	..	..	..	..	..	..	..	..	..	..	..	..
Scleropodium purum	..	..	..	..	..	..	..	..	..	..	..	..	..
Stereodon cupressiformis	55	60	15	60	80	50	40	20	30	65	65	95	100
Cladonia impexa	..	..	..	15	5	..	10	5	10	30	15	..	35
— rangiferina	..	..	..	..	..	..	..	..	..	..	..	..	..
Light $^0/_0$ (i)	32.6	23.0	15.2	25.9	21.6	25.4	15.6	9.00	7.20	6.50	11.4	7.88	8.59
pH of the peat	3.6	3.7	3.9	3.4	3.5	4.0	3.8	3.9	3.7	3.6	3.9	3.7	4.0
- - - —	3.7	..	4.0	3.5	3.6	..	3.9	4.0	3.9	3.7	3.9	3.8	4.2
- - - —	4.0	..	4.0	3.6	3.7	..	3.9	4.1	3.9	..	..	3.8	..
pH of the subsoil	..	..	..	..	..	..	..	..	..	..	..	..	..
Thickness of the peat (cm.)	3-5	6-7	1-6	3-6	3-8	..	6-9	6-8	5-9	7-8	3-5	5-10	3-6
Subsoil	sand	sand	sand	sand	sand	sand	sand	stony sand	stony sand	sand	sand	sand	sand
Species of tree	P. sil.	P. sil.	P. sil.	P. sil.	P. mon.	P. sil.	P. mon.	P. mon.	P. exl.	P. mon.	P. mon.	P. exl.	P. mon.
Age of tree	40	70	35[1]	45[1]	45[1]	100	40[1]	40[1]	40[1]	70	70	70	40

No. 18, 32 and 33 are labile.

parietinum sociation.

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Fr.	Fr.	Ti.	Ti.	Sg.	Sg.	Sg.	Fr.	Ho.	Sa.	Ti.	Sn.	Ho.	Rv.	Rv.	Sn.	Ti.	Rn.	Al.	Al.
..	5	..	..	..	..	..	..	..	..	80	..	..	..	..	15	100	..	..	..
..	10	5	..	40	..	..	..	40	..	..	..	5	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	10	..	..	..	45	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	20
..	..	..	..	15	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..
..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	25	..	..	..	..	..	..	..	5	10	..	..	..	..	..	..	..
40	65	..	25	45	35	70	20	35	5	..	70	55	..	..	35	..	90	15	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	20	..
..	..	..	10	..	..	..	..	..	..	55	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	20
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..
10	5	..	..	5	30	..	..	..	..	..	..	..	..	..	..	..	..	10	30
..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	30	10	..	..	..
..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	10	..	..	15	..	..	..	..	..	20	..	25	..	5
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10
..	15	25	60	15	50	15	25	..	90	..	20	90	35	20	15	20	25	..	15
100	80	55	40	50	50	10	40	90	45	45	80	35	45	..	90	25	35	55	100
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..
100	100	100	100	100	100	100	100	100	100	100	100	100	100	95	100	95	100	100	100
..	5	5	35	15	5	75	75	75	35	100	20	90	30	80	60	20	30	..	60
..	..	30	..	..	..	..	..	..	5	15	..	..	..	10	35	..	..	5	..
..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	40	..	..	..	..
..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..
..	..	..	15	..	..	..	..	..	..	70	10	..	10	20	40	20	85	..	..
95	70	90	55	85	25	65	95	..	..	20	100	50	80	20	80	40	20	55	95
20	5	10	..	..	10	5	..	..	..	..	..	..	..	..	..	..	..	..	10
5	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3.46	4.55	..	..	..	21.1	10.5	13.8	35.1	17.4	5.45	12.3	15.4	10.4	8.89	5.20	4.41	10.5	..	..
3.6	3.6	3.8	3.9	3.7	3.8	4.0	3.7	3.9	3.8	4.0	3.8	3.7	3.9	4.1	3.8	3.8	4.1	4.2	3.8
3.8	4.0	3.8	3.9	3.8	3.8	4.0	3.7	..	3.8	4.1	3.9	4.0	3.9	4.1	3.8	3.9	4.1	4.3	3.8
..	..	..	..	..	..	4.1	3.8	..	3.8	..	4.0	4.1	4.0	4.3	3.8	..	4.1	..	..
..	..	..	4.5	..	3.9	..	..	..	..	..	..	..	..	..	..	..	..	5.0	..
3-6	2-6	..	3-7	2-5	4-8	3-8	7-8	4-8	4-6	..	2-5	4-8	5-7	4-6	8-12	5-8	2-6	2-3	3-6
gravel	gravel	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	gravel	sand	sand	clayey sand	clayey sand
P. exl.	P.can.	P. sil.	P. sil.	P. mon.	P. mon.	P. mon.	P. exl.	P. sil.	P. sil.	P. exl.	P. exl.	P. sil.	P. mon.	P.aus.	P. exl.	P. exl.	P. sil.	P. sil.	P. exl.
40	40	40	70	45[1]	45[1]	45[1]	70	60	75	95	30[2]	70	35	..	80	35[2]	70	30[1]	35[1]

