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Cover Figure:
The sloping mire of Vuossoiva in Savukoski, summer 1982. Photo by Kauko Holappa.

Mire type succession, peat properties and mire plant ecology in Northern Ostrobothnia, Kainuu and Koillismaa, Northern Finland

ABSTRACT

A study is made of the mires of the Northern Ostrobothnia, Kainuu and Koillismaa regions of Northern Finland, their typology and peat stratigraphy. These mires are located between 64° and 66°N lat. and 24° and 30°E long., at the transition between the middle and northern boreal vegetation zones.

Almost a half of the thickness of peat in the mires of the region was deposited before the arrival of spruce (*Picea*), although there are places in the western parts where the whole peat deposit was laid down since that time, and the majority of the mires in the coastal strip are of primary origin. The mires began to develop thick layers of *Sphagnum* mosses as the macroclimate became cooler and damper, and the dynamic character of the mire type succession visible in the peat stratigraphy can be attributed very largely to fluctuations in the water content and pH of the peat. No less than seven phases characterized by distinct mire types can be recognized in the history of the mires of this region.

By combining recent mire types with ecologically similar ones observable from subfossil evidence it was possible to reduce the overall number to 15 types that could be distinguished in the various horizons on the grounds of their mean botanical composition, the physical properties of their peat and the element concentrations in the peat ash and certain correlations between these.

As peat becomes more humified the proportions of plant remains in it decrease and the percentage of amorphous biomass of grain size <0.125 mm increases in a manner that correlates linearly ($r^2 = 0.99$) with the degree of humification as defined by von Post (1922). Correspondingly, the proportion of very slowly decomposing plant material that is still recognizable will increase in well humified peat. The accumulation of plant remains observes certain models in relation to the degree of humification that enable the latter to be deduced if one knows the proportions of the various plants. Similarly the peat-forming factors are dependent on the depth of the peat in the mire.

On account of the mire margin and centre effects, and also differences in the nature of the bedrock, the physical properties of peat and the geochemical properties of its ash can vary widely. Greater element concentrations will be found in mire types with a margin effect than in those with a centre effect, for example, while mesotrophic and eutrophic mires with a margin effect will contain peat with higher than average dry densities. Likewise, Fe, Ca, Mg, Al and P concentrations in peat will differ between ombrotrophic and minerotrophic conditions, and present-day surface mire types will possess higher element concentrations than the corresponding types when they occur at the base of a mire.

The effects of soils and bedrock on mires and their ecology are manifested more accurately by plant species than by families or other groupings, most of which are middling or indifferent with respect to nutrients. This work attempts for the first time to define a set of bioindicator values, or ecological niches, for almost 200 mire plant species to describe the ecology of mires and their peat. This uses information on dry density (kg/m^3), water content (%), H_{1-10}, amorphous matter (%), organic matter (%), ash content (%), pH, mV, Al, Ca, Mg, K, Na, P, Fe, Mn, Cu, Pb and Zn.

The geochemistry of peat ash and its Cu, Zn and Pb concentrations could be particularly useful for ore prospecting, as high concentrations are clearly restricted to certain areas. The findings point to a number of sites in the region where heavy metal concentrations in the peat are exceptionally high, and could thus lead to ore prospecting as well as to further research in the fields of mire ecology, the evaluation of peatland environments and vegetational history.

Key words: paludification, mire type, succession, humification, trophy, margin/centre effects, peat properties, bioindicator

Pohjois-Pohjanmaan, Kainuun ja Koillismaan suotyyppien sukkessio, turpeiden ominaisuudet ja suokasvien ekologia

FINNISH ABSTRACT

Tässä työssä tutkittiin Pohjois-Pohjanmaan, Kainuun ja Koillismaan soiden suotyyppejä ja niiden turvekerrostumia. Suot sijaitsevat 64º - 66º pohjoisten leveyspiirien ja 24º - 30º itäisten pituuspiirien rajaamalla alueella, joka on keski- ja pohjoisboreaalisten kasvillisuusvyöhykkeiden vaihettumisaluetta.

Suurin osa rannikkoalueen soista on primääristä alkuperää. Tutkimusalueella lähes puolet soiden turpeen paksuudesta muodostui ennen kuusen (*Picea*) tuloa seudulle. Sen jälkeen kehittyi länsiosiin paikoin koko turvekerrostuma. Suot alkoivat voimakkaasti rahkoittua suurilmaston viiletessä ja muuttuessa kosteammaksi. Turvestratigrafiasta tunnistettujen eri suotyyppivaiheiden sukkession dynaamisuus on selitettävissä turpeiden vesipitoisuuksien ja pH-arvojen avulla. Suon kehityshistoria rakentuu jopa seitsemästä eri suotyyppivaiheesta.

Tutkimusalueella esiintyy useita kymmeniä suotyyppejä, joista ekologisesti samankaltaiset resentit ja subfossiiliset suotyypit yhdistettiin 15 eri tyyppikerrostumaksi. Niiden keskimääräinen botaaninen koostumus, turpeiden fysikaaliset ominaisuudet sekä turpeen tuhkan alkuainepitoisuudet ja korrelaatiot poikkeavat toisistaan verrattaessa eri kerrostumia.

Turpeen maatuessa kasvijäännöksien suhteelliset osuudet pienenevät, jolloin turpeeseen muodostuu amorfista <0,125 mm kasvimassaa, joka korreloi lineaarisesti v. Postin (1922) maatumisasteiden kanssa (r^2 0,99). Vastaavasti erittäin hitaasti maatuvien ja vielä tunnistettavissa olevien suokasvien suhteellinen osuus nousee pitkälle maatuneissa turpeissa. Kasvijäännöksien kertymät turpeeseen ja maatumisaste noudattivat tiettyjä malleja, kun tiedetään turvenäytteestä eri kasvien suhteelliset osuudet (%) ja v. Postin maatumisaste. Myös syvyyden ja eri turvetekijäin välillä on selkeä riippuvuus. Meso- ja eutrofisissa reunavaikutteisissa suotyypeissä on keskimääräistä korkeammat kuivatiheydet.

Reuna- ja keskustavaikutteisuudesta kuin myös suoalueen kallioperän erilaisuudesta johtuen suotyyppien fysikaaliset ominaisuudet ja turvetuhkan geokemialliset pitoisuudet vaihtelevat laajalla vaihteluvälillä. Myös ombrotrofia erottuu minerotrofiasta turpeen geokemiassa Fe-, Ca-, Mg-, Al- ja P-pitoisuuksien osalta. Nykyisten suotyyppien pintaturpeissa on korkeammat alkuainepitoisuudet kuin samaan suotyyppikerrostumaan kuuluvassa pohjaosassa. Reunavaikutteisiin suotyyppeihin konsentroituu selvästi suuremmat alkuainepitoisuudet kuin keskustavaikutteisiin.

Maa- ja kallioperän vaikutusta soihin sekä suotyyppien ekologiaan ilmentävät eri kasvilajit tarkemmin kuin kasviheimo tai -ryhmä, jotka ovat pääasiassa keskiravinteisia ja indifferenttejä. Makrosubfossiilien avulla sekä kasvisolukoista tunnistetuille turvetta muodostaneelle lähes 200 eri kasvilajille on määritelty ensimmäistä kertaa suon ja turpeen ekologiaa kuvaava keskimääräinen bioindikaatioarvo, ns. ekologinen lokero (kuiva-kg/m^3, v %, H_{1-10}, amorf. %, org. %, T %, pH, mV, Al, Ca, Mg, K, Na, P, Fe, Mn, Cu, Pb, Zn).

Erityisesti turpeiden tuhkien geokemia ja Cu-, Zn-, Pb-pitoisuudet antavat viitteitä myös malminetsintään, koska korkeat pitoisuudet rajoittuvat selkeästi tietyille alueille. Tuloksien perusteella tutkimusalueella on useita kohteita, joissa turpeissa esiintyy poikkeuksellisen korkeita raskasmetallipitoisuuksia.

Tutkimustuloksia voitanee soveltaa erilaisiin suoekologisiin jatkotutkimuksiin, suoympäristön laadun ja tilan arvioimiseen, kasvillisuushistorian tutkimuksiin sekä malminetsintään.

Avainsanat: soistuminen, suotyyppi, sukkessio, maatuminen, trofia, reuna-keskustavaikutus,turpeen ominaisuus,

Mire type succession, peat properties and mire plant ecology in Northern Ostrobothnia, Kainuu and Koillismaa, Northern Finland

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1. INTRODUCTION

The general aim of this work was to gather new information on the mires of Northern Ostrobothnia and the Kainuu and Koillismaa regions and the mire types that these represent. Specific answers were thus sought to the following questions: 1) How does the succession between the mire types of this area run? 2) What natural ecological groupings emerge when we combine the present mire vegetation with that deducible from the underlying peat? 3) How do these combinations fit in with the physical and chemical properties of the present and humified vegetation? 4) How can the information obtained in this way be used to define the composition and degree of humification of the peat? 5) What effects do the basal deposits underlying a mire have on the characteristics of its peat? 6) What ecological niches can the mire plants identified in samples be assigned to on the basis of their physical and geochemical properties? 7) What opportunities exist for making use of peat chemistry for ore exploration purposes?

In geological research the present holds the key to the past, i.e. by studying geological processes taking place today we can gain an insight into developments that occurred in nature in past times. As noted by Birks & Birks (1980), past developments and the processes associated with them can be investigated by describing geological deposits and their units or the organisms contained in them and reconstructing the environments in which past populations lived on the basis of the occurrence of key fossil species.

This work will thus employ the current vegetation patterns of the mires and related ecological information as keys to past events and to the peat geology implicated in their development, taking the vegetation of the present-day mire type and the peat deposit generated by it to represent the last stage in the mire type succession in each case.

Mire formation

The aapa mires of Northern Finland with all their characteristic features are a unique legacy of nature, and it is very probable that the most representative and best preserved of these will at some stage be added to the UNESCO World Heritage list as part of the Green Belt of Fennoscandia (www.environment.fi Press Release 22.1.2004. Ministry of the Environment).

Finland belongs to the circumpolar boreal biome, characterized by mires and coniferous forests, a continuous zone of taiga forests that is located south of the Arctic region, and is divided into the Northern Boreal, Middle Boreal and Southern Boreal zones within the area of this country. About

90% of the world's mires are to be found in Fennoscandia, Russia or Canada (Maltby & Proctor 1996, Immirzi et al. 1992), and it is clear that the humidity of the climate and the flatness of the terrain do much to promote the formation of mires in the boreal region. The mires of the taiga zone are chiefly of the aapa type – swampy fens and various spruce mires and pine bogs, while palsas are to be found in many places on the edges of the tundra. Raised bogs exist in the southern parts of the Boreal zone, but not in the more continental areas (Havas 1999), while mire formation is most pronounced in the Middle Arctic and Boreal zones (Eurola 1992).