Table XIII. Cladonia impexa sociation.

No.	1	2	3	4	5	6	7	8	9
Locality	Si.	Fr.	Fr.	Nø.	Fr.	Bl.	Fr.	Fr.	Du.
Empetrum nigrum	..	..	..	..	..	..	..	..	5
Deschampsia flexuosa	10	..	5	..	..	35	..	10	..
Festuca ovina	..	..	..	10	..	..	..	..	..
Blepharozia ciliaris	20	20	60	10	10	45	10	5	..
Dicranum rugosum	25	5	10	25	5	..	5	25	20
— scoparium	90	40	90	45	10	30	30	70	35
Hylocomium parietinum	65	45	90	60	35	..	85	100	35
— proliferum	10	..	5	..	..	..	..	10	..
Rhacomitrium hypnoides	..	..	..	20	40	..	..	..	..
Stereodon cupressiformis	100	90	95	90	35	55	100	50	70
Cetraria aculeata	..	..	..	..	5	5	..	..	20
— islandica	..	..	..	..	..	20	..	..	..
Cladonia impexa	90	100	95	95	100	100	100	85	90
— rangiferina	..	35	35	..	..	65	15	10	5
— rangiformis	..	..	..	..	10	..	..	..	..
— silvatica	15	..	..	..	..	..	..	..	..
— uncialis	..	..	..	..	..	..	..	..	15
Light $^0/_0$ (i)	26.0	11.4	20.0	9.87	29.2	..	21.9	23.4	ca. 80
pH of the peat	3.4	3.8	3.5	4.1	3.6	3.5	3.7	3.4	3.5
- - - —	3.5	3.8	3.6	4.1	3.7	3.6	3.7	3.8	3.7
- - - —	..	3.8	3.8	4.3	3.7	3.6	3.8*	3.9	3.7
Thickness of the peat (cm.)	1-4	4-9	3-6	3-6	1-2	0-6	5-8	4-8	3-7
Subsoil	gravel	sand	sand	sand	gravel	sand	sand	sand	sand
Species of tree	P. sil.	P. mon.	P. mon.	P. mon.	P. mon.	P. mon.	P. mon.	P. mon.	P. sil.
Age of tree	45[1]	70	70	35[1]	70	45[1]	70	70	40

* Besides pH: 3.8 and 3.8. The list of lickens is not complete.

Table XIV. Stereodon cupressiformis sociation.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Locality	Al.	Rv.	Al.	Fr.	Rn.	Si.	Sg.	Sg.	Sg.	Si.	Tv.	Bl.	Sv.	Sg.	Sg.	Sg.	Sg.	Fr.	Ti.
Picea abies	..	..	..	..	..	..	..	..	..	50	..	..	..	..	..	..	..	..	..
Pinus silvestris	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..
Calluna vulgaris	..	..	..	..	5	..	..	..	..	..	..	..	..	5	20	5	..	..	..
Empetrum nigrum	..	..	..	..	..	..	..	..	..	..	..	..	10	..	5	10	..	..	..
Erica tetralix	..	..	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..

Table XIV (continued).

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Locality	Al.	Rv.	Al.	Fr.	Rn.	Si.	Sg.	Sg.	Sg.	Si.	Tv.	Bl.	Sv.	Sg.	Sg.	Sg.	Sg.	Fr.	Ti.
Vaccinium myrtillus	5	..	..	..	..	..	..	..	..	15	..	..	..	..	..	..	..	..	..
— vitis-idaea	..	..	..	..	..	..	..	5	..	10	..	..	..	..	..	..	..	..	..
Potentilla erecta	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Trientalis europaea	..	..	..	..	..	..	..	..	..	..	..	15	..	..	..	..	..	..	..
Carex arenaria	..	35	..	..	..	..	..	..	..	..	..	..	20	..	..	..	..	..	..
— pilulifera	55	..	..	..	..	..	20	..	..	..	..	..	..	10	20	..	..	..	..
Deschampsia flexuosa	90	5	15	5	85	..	5	20	..	..	..	90	..	5	..	20	..	5	..
Amblystegium Juratzkan.	..	..	20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Blepharozia ciliaris	..	..	..	..	..	..	..	..	..	..	..	30	5	..	..	..	..	..	..
Brachythecium curtum	..	..	..	..	5	..	10	..	10	..	..	..	..	..	..	..	..	..	5
Ctenium crista-castrensis	..	..	..	..	..	..	..	5	..	..	..	..	..	5	..	5	5	10	..
Dicranum rugosum	..	..	..	..	..	30	10	20	..	..	40	10	..	..	10	5	..	..	..
— scoparium	35	40	90	20	60	85	80	60	30	35	55	50	10	15	20	55	25	20	5
— spurium	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..
Eurhynchium praelongum	..	..	..	..	..	..	..	20	..	..	..	..	..	..	..	..	..	15	..
Hylocomium loreum	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..	..	..	..
— parietinum	30	35	30	50	95	100	90	90	70	100	100	40	40	25	35	45	40	60	10
— proliferum	..	15	15	25	..	65	10	10	30	100	40	5	..	5	..	20	5	5	..
— triquetrum	..	60	..	..	..	5	..	..	..	..	5	40	5	..	..	..	..	..	..
Gymnocybe palustris	..	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..
Leucobryum glaucum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	..	..	..
Lophocolea bidentata	..	..	..	..	55	30	10	20	..	..	..	..	..	..	..	..	..	..	..
— heterophylla	..	..	10	..	..	30	5	..	35	..	..	..	..	..	..	..	..	5	..
Mnium hornum	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	5	35	..
Plagiothecium denticulat.	..	..	15	..	..	5	..	15	5	..	..	..	..	..	..	..	..	..	..
— undulatum	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	..	5	..	..
Polytrichum attenuatum	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— juniperinum	..	..	..	..	..	5	..	..	..	..	..	..	..	10	..	..	..	..	..
Scleropodium purum	100	80	45	50	80	50	..	5	..	..	..	15	..	..	..	..	..	5	..
Stereodon cupressiformis	100	90	80	75	100	100	95	100	95	100	100	100	100	100	95	100	100	100	90
Cladonia impexa	..	..	..	..	..	..	10	..	..	..	20	15	10	..	30	10	..	..	..
— rangiferina	..	..	..	..	..	..	..	..	..	..	10	..	..	..	5	..	..	..	..
— surrecta	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..	..	..	..
Light % (i)	2.62	6.25	2.45	2.84	3.37	4.34	6.97	2.44	2.94	6.00	20.7	..	16.7	12.0	11.8	7.60	..	3.08	0.93
pH of the peat	4.1	4.2	3.4	3.6	4.0	3.4	3.8	3.7	3.9	3.4	4.0	3.5	3.7	4.2	4.0	4.1	3.7	3.8	3.9
- - - —	4.2	4.3	3.6	3.9	4.0	3.6	3.8	3.8	3.9	3.5	4.0	3.6	3.7	4.3	4.0	4.2	3.9	3.9	3.9
- - - —	..	4.3	..	..	4.1	3.7	3.9	3.9	..	3.6**	4.0	3.7	3.7	..	..	..	..	3.9	..
pH of the subsoil	4.4	..	..	..	..	..	..	..	..	3.3	..	..	..	..	..	..	..	..	..
Thickness of the peat (cm.)	3-5	4-6	3-6	3-7	2-4	4-8	5-8	3-5	5-7	6-9	2-4	4-9	..	3-5	3-4	4-7	2-6	2-4	3-5
Subsoil	sand	sand	clayey sand	stony sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand	sand
Species of tree	P. sit.	P. aus.	P. exl.	P. exl.	A. pec.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. mon.	P. mon.	P. sil.	P. mon.	P. mon.	P. mon.	P. exl.	P. exl.	P. exl.
Age of tree	20[1]	60[1]	40	120	25[2]	25[2]	60	45[1]	65	40-60	40[1]	45[1]	20[1]	30[1]	30[1]	40	65	40	35[2]