Mires are initiated through the formation of peat, i.e. the sedimentation of decomposing mire plants *in situ* to form an inhomogeneous humus layer, at least 75% of the dry weight of which will be organic in origin (Virtanen et al. 2003). Other definitions specify that peat is an organic material in which more than 65% (by weight) is partially decomposed plant matter and 20–35% ash. On the other hand, peat is known to comprise 88–97% water, 2–10 dry matter and 1–7% gas (Charman 2002; Clymo 1983; Heathwaite et al.1993a).

When the continental ice sheet retreated about 10000 BP cal, the western half of Finland was covered by water. Subsequently the land uplift brought about by the melting of the glacier exposed a watery mineral soil that gradually began to undergo primary mire formation, as was also the case to some extent in the supra-aquatic area on the shores of the ice lake that had remained unaffected by the preceding marine phase. This land uplift is in fact still going on, amounting to a mean rise of 8 mm per year on the coast of the Bothnian Bay and about 5 mm per year close to the eastern border of Finland (Eronen 1983; Winterhalter et al. 1981).

The proportion of primary mire formation in the supra-aquatic parts of the country was 40% during the period immediately following the melting of the ice sheet, whereas paludification of forest land became more prominent (50%) from 6900–5900 BP cal onwards and some of the water basins (10–20%) became overgrown by vegetation during the period 5900–3200 BP cal (Huikari 1956; Korhola & Tolonen 1998). Following the Ancylus Lake period in the history of the Baltic, low-lying land that was exposed from beneath the water on the coastal plains of Northern Ostrobothnia underwent extensive primary mire formation (about 60%), so that the first peat deposits to be laid down were composed of plants that were adapted to watery conditions but had spread onto the mineral soils. By contrast, the proportion of mires resulting from paludification of forest soils diminished, to 35% in the period 3200–1250 BP cal, and that resulting from the in-filling of water basins to 5% in the period 5900–3200 BP cal. All in all, fluctuations in the rates of peat have taken place throughout the post-glacial era on account of changes in the macroclimate, shoreline displacement, forest fires, local topographic features, the extent of land uplift and discharge conditions in the waterways (Huikari 1956; Korhola 1995, 1996; Korhola & Tolonen 1998). The oldest mires in the region concerned here are located at altitudes of 150–300 m a.s.l. in Northern Finland and the youngest on the Bothnian Bay coast (Mäkilä & Muurinen 2008). The mean rate of peat accumulation over the whole country is 0.32 mm per year, with separate figures of 0.25 mm for aapa mires and 0.59 mm for raised bogs (Mäkilä & Toivonen 2004).

Classification of mires

Finland is traditionally divided into three regions with respect to the characteristic flora of each mire type and the observed combinations of types: these are known as the aapa mire, raised bog and palsa regions (Ruuhijärvi 1960; Eurola 1962). Likewise, some 80 distinct plant communities have been recognised as mire types (Eurola & Kaakinen 1978; Eurola et al. 1995). Correspondingly, research into forested mires has led to the recognition of 32 types (Laine & Vasander 1990, 2005). Alongside these schemes, Nordic mire classifications have also been proposed (Kaakinen 1980; Vegetationstyper i Norden, 1994; Tuominen et al. 2001), and Laitinen et al. (2007) have set out a Combined Finnish Mire Typology (CFMT) which links the mire complex concept put forward by Cajander (1913) with the notion of a climatic zonation of mire complexes. In addition, a zonational Mire Water Flow Typology (MWFT) has been proposed for boreal mire systems.

In his classic work of 1913, Cajander distinguished the four mire types that have traditionally been taken as the basis for Finnish mire research: spruce mires, pine bogs, flark fens and rich fens. Likewise, Auer (1923, 1924) made a significant contribution by determining the history of mires over a large part of Finland on the basis of pollen data. All in all, mires and both the development and composition of the peat contained in them have been studied extensively in various parts of Finland by numerous authors (Herlin 1896; Andersson 1898; Lindberg 1901, 1910; Kujala 1924; Waren 1924; Metsävainio 1931; Aario 1932; Lukkala 1920, 1920, 1933; Backman 1919, 1935, 1935; Brant 1948; Heikurainen & Huikari 1952; Ruuhijärvi 1960; Havas 1961; Vasari 1962; Aartolahti 1965; Tolonen 1967; Päivänen 1969, 1973; Lappalainen 1970; Korhola 1990, 1995; Tikkanen & Korhola, 1993; Berglund et al. 1996; Laine et al. 1996; Mäkilä 1997; Mäkilä et al. 2001; Mäkilä & Moisanen 2007). Radiocarbon dating has been used to obtain information on mire formation and the history of individual mires (Mäkilä & Muurinen 2008, Mäkilä et al.2009), while the exploitation of peat reserves for various purposes has generated means of carrying out not only peat inventories but also assessments of peat types, degrees of humification, ash content and various physical and chemical properties of peat (Zailer & Wilk 1907; Salmi 1950, 1955, 1958; Mäkilä 1980, 1984, 1994; Sillanpää 1972, 1975; Tolonen 1974, 1977, 1984; Tolonen & Hosiaisluoma 1978; Pakarinen & Tolonen 1977; Elomaa 1981; Urvas 1980; Westman 1981; Yliruokanen 1980). Geophysical methods have also been used to construct three-dimensional representations of the structure of given mires (see Hänninen & Lappalainen 1987; Hänninen 1992).

The nutrient content of the water in mires is clearly related to their growth through peat accumulation, since the transport of nutrients into the upper layers diminishes as the thickness of the peat increases (Ramann 1895), with the consequence that the nutrient economy of a mire will tend to shift from eutrophic to ombrotrophic with time (Weber 1902; Melin 1917; Kotilainen 1927). Similarly, the oxygen-deficient standing water in mire pools on level terrain will contain less available nitrogen than the surface water on sloping mires (Hesselman 1924; Olsen 1921). The water balance in mires has often been identified as a crucial factor in their growth (Moore & Bellamy 1974; Clymo 1983; Ingram 1983). Malmer (1975), on the other hand, emphasizes the importance of microtopography, the margins and central parts of mires, the series of ombrotrophic and minerotrophic mire types and the distance of each mire from the sea when describing hydrotopographic mire types, whereas Rybnicek (1985) regards the amount and nature of the water in a mire as the principal external factor determining the course of mire formation, while the geological character of the base of the mire exercises a mostly indirect influence. The nature and structure of the peat laid down in a mire will mostly be dependent on the plant community making up the peat, particularly its ability to bind nitrogen and phosphorus prior to the next stage in the development of the mire. This leads in turn to a natural succession in which each mire vegetation community alters and destroys itself.

Extensive geographical links exist between mire vegetation communities, so that there are very few endemic species and many vascular plants occurring on mires are highly adaptable in terms of trophic conditions. Conductivity measurements alone have sufficed to demonstrate variations in electrolyte concentrations both regionally and between different surfaces on the same mire (Havas 1963, Puranen et al. 1999).

Walker (1970), who employed data derived from 159 sampling points to demonstrate a progression in the development of mires in Britain, distinguished 12 plant communities that occurred on the path from a stretch of open water to the establishment of a raised bog. In the course of such a progression the mire types may be exchanged for almost any other mire type after only a short period of deposition. Similarly, the palaeobotanical model of Rybnicek & Rybnickova (1974) involves an 8-phase succession from an aquatic vegetation to a dry thin-peat pine forest, while another study based on stratigraphical analyses points to the existence of 7 genetic deposition types (Lishtvan et al. 1982).

A statistical clustering procedure (alternating groups) applied to data on a swampy sedge fen yielded a total of 11 phases in its development, leading Blytt (1886) to attribute the vegetational succession in a mire to changes in the macroclimate, a model that was later filled out by Sernander (1890) with the help of macrosubfossils. The resulting Blytt-Sernander terminology was subsequently used by Mangerud et al. (1974) to put forward a set of radiocarbon (C^{14}) chronozones as a Quaternary stratigraphy for Boreal areas, the climatic optimum for which was located in the period 6900–4900 BP cal, after which a cooling took place in accordance with the Blytt-Sernander model up to around 3800 BP cal (Seppä 1995).

A number of approaches to the classification of mires are possible, based on characteristics such as their flora, the structure and physiognomy of their vegetation, their morphology, hydrology or stratigraphy, and the physical or geochemical properties of their peat, and most of these classifications are interrelated in one way or another. All these approaches may be used to describe and classify mires, peats and peat deposition processes, as also can other methods, but most commonly it is the degree of humification and the nature of the plant remains that are used as the basis for the classification of peats (Moore 1984b; Lappalainen et al. 1984), while floristic classifications are based on the Central European "physicochemical" approach (Grosse-Brauckmann 1974b, 1976) which analyses the vegetation in terms of the hydrology of the mire and the nutrient status of the peat, based on physicochemical reactions and cation concentrations, mire margin and centre effects and the micro- and macrotypology of the mire. This dual system can also serve as a basis for the classification of mire vegetation (Huttunen 1984). All the above-mentioned factors affect the botanical composition of a peat, i.e. the occurrence, degree of humification and trophic status of the constituent plant remains.

In the opinion of Wells & Zoltain (1985), the Canadian Wetland Classification System (CWCS) is applicable throughout the Northern Hemisphere, since the range of plant species involved and the ecological and morphological nomenclature for mire types are very much the same as in Finland and Russia. Thus, where Boelter (1969) defines the main body of a coarse peat as the >0.1 mm fraction, Sneddon et al. (1971) require a diameter of >0.15 mm. Similarly, the decomposition of lignin-rich plant matter gives rise to slowly dispersing humic acids that contain aromatic fragments, whereas low-lignin plants yield humic acids containing carbohydrates and proteins which are relatively stable in the face of decomposition and deposition (Lishtvan et al. 1982).

It has been observed in the mires of North-Western and Central Europe, for instance, that boundaries referred to as “recurrence surfaces” (*Grenzhorizont*), between “black peat” and “white peat” (Weber 1911; Granlund 1932; Schneekloth 1965, 1968) tend to form on account of the transport of nutrients or variations in the climate. Frenzelin (1983), on the other hand, points out that differences in mire types cannot be used directly for reconstructing palaeoclimates, and Heathwaite et al. (1990) claim that is it virtually impossible to detect the contribution of climatic effects to autogenic changes taking place in the hydrology, geochemistry and ecology of mires in the course of their development.