* Besides: 4.3—4.4—4.4. ** Upper peat: pH 3.6.

Table XV. Luzula pilosa and moss sociations.

	Luzula— H. triq. soc.		Hylocomium triquetrum soc.				Hylocomium proliferum soc.			Dicranum majus soc.		
No.	1	2	3	4	5	6	7	8	9	10	11	12
Locality	Ti.	Ti.	Sn.	Sv.	Sn.	Sn.	Sa.	Si.	Si.	Gr.	Gr.	Gr.
Ilex aquifolium	..	..	..	..	..	..	..	..	5	..	..	..
Picea abies	..	10	..	..	20	..	..	..	80	..	..	5
Pinus silvestris	..	..	45	..	..	..	..	..	..	..	..	..
Sorbus aucuparia	..	..	..	..	5	..	..	..	..	..	..	..
Calluna vulgaris	..	..	..	..	..	..	10	..	..	..	..	..
Empetrum nigrum	..	..	..	..	..	..	5	..	..	..	..	..
Vaccinium myrtillus	..	..	..	..	..	..	..	..	10	..	..	..
Arenaria trinervia	..	..	..	..	..	5	..	..	..	..	..	..
Lactuca muralis	..	..	10	..	10	15	..	..	..	..	..	..
Listera cordata	..	..	..	20	..	..	..	..	..	..	..	..
Oxalis acetosella	95	..	..	..	..	..	..	..	..	..	..	..
Polypodium vulgare	..	..	..	..	..	..	5	..	..	..	..	..
Trientalis europaea	..	..	..	20	..	..	..	..	..	..	..	..
Veronica officinalis	..	..	..	..	5	..	..	..	..	..	..	..
Carex arenaria	55	..	80	5	..	..	10	..	..	..	..	..
Deschampsia flexuosa	60	20	100	..	..	100	..	35	10	..	..	..
Luzula pilosa	90	95	..	5	..	..	..	..	..	..	..	..
— sp.	..	..	..	5	..	..	..	..	..	..	..	..
Brachythecium curtum	10	15	..	..	55	10	..	..	..	15	20	40
Ctenium crista-castrensis	..	..	..	..	..	..	20	5	..	10	..	..
Dicranum majus	..	..	..	..	..	..	..	..	30	100	100	100
— rugosum	5	..	..	..	..	..	45	10	..	..	..	..
— scoparium	20	45	5	..	10	40	25	20	..	..	30	..
Eurhynchium praelongum	..	..	..	..	25	5	..	..	..	..	..	..
Hylocomium loreum	..	..	..	..	..	..	..	..	55	55	..	..
— parietinum	95	30	..	75	40	45	100	90	100	95	100	20
— proliferum	25	65	30	75	75	85	100	85	95	80	80	45
— triquetrum	95	100	100	100	95	90	20	..	30	10	5	15
Lophocolea bidentata	10	..	..	15	..	5	..	..	5	..	..	..
— heterophylla	..	..	..	..	75	..	..	10	25	..	20	15
Mnium rostratum	..	..	..	..	15	..	..	..	..	..	5	..
Plagiochila asplenioides	..	..	..	..	..	..	..	..	..	25	..	5
Plagiothecium denticulat.	..	..	..	..	..	..	..	..	..	..	..	5
— undulatum	..	..	..	..	..	..	..	..	25	45	55	..
Polytrichum attenuatum	..	..	..	..	..	..	..	..	..	5	5	..
Rhodobryum roseum	..	..	..	..	5	..	..	..	..	..	..	..
Scleropodium purum	50	30	100	85	60	20	70	50	25	50	..	..
Stereodon cupressiformis	100	75	5	5	10	15	..	30	15	15	25	10
Thuidium tamariscifolium	..	..	..	..	..	..	..	..	25	10	15	40
Peltigera cannina	..	..	..	10	..	..	..	..	..	..	..	..
Light % (i)	..	..	3.38	..	7.73	10.0	..	6.30	5.91	9.13	3.50	3.13
pH of the peat	3.8	4.2	4.1	4.0	4.3	3.8	4.0	3.7	3.4	3.6	3.5	3.5
- - - —	3.9	4.2	4.1	4.1	4.6	3.9	4.2	3.8	3.5	3.7	3.6	3.8
- - - —	4.1	4.4	4.3	4.1	4.7	4.0	..	..	3.5	3.8	3.8	3.8