Wheeler & Proctor (2000) propose that a cluster of principal gradients of variation involving minerotrophic-ombrotrophic, acid-basic, nutrient level, water level, lithotrophic-oceanic, marginal-central, peat depth and groundwater influence, swampiness and climatic and other factors should be applied to the study of mires in North-Western Europe. Correspondingly, Økland et al. (2001) recognize two universally important gradients in the ecology of mires, nutrient status (poor/rich) and water level, two principal regional gradients, treeless/forested and the availability of phosphorus and nutrients, i.e. productivity, and five locally significant gradients, groundwater influence/flooding/paludification, salinity, peat accumulation capacity, microtopography and stability of the snow cover.

Most mire and peat classifications that have been proposed are genetic in nature, except for that of Troels-Smith (1955), which was the first broad-based descriptive system to be devised for use in the field and allows for the analysis of organic sediments possessing a wide variety of inherent properties. Mire deposits are repeatedly found to be mixtures of different peat characteristics (Birks & Birks 1980). The Finnish system for the classification of peats nevertheless follows in broad outline that laid down by the International Peat Society (IPS; see also Kivinen 1976; Lappalainen et al. 1984).

Geochemistry of mires

Under normal conditions the organic materials in soils usually carry a negative charge, as do the oxides of manganese (Rose et al. 1979, Heikkinen 2000), and ions with a higher charge bind more readily and more efficiently that those with a weaker charge (Alloway 1992). The principal factor in the release of metals under reducing conditions is their dissolution to form oxyhydroxides, whereupon the ions have weaker charges than under oxidative conditions, when their solubility increases and binding decreases (Chuan et al. 1996, Heikkinen 2000). Thus cations are retained under oxidative and neutral or alkaline conditions and anions correspondingly under oxidative and acidic conditions. Consequently a high proportion of the metals in a reducing environment are bound to sulphides or precipitated with them (Rose et al. 1989).

Organometal complexes and chelates are more stable than inorganic compounds or metal-ion complexes (Harmsen 1977; Plant & Raiswell 1983; Yong et al. 1992; Heikkinen 2000). Iron and manganese, for example, are in divalent form at + 400 mV (Sikora & Keeney 1983) and behave in a very similar manner, except that manganese reduces more readily than iron but is more difficult to oxidize (Lindholm 2005; Mackereth 1966), to the extent that the ratio of iron to manganese can be used as a measure of redox potential. In waterways a rise in this ratio is indicative of eutrophication, whereupon the prevailing conditions tend to favour reduction (Lindholm 2005; Myllymaa & Murtoniemi 1986; Heikkilä 1999). Peats with a high iron concentration can also contain a large amount of uranium, the solubility of which is 2–3 times higher at pH 7.5–7.8 than at pH 5.5 (Kochenov et al. 1965). Mineral precipitations in mires frequently contain iron in various forms such as siderite ($FeCO_3$), goethite ($FeO*OH$) or vivianite ($Fe_3(PO_4)_2*8H_2O$) (Virtanen 1994, Bgatov et al. 1986).

The sorption properties of elements are greatly affected by the acidity of the soil (Heikkinen 2000; Bourg 1988; Salomons 1995; Chuan et al. 1996) and the influence of an alkaline bedrock can also be reflected in the pH of the overlying peat (Salmi 1958). Similarly, copper, zinc and lead in soil become soluble under both alkaline and acidic conditions (Kabata-Pendias & Pendias 1992; Alloway 1995a; Wilson & Bell 1996; Heikkinen 2000). Reducing conditions prevail in groundwater zones and the proportion of oxygen will decrease, leading to a lower redox potential (Heikkinen 2000).

Where humic substances such as humin, humic acids, fulvic acids, polysaccharides, proteins, peptides and aminoacids and inorganic chloride, phosphate and carbonate ions contain reactive groups, i.e. -COOH, -OH, -OCH, $-NH_2$, =N, -SH and -C=O (Yong *et al*. 1992, Heikkinen 2000), organic substances mostly form inner ring complexes with metals. Fulvic acids contain more reactive carbonate groups, however, and are thus extremely efficient at forming complexes (Schnitzer 1978; Hartikainen 1996; Heikkinen 2000). The stability of organic complexes, on the other hand, is partly brought about by the numbers and chemical characteristics of their atoms, the number of rings in a chelate, the chemistry of a metal, pH, oxidation-reduction conditions, ion exchange and microbial activity in the soil (Harmsen 1977; Schulin *et al*. 1995; Heikkinen 2000).

Chelates are the most stable of all organometalic complexes (Rose *et al*. 1979; Yong *et al*. 1992; Heikkinen 2000), the number of compounds present being dependent on the properties of the bedrock and surficial deposits in the area concerned and the composition of the rainwater. Soil waters in coastal areas, for instance, contain large amounts of chloride and sulphate ions (Moore & Bellamy 1974; Lahermo et al. 1990; Heikkinen 2000). The attachment of metals to colloids and their subsequent transport together with these will depend on factors such as the amounts of colloids and water in the soil and the acidity, oxidation-reduction conditions and water permeability of the peat or soil (Heikkinen 2000). The most common sulphide mineral to be found in till is a pyrite that has been partly altered to goethite, and pyrite has also been encountered in places in peat, together with chalcopyrite, covellite and metallic copper (Lett & Fletcher 1980).

There is less inorganic material by volume in peat than in mineral soil (Sillanpää 1975), while most heavy metals are retained best in soils that are neutral or alkaline and are leached out as the pH decreases (Kabata-Pendias & Pendias 1992; Alloway 1995; Wilson & Bell 1996; Heikkinen 2000). By contrast, the presence of calciferous seams in the bedrock will suffice to raise the pH of the overlying peat to levels close to neutral (Salmi 1958, 1967).

Minerals can dissolve to some extent in groundwater and in organic acids derived from humus, which in turn means that elements that have been transported in water will become enriched in the vegetation as a consequence of evaporation, with some plants attracting certain elements to a greater extent than others. Thus zinc tends to accumulate in the violet *Viola calaminaris* and the moss *Pohlia wahlenbergii*, for instance (Jonasson *et al*. 1983), and gold in the field horsetail, *Equisetum arvense* (Salmi 1955). In the case of peat horizons, however, the high level of the groundwater and shoreline plants tend to be ones that, by virtue of their aerenchymatous cells, are able to tolerate larger amounts of ferrous iron than is the case with true dry land plants (Eurola 1992). In fields created on drained mires, for example, the change in elemental accumulations in timothy grass, *Phleum pratense,* can still be seen 13 years later (Erviö 1989). Similarly, the concentrations of various elements in the dwarf shrubs *Vaccinium vitis-idaea*, *V. myrtillus*, *V. uliginosum* and *Empetrum nigrum* coll. growing in troughs ploughed in regeneration forests and in unploughed areas vary in an irregular manner, except for iron and aluminium, which accumulate more markedly in dwarf shrubs growing on the bottoms of troughs and on the crests of ridges (Sepponen 1989). It has also been noted that heavy metals deposited by rainfall are capable of causing changes in the geochemistry of soils (Kubin 1989), leading to abnormally high concentrations in plants. Element concentrations in mire plants have also been studied in Jämtland (Malmer & Sjörs 1955), and high copper accumulations have been reported in the mosses *Pohlia nutans* and *Scapania* in Canada (Beschel 1959; Fraser 1961). Likewise crystals of framboidal pyrite formed from iron hydroxides have been observed in *Sphagnum* and *Mnium* mosses (Papunen 1966).

Trophic (nutrient) levels in mires

The terms minerotrophic and ombrotrophic have been used in connection with mire research since the 1950s (Viro 1955; Ruuhijärvi 1960; Eurola 1962) and in Finland, Sweden and Central Europe since the earlier part of the last century (see, for instance, Ruuhijärvi 1960), but the definitions of the given nutrient levels have varied from one country to another (Table 1). If a mire has a Ca/Mg ratio of <1.0, it may alter from a minerotrophic mire affected by flowing water to become ombrotrophic, but it will never be totally influenced by flowing water (Moore & Bellamy 1974). In fact, the ratio is not always as low as this even in ombrotrophic peats, although these may occur in the interior parts of Fennoscandia, possibly on account of human-induced calcium enrichment or a naturally high concentration (Sonesson 1970). In spite of the difference in geochemical composition between ombrotrophic and minerotrophic mires, high concentrations of Ca, Mg, Fe, Al and Si may be found in the surface horizons of mires due to environmental factors or secondary disturbances (Mörnsjö 1968).

The nutrient content of a peat may thus represent the sum of numerous physico-chemical growth factors that can be defined as including climatic factors, acidity, electrical conductivity (electrolyte content), the amounts of certain specific nutrients present, peat depth and, in the case of mires in a natural state, also water mobility (nutrient inputs) and water level. This trophic level indicates the ease with which plants can obtain nutrients, which can be influenced by the acidity of the peat, as plant species growing on an acidic substrate must have a high exchange capacity. Acidity, in turn, will be affected by the water and calcium content of the peat. In practice it is the plants and their communities, i.e. mire types, that are employed as measures of trophic level. The differences between the trophic levels in terms of acidity, the electrical conductivity of the mire water and the calcium content of the peat (according to Eurola & Kaakinen 1978; Tolonen & Hosiaisluoma 1978; Eurola *et al*. 1995; Tahvanainen 2004; Eurola & Huttunen 2006) are set out in Table 2. Ratcliffe (1964) sets the pH of oligotrophic peats in Scotland at <5 and their Ca content at 30 mg/100g (or pH <5.7 and Ca content <4 mg/l in the mire water), with corresponding figures of pH 5-6 and Ca 30-300 mg/l for mesotrophic peats (or pH 5.7-6.5 and Ca 4-10 mg/l in the mire water) and pH >6 and Ca >300 mg/l for eutrophic peats (or pH >6.5 and Ca >10 mg/l in the mire water).

It is common for analyses based on surface peat horizons to show scarcely any difference between ombrotrophic and oligotrophic conditions, whereas the difference is clearer lower down in the peat. Mesotrophic and eutrophic conditions, on the other hand, show clear differences in the majority of cases, especially where pH values and concentrations of Al, Mg, Ca and Fe are concerned. This being so, the concept of ombrotrophic conditions would seem to apply only to mire water chemistry and be inapplicable to peat chemistry. Since mire plants derive their nutrients from the mire water, ombrotrophic conditions are manifested most clearly in this way, i.e. through the vegetation and its growth record (see Vasander 1981a, b, 1983; Lindholm & Vasander 1979; Eurola & Holappa 1984).

pH	Weber 1907 M-Europe	Ruuhijärvi 1960 Finland	Sjörs 1971 Sweden	Jeglum 1971 Canada	Bradis & Andrienko 1972 Ukrainian	Neuhäusl 1972 M-Europe	Pollet 1972 Newfounland	Elpatievsky 1972 Russian	Pakarinen 1975 Finland	Moore & Bellamy 1974 Great Britain	Tolonen 1974, Tolonen & Hosiaisluoma 1978 Finland
	Ombro	Ombro	Ombro	Very Oligo	Oligo	Ombro	Ombro	Dystrophic	Ombro	Ombro (bog)	Ombro
4			Poor fen						Weakly minerotrophic (oligo)		
				Oligotrophic				Oligotrophic			
			Minero moderately rich fen								Oligotrophic
		Minerotrophic			Mesotrophic						
								Meso-Oligotrophic			
										Minerotrophic (fen)	
							Weakly minerotrophic				
	Mesotrophic			Mesotrophic		Soligenous				reotrophic	
									Moderately minerotrophic (Meso)		
								Mesotrophic			
			Rich fen		Eutrophic						
5				Eutrophic				Meso-eutrophic			
	Eutrophic								Strongly minerotrophic (Eutrophic)		
				Extremely rich fen	Alkalitrophic		Eu-minerotrophic	Eutrophic			
			Extremely rich fen								

Table 1. Trophic levels as defined in various countries. Om = ombrotrophic, Ol = oligotrophic, Me = mesotrophic, Eu = eutrophic, Min = minerotrophic

	pH /peat	mS/m/peat	Ca mg / l dry peat	Ca mg/l mire water
Eutrophic	> 6	> 40	> 5000	> 5000
Mesotrophic	< 5	< 40	< 5000	> 2000
Oligotrophic	< 4	< 26	< 4000	< 2000
Ombrotrophic	< 4	< 10	< 2000	< 1000

Table 2. Trophic levels defined in terms of peat acidity (pH) and electrical conductivity (mS/m) and calcium concentration (mg/l of dry peat and mg/l in the mire water) (Eurola & Kaakinen 1978; Tolonen & Hosiaisluoma 1978; Eurola et al. 1995; Tahvanainen 2004; Eurola & Huttunen 2006).

While mire margin ecosystems are constantly under the influence of nutrient inputs from other systems, mire centres have a vegetation that lives entirely off the nutrients in the peat itself or received in the form of rain, the only exception being the influx of nutrients in meltwater from the snow of the surrounding areas in spring. This means that an ombrotrophic vegetation will always be lacking in minerotrophic species and subject to a mire centre effect. A minerotrophic vegetation, on the other hand, can be influenced by either a mire centre or a marginal location, with the latter tending to exercise a spruce mire, swamp, groundwater or meltwater effect. The potential for draining a mire is also clearly connected with the presence of a margin or mire centre effect, with spruce mire-related types responding best to drainage, along with only one mire centre vegetation type, the tall-sedge pine fen, which is said by Westmann (1981) to have a slightly swampy or groundwater-influenced character. Mire types with margin effects tend to have higher element concentrations, but acidity behaves in an irregular manner in this respect (Eurola & Holappa 1984).

Ombrotrophic conditions can be detected best by calculating the annual intake of nutrients per unit area and correspondingly, the assumed annual intake of nutrients per living vegetation horizon (15 cm). This layer thickness is insufficient, however, for the estimation of nutrients entering minerotrophic mires in larger amounts than the potassium and ammonia nitrogen derived from rainwater. Further factors that affect the quantities of nutrients present are runoff and possible evaporation (Eurola & Holappa 1984).

2. THE AREA STUDIED

The mires investigated for the present purposes are located in an area of the Finnish provinces of Northern Ostrobothnia, Kainuu and Koillismaa bounded by latitudes 64–66°N and longitudes 24–30°E (Fig. 1). The topography of the area varies more in an east-west direction than from north to south, the coastal belt being flat or gently undulating, while the central parts are dominated by a ridge running north-south, followed in the east by the hill country of Southern Lapland and Kainuu with its many erosional valleys (Fogelberg & Seppälä 1986). Mires began to develop rapidly in the central part of the western sector of the area between approx. 9800 and 5800 BP cal (Mäkilä & Muurinen 2008).

The rate of land uplift in this area is about 8 mm per year on the coast and 5 mm per year close to Finland's eastern boundary, and the highest ancient shorelines left by the Ancylus Lake stage in the history of the Baltic basin (10800–9000 BP cal) are to be found just above 200 m a.s.l. Following the brief Mastogloia period, the salinity of the water rose and the Baltic basin entered the Litorina Sea phase (approx. 9000–5000 BP cal), the highest shorelines from which extend nowadays to almost 100 m a.s.l. (Eronen 1983, Eronen *et al.* 2001; Winterhalter *et al.* 1981).

The bedrock of the area consists mostly of Late Archaean acidic granites crossed by the north-south-oriented Puolanka Schist Belt and the narrower Kainuu Schist Belt running parallel to it. Smaller occurrences of alkaline rocks are also to be found in the north-western parts of the area, around Ranua and in the Kemi-Tornio district, and also in the surroundings of Kuusamo in the north-east. The northern part of the area is occupied by the Archaean Pudasjärvi granite gneiss complex. To the west of this is a continuous gneiss belt with alkaline plutonic rocks in places which then extends further south in a NW-SE direction. Also belonging to the Proterozoic Svecokarelian bedrock of Finland are the Peräpohjola Schist Belt and the Northern Ostrobothnian Schist Belt that surrounds the Jotnian sediments of the Muhos Formation (Laajoki 1983, Simonen 1990).

The thickest surficial deposits are located in the coastal areas. Tills overlie the majority of the area studied here (Johansson & Kujansuu 2005) and a number of till beds of varying ages can be distinguished (Aario & Forström 1979; Kujansuu & Niemelä 1984). The highest points on the coast of the Bothnian Bay possess a drumlin and cover till topography and the valleys feature Rogen and other types of hummocky moraines and glaciofluvial formations, often smoothed over by littoral processes. In places there are curved hill formations, which are generally partly glaciofluvial in origin. In Koillismaa and Kainuu, which are predominantly supra-aquatic areas, there are cover tills and drumlin fields, products of glacial action, with dead ice hummocky moraines and seam formations located between the glacial lobes (Aario 1984; Kujansuu & Niemelä 1984). Some interglacial and interstadial peat and gyttja horizons from times preceding the last glaciation have also been identified in the area (Korpela 1969). The surface landforms of the western half of the area are mostly composed of glacial and glaciofluvial sediments, so that bedrock outcrops are of minor importance in this respect. One consequence of the pronounced rate of land uplift, however, is that there are shore ramparts situated nowadays a considerable distance away from the coastline. On the coast itself, the local eskers and other sand-based landforms have been smoothed over by shoreline processes, while the topography of the depressions between these has been filled in by mires.

In terms of the climate classification of Köppen (1931), the area concerned here has a moist birch climate. Since the extent of the area from north to south is about 250 km, the spring and summer part of the year is some 3 weeks longer in the south and the thermal growing season comes to an end 2–3 weeks earlier in the north. Considering the climatically determined division into vegetation zones, the western half of the area is generally speaking Middle Boreal in character, the Kuusamo district is slightly oceanic and Northern Boreal and the intervening zone is a neutral Northern Boreal area (Hämet-Ahti & Jalas 1968). According to Eurola and Vorren (1980), the Kuusamo area belongs to the southern part of the North Boreal zone, although the northern half of the region considered here belongs for the main part to the Middle Boreal zone and is bounded in the west by a corridor of the southerly Middle Boreal zone in the valley of the Oulu River, after which there is only a narrow strip of the Bothnian Bay coast that represents the Southern Boreal zone.

The development of the mires in the region to form raised bogs and aapa fens, as determined by the macroclimate, is also reflected in spatial variations in the distribution of strings, intermediate surfaces and flarks, with the proportion of strings increasing on the raised bogs and that of flarks on the aapa fens, while the extensive expanses of intermediate surfaces represent the most common level on the poor fens. Variations in evapotranspiration and temperature sums are closely reflected in the surface topography of the mire complex types (Eurola *et al.* 1984). Long-term statistics show mean annual precipitation in the region to be of the order of 500–600 mm, and even close to 700 mm in places (www.fmi.fi/saa/tilastot_146.html). It should be noted, however, that Bailey (2003) claims that the best correlation with the areas belonging to particular ecosystems is achieved by an ”ecological classification” that is not based exclusively on mean temperatures and mean precipitation figures.

Phytogeographically, the region studied here is located at the western end of the extensive boreal taiga forest belt and close to the transition between its middle and northern zones, in an area where pine-dominated heath forest types are predominant. Spruce is most abundant as a forest species in the east and north-east and around Lake Oulujärvi, while birch is most common on the low-lying coastal fringe. In the division of Finland into phytogeographical regions the southern parts of the Middle Boreal zone are regarded as belonging to Ostrobothnia and Kainuu, where both southerly and northerly plant species and vegetation types thrive (Kalliola 1973). According to Eurola (1962) and Ruuhijärvi (1960), the mires of the area studied here fall into the Ostrobothnia and Peräpohjola aapa fen zones, while the aapas of Ostrobothnia can be further divided on the basis of their plant cover into the aapa mires of Northern Ostrobothnia, the eutrophic aapa mires of Northern Ostrobothnia and the aapa mires of Kainuu. The sloping fens of Kuusamo can in turn be regarded as forming one subset of the aapa mires of Ostrobothnia. A rather similar areal division was arrived at in the Third National Forest Transect Estimate, which was based on the frequencies of occurrence of forest and mire plants (Kujala 1964), in relation to which the area studied here is located in the regions of Northern Ostrobothnia, Central Ostrobothnia, Kainuu, Peräpohjola and Kuusamo, and also partially in the Suomenselkä watershed area. Interpretations of the history of the vegetation and tree cover based on pollen and macrosubfossil evidence are available both on a regional scale (see Vasari 1962, 1963b, 1964b, 1966, 1974) and for the whole of Northern Finland (Siren 1961; Donner 1965; Mangerud *et al.* 1974; Vasari 1974; Eronen 1979, 1983, 1996; Eronen & Zetterberg 1996; SILMU 1996, Hicks *et al*. 1996; Seppä & Hammarlund 2000). Studies of the early phases in the vegetation succession of the shores of the Bothnian Bay have been published by Havas (1961) and Vartiainen (1980).