Table XV (continued).

	Luzula—H. triq. soc.		Hylocomium triquetrum soc.				Hylocomium proliferum soc.			Dicranum majus soc.		
No.	1	2	3	4	5	6	7	8	9	10	11	12
Locality	Ti.	Ti.	Sn.	Sv.	Sn.	Sn.	Sa.	Si.	Si.	Gr	Gr.	Gr.
pH of the subsoil	..	..	4.1	..	4.2	..	..	4.9	..	..	..	..
Thickness of the peat (cm.)	5-9	4-7	8-14	..	2-6	4-7	3-7	4-7	7-10	10-15	3-8	5-10
Subsoil	sand	sand	gravel	sand	gravel	gravel	sand	stony sand	sand	clayey sand	clayey sand	clayey sand
Species of tree	P. sil.	P. sil.	P. exl.	P. sil.	P. exl.	P. exl.	P. sil.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.
Age of tree	50	50	80	30[1]	55	50	40[2]	40[1]	60	80	60	60

Table XVI. Lophocolea heterophylla sociations.

No.	1	2	3	4	5	6	7	8	9
Locality	Sn.	Gr.	Rø	Rø	Al.	Al.	Al.	Sn.	Sg.
Abies alba	..	..	..	..	..	..	..	10	..
Vaccinium myrtillus	..	..	..	..	..	..	5	..	..
Brachythecium curtum	15	5	15	..	..	20	..	..	5
Dicranum scoparium	..	20	..	..	5	25	..	..	..
Eurhynchium praelongum	..	..	..	..	..	..	..	5	10
Hylocomium parietinum	..	5	..	..	..	10	..	..	..
Lophocolea heterophylla	55	30	95	45	95	90	15	30	..
Plagiothecium denticulatum	10	45	55	30	85	100	20	..	..
Polytrichum attenuatum	..	..	..	..	..	5	..	..	..
Scleropodium purum	..	..	..	..	..	5	..	..	..
Stereodon cupressiformis	..	..	20	30	50	95	55	5	20
Thuidium tamariscifolium	..	..	..	..	..	..	10	..	..
Light $^0/_0$ (i)	..	1.84	0.45	0.37	1.58	2.92	1.43	1.38	0.65
pH of the peat	3.8	3.8	3.7	3.6	3.7	3.7	3.4	3.8	4.0
- - - —	3.9	3.8	3.7	..	3.7	3.7	3.5	4.0	4.0
- - - —	..	3.8	3.9	..	..	3.7	..	4.1	..
pH of the subsoil	..	..	..	5.0*	..	..	3.9	..	..
Thickness of the peat (cm.)	7-10	4-8	4-6	6-8	4-6	3-5	5-8	5-7	1-3
Subsoil	gravel	clayey sand	clayey sand	clayey sand	clayey sand	sand	sand	gravel	sand
Species of tree	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	P. exl.	A. pec.	P. exl.
Age of tree	35[2]	40[2]	70	80	65	50[2]	50[2]	20[2]	35[1]