Mires are in relative terms more abundant in this area than anywhere else in Finland (Virtanen *et al.* 2003; Raunio *et al.* 2008). The richest of these in vegetational terms are to be found beside streams, rivers and lakes and in areas with an alkaline bedrock. Considerable variations in temperature conditions, runoff, humidity, oceanity-continentality, topography, bedrock and surficial deposits nevertheless occur within the area, providing suitable conditions for the occurrence of an abundance of aapa fens and a wide variety of mire types. There are places on the low-lying plains on the Gulf of Bothnia coast where mires account for over 60% of the land area, and the fens in the centres of many of these may be interspersed with flarks. Similarly there are large numbers of poor *Sphagnum papillosum* fens with small flarks, *Eriophorum vaginatum* pine bogs, *Carex globularis* spruce-pine mires and poor pine fens. Spruce mires, on the other hand, are relatively rare, and rich fens are mainly to be found in the valley of the Oulu River. The “Lapland Triangle” between the Tornio River and the Kivalo range of hills is another area where more than 60% of the land area is occupied by aapa fens, although rich birch fens are also common here, as are rich pine fens and sloping fens, while flark fens tend to develop on level ground. Some rich fens can be found where the bedrock of the ancient Karelidic mountain chain crosses the Kainuu area, although they cannot compare in terms of species richness with those of the Tornio district and certainly not with those of Kuusamo. It has been estimated that about 10% of the rich fens over the whole area studied here have been preserved in an unditched state (Kaakinen & Kukko-oja 1981). The most commonly occurring mire types in the area are *Eriophorum vaginatum* and dwarf shrub pine bogs and poor pine fens, together with thin-peat spruce forests and true spruce mires, while groundwater-influenced sloping fens are common on the hills of the Kuusamo district and oligotrophic flark fens are typical of the valleys, but there are few *Eriophorum vaginatum* pine bogs or *Carex globularis* spruce-pine mires. One common feature of the hill terrain of Kuusamo, however, is the occurrence of *Sphagnum fuscum* spruce-pine mires (Paasovaara 1986).

According to Heikurainen (1960), the percentages of the land area of the region considered here occupied by the main mire types and their principal locations in the period prior to the extensive draining of peatlands were the following: *Eriophorum vaginatum* pine bogs (6.1–15%, Kainuu); thin-peat pine forests (3.1–15%, western half of the area); sedge fens (6.1–12%, west to north-east); dwarf-shrub pine bogs (4.1–12%, east); flark fens (5.1–10%, west to north-east); thin-peat spruce forests (0.1–10%, throughout); true *Carex* pine mires (5–9%, throughout); short-sedge fens (7.4%, throughout); spruce-pine mires (0.1–6%, throughout); true spruce mires (<5%, Kainuu); rich pine fens (0.1–5%, Tornio, Kuusamo); poor birch fens (4.1%, Tornio, west); grassy birch-spruce mires (1.1–4%, west); true rich fens (0.1–>4%, Tornio, Kuusamo); *Sphagnum fuscum* spruce mires (0.1–>2.6 %, Tornio, Kuusamo) and birch-spruce mires with rich fen features (0.1–2%, Tornio, Kuusamo).

The extent of draining operations directed at the various mire types in the aapa mire area was examined by Eurola *et al*. (1991) with respect to the ten most common types: *Eriophorum vaginatum* pine bogs 11.8%, *Carex globularis* pine mires 7.9%, thin-peat pine forests 6.6%, mesotrophic flark fens 5.6%, *Carex globularis* spruce-pine mires 5.5%, true Carex pine mires 4.2%, true short-sedge pine fens 4.2%, true dwarf-shrub pine bogs 3.7%, *Vaccinium myrtillus* spruce mires 3.3% and true spruce-pine mires 3.3% (total 56.1%). To generalize, pine bogs accounted for the majority of the mires in Ostrobothnia, 60%, poor fens for 34%, spruce mires for only 6% and rich fens for less than 0.5% (Parikka *et al.* 1999).

3. MATERIALS AND METHODS

Field investigations

Practically all the mire sites studied for the present purposes (Fig. 1) are situated in the Ostrobothnian aapa mire region (Ruuhijärvi 1960; Eurola 1962). A total of 11 peat profiles were obtained from the Pilpasuo mire in Oulu (no. 2 in Fig. 1; see Rehell 1985) and series of 5 samples each were taken from the mires of Takasuo in Ylikiiminki (no. 1) and Ruostesuo in Kiiminki (no. 3). Further profiles were obtained from mires of various types located all over the area, yielding a total of 71 cores representing 45 mires in a natural state. Data on macrosubfossils from Pilpasuo were taken from the work of Rehell (1985), data on Kiimisuo on the island of Hailuoto (no. 15) from that of Rönkä (1985), data on Järvenpäänsuo in Utajärvi (no. 12) from that of Holappa (1976) and data on Purkuputaansuo in Kuusamo (no. 13) from that of Miettinen (1983, 1985).

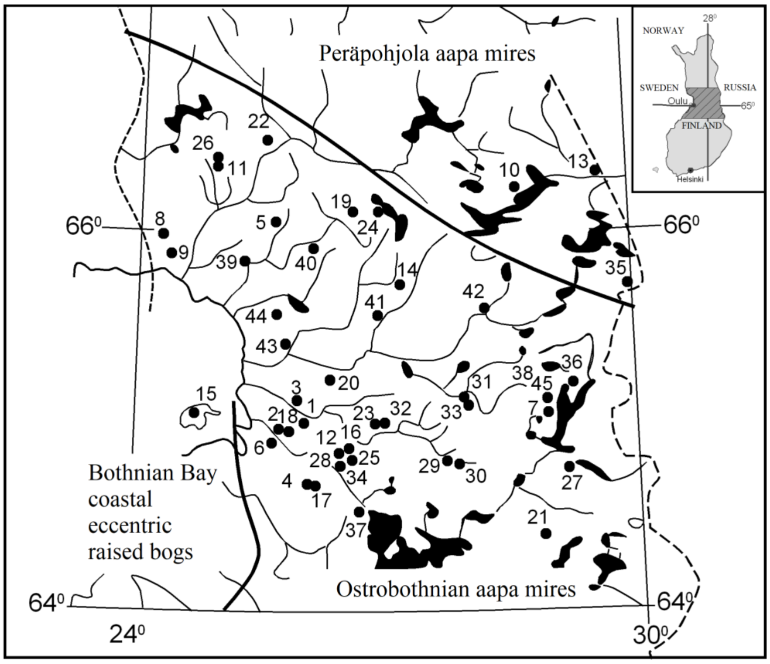


Fig. 1. The area studied here, the mire sites and their locations and the numbers of samples taken (in brackets after the name): 1. Takasuo (143); 2. Pilpasuo (261, Rehell 1985); 3. Ruostesuo (47); 4. Päijännesuo (19); 5. Rautuojanaapa (24); 6. Länsisuo (10); 7. Säkkisuo (14); 8. Vaarajänkkä (18); 9. Karsilonmaa (19); 10. Riissuo (49); 11. Ristivuoma (11); 12. Järvenpäänsuo (30, Holappa 1976); 13. Purkuputaansuo (12, Miettinen 1985); 14. Posonpalo (10); 15. Kiimisuo (27) (Rönkä 1985); 16. Väliahonsuo (17); 17. Reikäsuo (12); 18. Kehäsuo (29); 19. Paloaapa (8); 20. Arosuo (9); 21. Mustinsuo (40); 22. Ternuvuoma (8); 23. Olvassuo (20); 24. Hiisisuo (15); 25. Kivisuo (17); 26. Kilsiaapa (9); 27. Säynäjäsuo (25); 28. Heinäsuo (3); 29. Rytisuo, Parola (18); 30. Pihlajavaara (4); 31. Lomasuo (4);. 32. Kärkäs (2); 33. Rytisuo, Sikavaara (5); 34. Käkiperä (5); 35. Matosuo (66); 36. Ulkupuro (27); 37. Siirasoja (7); 38. Siikavaara (2); 39. Simoskanaapa (4); 40. Näätäaapa (5); 41. Saarisuo (5); 42. Siekkisensuo (8); 43. Sarvisuo (5); 44. Iso-Hirvineva (4); 45. Lahnaletto (15). A total of 1095 samples were taken. The division into regions (black lines) is after Ruuhijärvi (1960) and Eurola (1962).

The peat samples were taken with a Russian corer and surface peat samples were cut with a knife or a thin-walled steel cylinder approximately 11 cm in diameter. The cores were sampled at 10 cm intervals, and some also at 5 and 15 cm intervals if the core displayed clear boundaries between the horizons. The redox potential and pH were measured directly from the fresh samples in the field or immediately on arrival in the laboratory (Table 3).

All the cores extended from the mire surface to the basal sediment, except for that from the mesotrophic sedge fen of Riissuo in Posio, where some of the deepest horizons were missing (Fig. 1. site no. 10). The profiles with depths of less than 30 cm represent ”biological mires” with a vegetation cover of >75%. Some of the rich fen sites, for instance, have a highly abundant vegetation (Kaakinen & Kukko-oja 1981).

	Analyses
No. of samples	1095
Gyttja samples	7
Moisture, coarseness, sedges, *Eriophorum vaginatum*, plasticity, staining, lignin, colour (1-5)	1079
Fibre content %	812
mV	767
w %, kg/m^3	1077
H_{1-10}	1090
Amorphous material (< 0.125 mm)	535
Organic material %	1076
Ash content %	1078
pH	1088
P	767
Na	1031
K, Zn	1043
Ca	1037
Al, Mg, Fe	1042
Mn	1036
Cu	1044
Pb	1040

Table 3. Numbers of peat samples taken from the sites studied and numbers of the various analyses performed. Total number of mires studied 45; total number of mire types represented in the peat horizons 213.

The moisture content of the peat was estimated by hand in the field on the scale: 1 air-dry, 2 relatively dry, 3 normally moist, 4 wet, and 5 mostly water. The coarseness of the peat was determined on the scale: 1 extremely coarse, 2 coarse, 3 fairly coarse, 4 moderately smooth, and 5 very smooth. Correspondingly, the proportions of sedge roots, *Eriophorum vaginatum* fibres and wood were determined as: 1 absent, 2 sparse, 3 moderate, 4 abundant, and 5 dominant. The plasticity of the peat was divided into: 1 not pliable, 2 slightly pliable, 3 fairly pliable, 4 easily pliable, and 5 extremely easily pliable; and its staining capacity (on the hands) as: 1 does not stain, 2 stains slightly, 3 stains, 4 stains fairly well, and 5 stains extremely well.

Laboratory methods

Mire type stratigraphies and macrosubfossil analyses

Since it is not really known what is the best means of subdividing a core stratigraphically (Gordon & Birks 1972), the approach adopted here was to identify the peat horizons on the basis of their plant species composition (see Eurola & Kaakinen 1978; Eurola *et al*. 1995) with additional reference to the physical properties of the peat, the concentrations of the elements Al, Mg, Fe, Ca, K, Na, Fe, Mn, Cu, Pb and P and the ratios Ca/Mg, Fe/Mn, Ca/K, Na/K, Fe/P and Cu/Zn. The laboratory analyses and their various stages were performed in accordance with the diagram in Fig. 2.

Mire types that were close to each other ecologically and in terms of their species composition were then combined to form a single type, as seen in Table 4. The species themselves were identified from plant remains and seeds by comparing preparations of tissue samples with modern reference specimens and by referring to the relevant literature (Arnell 1981; Beijerinck 1947; Berggren 1969; Eurola & Kaakinen 1978; Katz *et al*. 1977; Nyholm 1975, 1979, 1981; Paasio 1963). For better identification of the mire plant remains in the best-humified peat samples, the fine-grained humus was removed using nitric acid, HNO3:H2O 1:2 (Paajala *et al*. 1981), and the material was washed in 1 mm and 0.25 mm sieves consecutively until the water passing through was clear. The fractions remaining in the sieves and the original sample were examined by eye and under a microscope to determine the percentages of the plant species.

The species compositions of the mire types, i.e. the proportions of the various peat constituents, were determined as follows:

1. The peat composition of the acrotelm was calculated from the data of Ruuhijärvi (1960) concerning the cover percentages of given species and families relative to the total flora of the mire type in question (Table 10).
2. Estimates were obtained by means of both macroscopic and microscopic observations for the percentages of given plant remains in the combined material of recent and subfossil mire types.

The three most commonly occurring plant species or species groups in percentage terms were then taken to represent the peat type in question, with the principal factor named last in this formula.

3. The botanical compositions of peats representing different tropic levels were defined according to the system of Eurola and Kaakinen (1978).

4. As a peat becomes more humified a completely decomposed plant mass with a grain size of less than 0.125 mm, referred to as amorphous material (A), is formed. In the present work this amorphous material was taken together with the plant remains to form a single element in the formation of the peat and was then defined in one of the following manners: a) when the amorphous material accounted for <25% of the peat, the latter was said to be fibrous (not amorphous), so that no A was appended to the peat formula, b) when there was 25–50% amorphous material present in the peat the symbol A was appended to its formula, *e*.g. AC (amorphous *Carex* peat), c) if there was >50% amorphous material, so that this became the major component of the peat, it qualified to be mentioned last in the formula, e.g. CA (*Carex* amorphous peat).

The influence of the macroclimate on the isolation of the mire basins and the spread of spruce to the area was assessed from a study of the literature, involving a total of 60 works (Appendix 1). In addition, pollen analyses were available for 19 mires (Appendices 2 and 3). Spruce can be assumed to have been present at the time of deposition of a given horizon if it accounts for about 10% of the pollen sum (Hicks 1977, Hicks *et al.* 1996).

Physical and geochemical analyses

Determination of the proportions of amorphous material was based on a preliminary experiment in which 93 peat samples representing different mire types were sieved using mesh sizes of 4, 2, 1, 0.5, 0.25, 0.125 and 0.074 mm. This demonstrated that the <0.125 mm peat fraction represented extremely well decomposed plant material among which it was possible to distinguish only diatoms, pollen grains and spores. Thus the dry weight percentage of the <0.125 mm fraction (washing loss, see Fig. 2) in a homogenized parallel sample of precisely the same weight could be taken to correspond to the amount of amorphous material in the peat.

The samples were analysed in the laboratory for water content, wet and dry densities and ash content. A figure was obtained for the accumulation of organic matter by deducting the proportion of ash from the dry density. For the element determinations approx. 100 mg of peat ash was dissolved in 5 ml of concentrated HCl, after which 5 ml of 2N HNO_3 was added and the residue mixed and infiltrated with hot distilled water to a volume of 100 ml. The solution was then analysed using an atomic absorption spectrophotometer (AAS) for the following elements (accuracies in ppm in parentheses): Al (30), Ca (1), Cu (3), Fe (6), K (3), Mg (0,3), Mn (2), Na (0,2), Pb (10) and Zn (1). Phosphorus (P) was determined by dissolving peat ash in HCl, drying the product and dissolving this in HNO_3 before adding distilled water to obtained the desired volume. The phosphorus was then complexed with ammonium molybdate $(NH_4)_2MoO_{2,}$ and colorimetric determination performed at a wavelength of 700 nm half an hour after 0.75 ml of a 10% solution of citric acid, 2 ml of sodium hydrogen sulphite solution, 4 ml of ammonium molybdate solution and 5 ml of metol solution had been mixed into the sample. The instrument was calibrated with distilled water and a KH_2PO_4 solution.

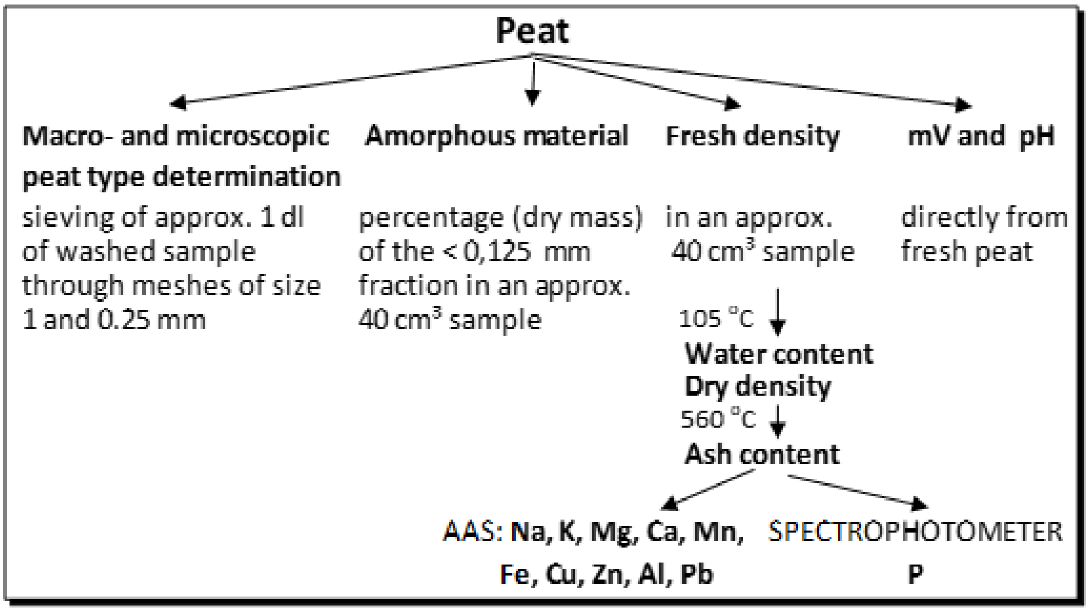


Fig. 2. Scheme for the determination of peat properties.

Processing of the results

The results of the analyses were handled using the Excel program and examined with respect to their means and standard deviation and by correlation analysis. According to Lokki (1980), 25–30 observations are required to normalize the mean and standard deviation of a statistical dataset, provided that the distribution of the original measurements is more or less symmetrical. The figures and diagrams used to display the results were mostly produced using the Excel program. The pollen diagrams were printed out using the Tilia program.

Since the atmospheric ^{14}C content varies, radiocarbon years calculated in the traditional way can deviate from calendar years quite considerably, sometimes by more than 1000 years. All the radiocarbon dates quoted here have been calibrated using the Cal Online program.

4. RESULTS

Mire formation and stratigraphy and the mire type succession

Spruce first spread to the area (Appendix 1, see text for calibrated dates) around 5500–5750 BP cal in the case of Kuusamo (Hicks 1975, 1985; Seppälä & Koutaniemi 1985) and Kainuu (Reynaud & Hjelmroos 1976; Keskitalo 1982) and soon after 5120 BP cal in the central parts of the region (Holappa 1976; Hicks 1977; Reynaud & Hjelmroos 1980) (kuva 3) and the south-eastern and southern parts (Keskitalo 1982; Vuorela 1990; Vuorela & Kankainen 1991) and somewhat later still on the coast and in the hill country of the Tornio district of Lapland (Hicks 1988 a, b). In the low-lying coastal strip and the central part of the area the mires mainly formed some time after the arrival of spruce. The youngest of the poor ombro-oligotrophic mires in the coastal area were almost entirely covered by *Sphagnum* mosses, giving them a high proportion of mosses and other cryptogams relative to herbaceous plants and dwarf shrubs. On the more eutrophic mires, however, it was the herbaceous plants that were dominant, while dwarf shrubs were most prominent in the surface peat around the time of the spread of spruce (Appendices 2 and 3).

At the time when the mire basins were becoming isolated from the sea it was the sedges (*Carex*) that contributed most to the growth of peat (>20%, Fig. 4), followed by woody material and *Sphagnum* mosses (10–20%) and some brown mosses (Bryidae) and horsetails (*Equisetum*). The proportion of herbaceous plants in these horizons was less than 5%. The basal peat of forested mires frequently featured remains of the mycorrhizal fungus *Cenococcum graniforme*.

The proportion of the rusty peat moss, *Sphagnum fuscum,* in the surface peat of the young ombrotrophic and oligotrophic mires increased from a depth of about 120 cm upwards (Fig. 5), and the data also suggest that *Sphagnum* mosses accumulated to an extent of almost 20% in the basal horizons representing the early stages in the development of the older mires (Fig. 6).

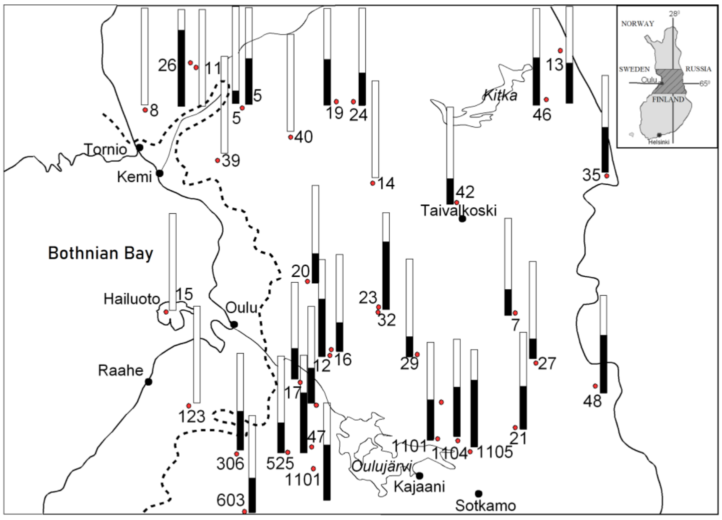


Fig. 3. Mire formation in Northern Finland before and after the spread of spruce (*Picea*) to the area. The black lower part of each column denotes the proportion of the whole peat depth that was deposited while spruce was absent from the forest and the blank upper part the proportion deposited after the appearance of spruce. For mire sites 5–42, see Fig. 1 and Appendix 2/1-10;for site 50, see Seppälä & Koutaniemi (1985); for sites 306–1105, see Keskitalo (1982); for site 47, see Okko (1955); and for site 48, see Virkkala & Valovirta (1957). The dashed line shows the position of the shoreline at the time when spruce reached it (Lukkala 1933).