* In a depth of 10 cm.: pH. 4.3.

Table XVII.

	Rubus—Holcus lanatus soc.	Anthoxanthum odoratum soc.	Dryopteris dilatata soc.	Equisetum silv.—Holcus lanatus soc.	Molinia coerulea soc.	Deschampsia caespitosa soc.	Carex hirta soc.	Holcus mollis soc.
No.	1	2	3	4	5	6	7	8
Locality	Rø	Rø	Rø	Rø	Al.	Al.	Al.	Fr.
Lonicera periclymenum	95	100	..	100	..	..	..	..
Rubus fruticosus	..	..	5	..	..	..	..	..
— idaeus	95	30	40	35	..	20	..	..
Calluna vulgaris	..	..	..	..	10	..	..	..
Arenaria trinervia	..	..	5	..	..	..	..	..
Campanula rotundifolia	..	..	..	..	..	..	..	10
Dryopteris dilatata	10	..	60	35	..	30	..	..
— filix-mas	..	..	..	..	..	5	..	..
Equisetum arvense	..	..	..	..	..	5	..	..
— silvaticum	..	..	..	50	..	..	..	..
Galeopsis tetrahit	..	..	5	..	..	..	..	..
Galium boreale	..	..	..	..	5	..	..	..
— harcynicum	..	..	..	..	..	..	..	5
— uliginosum	..	..	..	..	..	5	..	..
Geranium Robertianum	..	..	10	..	..	..	..	..
Hypericum maculatum	..	..	..	..	5	..	..	..
— pulcrum	..	..	..	..	..	..	..	15
Lactuca muralis	..	..	..	15	..	..	5	..
Lathyrus montanus	..	..	..	..	15	..	..	..
— pratensis	..	..	..	..	..	10	..	..
Majanthemum bifolium	..	..	..	70	..	..	..	..
Oxalis acetosella	10	..	15	40	..	100	..	..
Pirola minor	..	..	..	..	10	..	..	..
Potentilla erecta	..	5	..	25	45	..	5	..
Stellaria graminea	..	..	..	..	..	10	..	..
— media	5	..	..	..	..	..	..	..
Urtica dioeca	10	..	..	..	..	..	..	..
Veronica officininalis	..	..	..	..	..	5	..	..
Viola canina	..	..	..	..	..	..	..	5
— silvestris	50	..	..	..	..	..	..	..
Agrostis stolonifera	..	..	..	5	40	100	10	85
— tenuis	..	..	..	..	..	..	..	5
Anthoxanthum odoratum	50	100	..	15	5	..	..	..
Carex arenaria	..	..	..	..	..	..	..	5
— hirta	..	..	..	..	..	55	100	..
— pallescens	..	..	..	..	5	..	..	..
— panicea	..	..	..	5	..	15	..	..
— pilulifera	..	10	..	..	5	..	..	..
— sp.	..	..	..	..	..	5	..	..
Dactylis glomerata	..	..	..	..	5	..	5	..