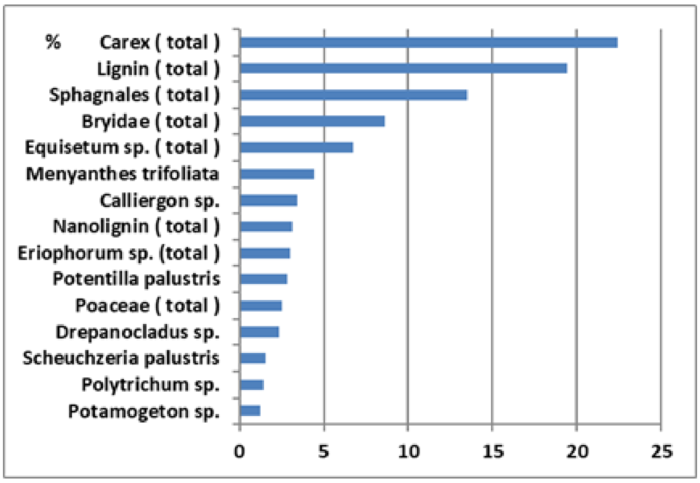


Fig 4. Average botanical composition (%) of the bottom 5-10 cm of the peat at the time when mire formation began.

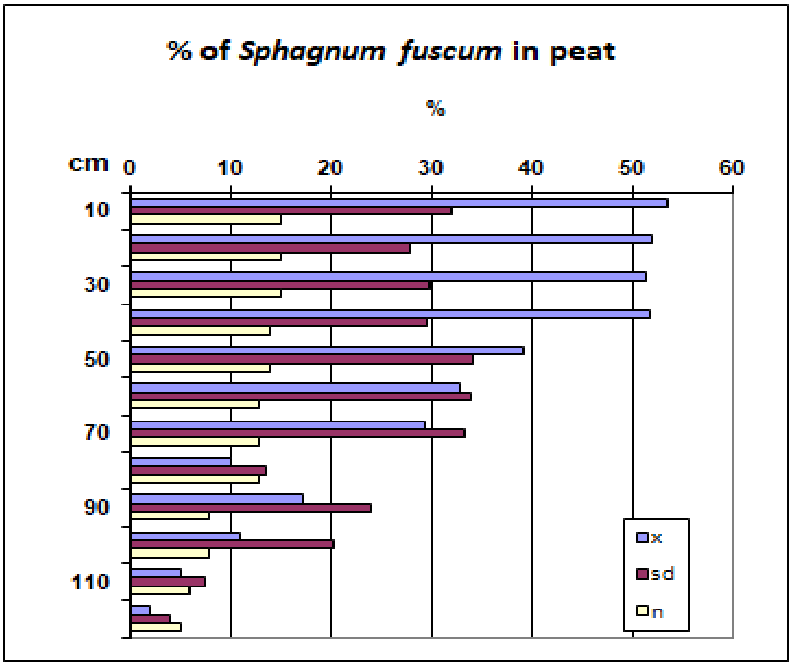


Fig. 5. Mean percentages (with standard deviation and number of samples) of *Sphagnum fuscum* in the surface peat layers of the ombro-oligotrophic mires as a function of depth.

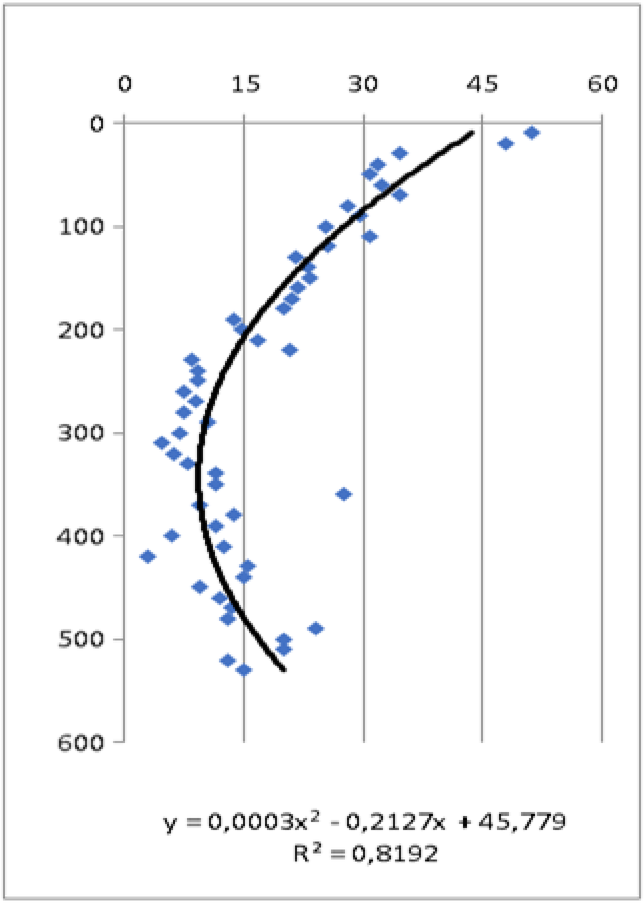


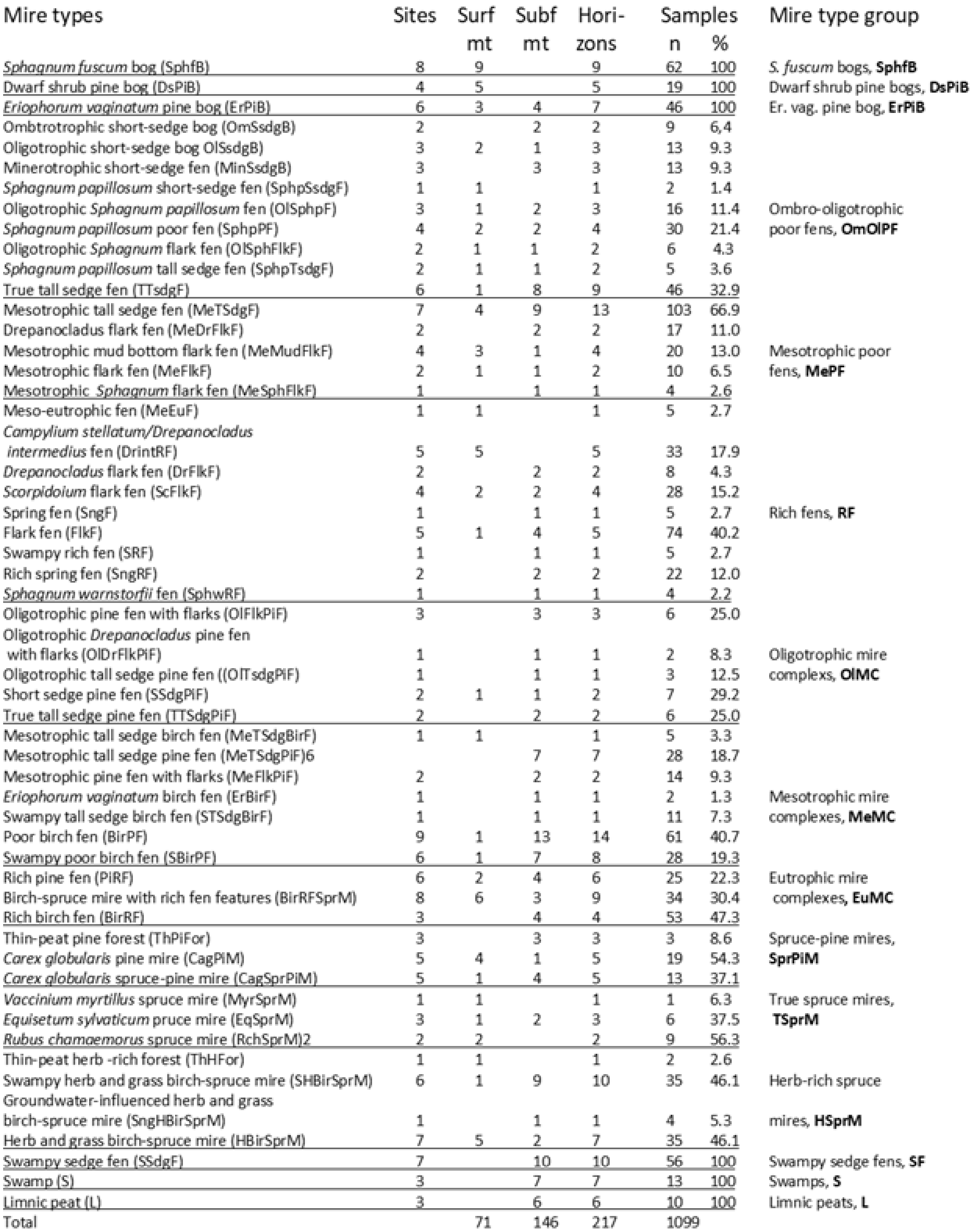
Fig. 6. Mean percentages of *Sphagnum* mosses at various depths in the whole series of mires. The polynomial function and its explanatory power (r^2) indicate the strength of the association of the percentage of *Sphagnum* moss with depth.

The dependence of the percentage of each category of plant remains (y) on the depth of the mire (x cm) and its coefficient of determination (r^2) were calculated for all the instances in which the plant remains in question accounted for at least 1% of the amount of peat (number of samples n = 1086):

Potentilla sp.	n =	117	$y = 0.03521x + 1.6423$	$r^2 =$	19.1
Lignin		314	$y = 0.06528x + 16.360$		9.3
Bryidae		545	$y = 0.03185x + 13.439$		5.7
Scheuchzeria palustris		301	$y = 0.01344x + 14.795$		2
Equisetum sp.		513	$y = 0.00689x + 10.772$		0.6
Menyanthes trifoliata		454	$y = 0.00450x + 13.863$		0.3
Eutrophic *Sphagnales*		357	$y = -0.000197x + 10.370$		0
Carex		907	$y = -0.01586x + 31.272$		0.9
Eriophorum vaginatum		327	$y = -0.02451x + 24.521$		1
Nanolignin		722	$y = -0.02276x + 17.050$		3.5
Sphagnum acutifolia section		311	$y = -0.13065x + 35.282$		10.6
S. cuspidatum section		271	$y = -0.06057x + 20.346$		13.9
Sphagnales		867	$y = -0.08396x + 38.393$		14.2
S. papillosum		139	$y = -0.08752x + 25.819$		17.4
S. fuscum		133	$y = -0.25055x + 56.579$		18.6

The distribution of the peat cores in terms of the mire types of their surface peat and the horizons representing earlier phases in mire development is set out in Table 4. Altogether there were 217 peat or gyttja-peat horizons which could be assigned to mire types on the basis of their plant species and physicochemical properties, including 146 that were subfossil mire types and 6 that had been deposited in water, representing a limnic peat type. By combining types that were ecologically close to one another, a set of 14 eventual mire types was obtained in addition to the limnic type (L). Of these, only the following groups were represented by less than 30 samples: true spruce mires (TSprM), dwarf-shrub pine bogs (DsPiB), swamps (S), oligotrophic mire type complexes (OlMC) and limnic peats (L).