Table XVII (continued).

	Rubus—Holcus lanatus soc.	Anthoxanthum odoratum soc.	Dryopteris dilatata soc.	Equisetum silv.—Holcus lanatus soc.	Molinia coerulea soc.	Deschampsia caespitosa soc.	Carex hirta soc.	Holcus mollis soc.
No.	1	2	3	4	5	6	7	8
Locality	Rø	Rø	Rø	Rø	Al.	Al.	Al.	Fr.
Deschampsia caespitosa	..	..	..	20	..	95	..	..
— flexuosa	25	100	5	40	55	15	70	20
Holcus lanatus	85	90	..	45	25	10	10	..
— mollis	..	20	..	..	..	..	..	95
Juncus conglomeratus	..	..	..	..	5	25	..	..
Luzula multiflora	..	..	..	..	..	..	..	10
— pilosa	..	..	10	..	..	..	..	..
Melica uniflora	..	..	25	..	..	..	..	..
Molinia coerulea	..	..	..	55	90	10	..	..
Nardus strictus	..	..	..	..	..	15	..	..
Poa pratensis	..	..	..	..	..	..	..	10
Blepharozia ciliaris	..	..	..	..	..	..	..	5
Brachythecium curtum	30	15	95	40	15	..	45	..
Catharinaea undulata	..	..	15	..	..	..	..	..
Dicranum scoparium	..	..	..	..	..	..	..	5
Eurhynchium praelongum	..	..	10	..	..	..	..	..
— striatum	..	..	..	..	..	..	..	10
Hylocomium parietinum	..	..	10	..	..	..	..	85
— proliferum	..	..	20	10	..	..	..	..
— squarrosum	..	..	5	..	..	30	..	..
— triquetrum	..	..	35	..	..	..	..	..
Lophocolea bidentata	90	30	20	40	15	..	60	..
Mnium rostratum	..	..	80	..	..	..	..	..
Plagiothecium denticulatum	..	5	25	5	..	..	..	..
— repens	..	..	15	..	..	..	..	..
— silvaticum	..	..	20	5	5	..	..	..
Polytrichum attenuatum	..	..	20	..	5	..	..	..
Scleropodium purum	90	95	75	60	95	65	70	..
Stereodon cupressiformis	..	..	10	5	5	..	..	55
Thuidium tamariscifolium	..	..	55	5	..	5	..	..
Light $^0/_0$ (i)	15.4	34.6	9.00	13.9	..	42.3	14.8	20.2
pH of the surface soil	4.4	4.6	3.5	4.5	4.6	5.2	4.3	3.6
- - - — -	4.5	4.7	3.6	4.8	4.8	5.4	4.3	3.7
- - - — -	..	4.8	3.6	4.9	..	..	4.4	..
pH of the subsoil	..	..	..	5.8	5.5	5.8	..	..
Thickness of the peat (cm.)	..	..	..	..	..	..	2-6	2-4
Subsoil	clayey sand	clayey sand	clayey sand	clayey sand	clayey sand	clayey sand	sand	sand
Species of tree	P. sil.	P. sil.	A. pec.	P. sil.	P. sil.	P. sil.	P. sil.	P. sil.
Age of tree	80	80	100	80	30[1]	60	60	40[1]

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Fig. 1. *Rubus idaeus—Brachythecium curtum—Oxalis acetosella* sociation rich in *Milium effusum*. Table I, 6. Grib Forest.

Fig. 2. *Pteridium aquilinum—Vaccinium myrtillus* sociation. Table V, 1—2. Silkeborg.

Populations of *Cladonia impexa*, *Hylocomium parietinum*, and *Deschampsia flexuosa—Calluna* (Example 13, p. 35). At bottom, left, *Polypodium vulgare* and *Rumex acetosella*. South is to the left in the figure.

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