Classification according to the system of Cajander (1913) shows that it is the poor fen and rich fen types that possess the thickest peat horizons, with the rich fens having a greater than average fluctuation in this respect (Table 5) on account of the unusually great depth of one *Calliergon richardsonii* flark fen in the Kuusamo area (Matosuo, RiL, 6.55 m + 1.75 m gyttja). If this site is excluded the mean depth of the rich fens is 1.25 m. The mean thicknesses of the mire type complexes and gyttja horizons for the whole area studied, together with the maximum and minimum values, are presented in Figure 7.



Mire types	Sites	Surf mt	Subf mt	Hori-zons	Samples n	Samples %	Mire type group
Sphagnum fuscum bog (SphfB)	8	9		9	62	100	*S. fuscum* bogs, **SphfB**
Dwarf shrub pine bog (DsPiB)	4	5		5	19	100	Dwarf shrub pine bogs, **DsPiB**
Eriophorum vaginatum pine bog (ErPiB)	6	3	4	7	46	100	Er. vag. pine bog, **ErPiB**
Ombtrotrophic short-sedge bog (OmSsdgB)	2		2	2	9	6,4	
Oligotrophic short-sedge bog OlSsdgB)	3	2	1	3	13	9.3	
Minerotrophic short-sedge fen (MinSsdgB)	3		3	3	13	9.3	
Sphagnum papillosum short-sedge fen (SphpSsdgF)	1	1		1	2	1.4	
Oligotrophic *Sphagnum papillosum* fen (OlSphpF)	3	1	2	3	16	11.4	Ombro-oligotrophic
Sphagnum papillosum poor fen (SphpPF)	4	2	2	4	30	21.4	poor fens, **OmOlPF**
Oligotrophic *Sphagnum* flark fen (OlSphFlkF)	2	1	1	2	6	4.3	
Sphagnum papillosum tall sedge fen (SphpTsdgF)	2	1	1	2	5	3.6	
True tall sedge fen (TTsdgF)	6	1	8	9	46	32.9	
Mesotrophic tall sedge fen (MeTSdgF)	7	4	9	13	103	66.9	
Drepanocladus flark fen (MeDrFlkF)	2		2	2	17	11.0	
Mesotrophic mud bottom flark fen (MeMudFlkF)	4	3	1	4	20	13.0	Mesotrophic poor
Mesotrophic flark fen (MeFlkF)	2	1	1	2	10	6.5	fens, **MePF**
Mesotrophic *Sphagnum* flark fen (MeSphFlkF)	1		1	1	4	2.6	
Meso-eutrophic fen (MeEuF)	1	1		1	5	2.7	
Campylium stellatum/Drepanocladus intermedius fen (DrintRF)	5	5		5	33	17.9	
Drepanocladus flark fen (DrFlkF)	2		2	2	8	4.3	
Scorpidoium flark fen (ScFlkF)	4	2	2	4	28	15.2	
Spring fen (SngF)	1		1	1	5	2.7	Rich fens, **RF**
Flark fen (FlkF)	5	1	4	5	74	40.2	
Swampy rich fen (SRF)	1		1	1	5	2.7	
Rich spring fen (SngRF)	2		2	2	22	12.0	
Sphagnum warnstorfii fen (SphwRF)	1		1	1	4	2.2	
Oligotrophic pine fen with flarks (OlFlkPiF)	3		3	3	6	25.0	
Oligotrophic *Drepanocladus* pine fen with flarks (OlDrFlkPiF)	1		1	1	2	8.3	Oligotrophic mire
Oligotrophic tall sedge pine fen ((OlTsdgPiF)	1		1	1	3	12.5	complexs, **OlMC**
Short sedge pine fen (SSdgPiF)	2	1	1	2	7	29.2	
True tall sedge pine fen (TTSdgPiF)	2		2	2	6	25.0	
Mesotrophic tall sedge birch fen (MeTSdgBirF)	1	1		1	5	3.3	
Mesotrophic tall sedge pine fen (MeTSdgPiF)6			7	7	28	18.7	
Mesotrophic pine fen with flarks (MeFlkPiF)	2		2	2	14	9.3	
Eriophorum vaginatum birch fen (ErBirF)	1		1	1	2	1.3	Mesotrophic mire
Swampy tall sedge birch fen (STSdgBirF)	1		1	1	11	7.3	complexes, **MeMC**
Poor birch fen (BirPF)	9	1	13	14	61	40.7	
Swampy poor birch fen (SBirPF)	6	1	7	8	28	19.3	
Rich pine fen (PiRF)	6	2	4	6	25	22.3	Eutrophic mire
Birch-spruce mire with rich fen features (BirRFSprM)	8	6	3	9	34	30.4	complexes**, EuMC**
Rich birch fen (BirRF)	3		4	4	53	47.3	
Thin-peat pine forest (ThPiFor)	3		3	3	3	8.6	Spruce-pine mires,
Carex globularis pine mire (CagPiM)	5	4	1	5	19	54.3	**SprPiM**
Carex globularis spruce-pine mire (CagSprPiM)	5	1	4	5	13	37.1	
Vaccinium myrtillus spruce mire (MyrSprM)	1	1		1	1	6.3	True spruce mires,
Equisetum sylvaticum pruce mire (EqSprM)	3	1	2	3	6	37.5	**TSprM**
Rubus chamaemorus spruce mire (RchSprM)2	2	2		2	9	56.3	
Thin-peat herb -rich forest (ThHFor)	1	1		1	2	2.6	
Swampy herb and grass birch-spruce mire (SHBirSprM)	6	1	9	10	35	46.1	Herb-rich spruce
Groundwater-influenced herb and grass birch-spruce mire (SngHBirSprM)	1		1	1	4	5.3	mires, **HSprM**
Herb and grass birch-spruce mire (HBirSprM)	7	5	2	7	35	46.1	
Swampy sedge fen (SSdgF)	7		10	10	56	100	Swampy sedge fens, **SF**
Swamp (S)	3		7	7	13	100	Swamps, **S**
Limnic peat (L)	3		6	6	10	100	Limnic peats, **L**
Total		71	146	217	1099		

Table 4. Surface mire types and subfossil mire types identified from plant remains, numbers of samples (n) and division of the mire types into ecologically consistent groups. Surf mt = surface mire type, Subf mt = subfossil mire type

Mire type	n	Mean peat depth cm x	sd	Mean depth of recent surface mire types cm x	Sd
Spruce mires	11	56	40	41	32
Pine mires	22	151	128	54	29
Poor fens	18	215	127	61	50
Rich fens	8	191 (125)	198	133 (64)	196
Mire complexes	12	97	95	43	14
Total	71	148		61	

Table 5. Mean peat depths in the total material and in the recent surface peat (x, cm) and standard deviation (sd) by mire types. Values in parentheses are with the Matosuo data excluded.

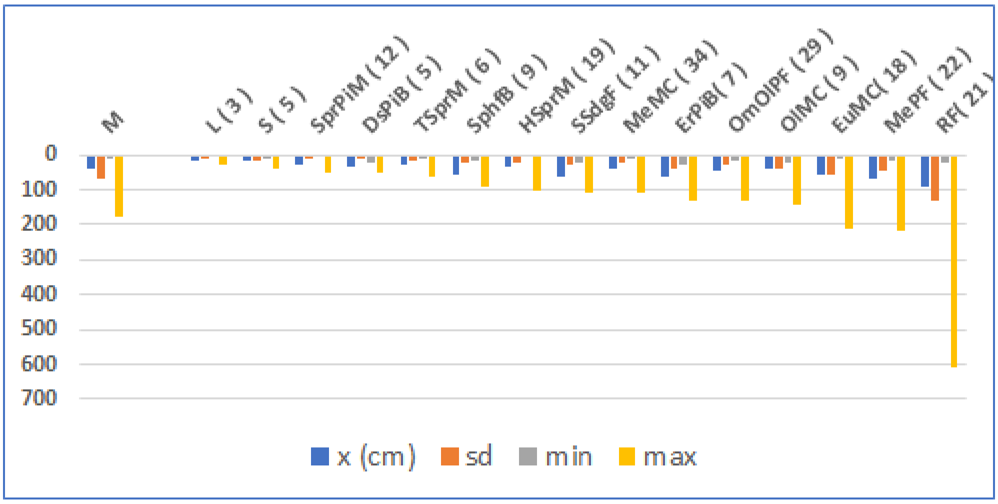
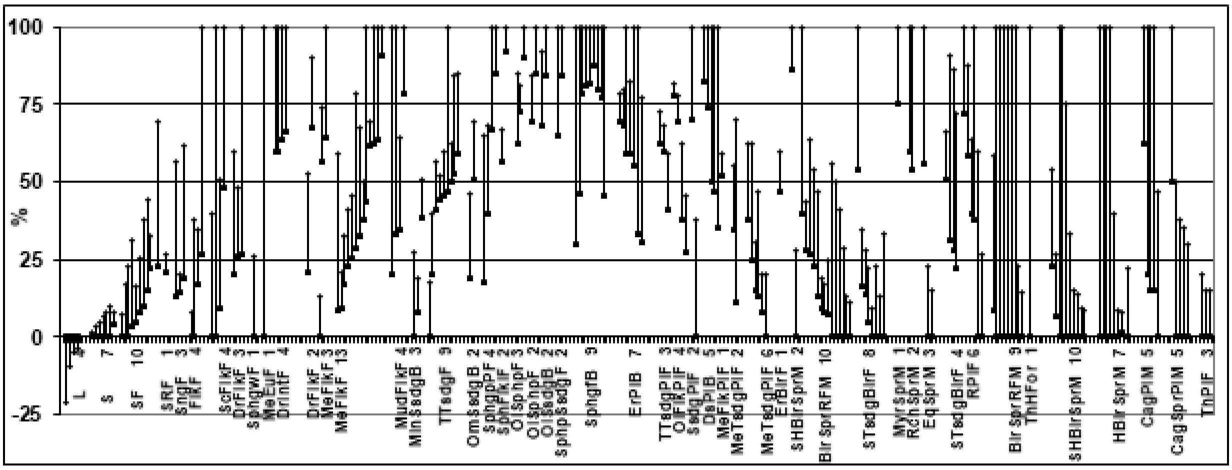


Fig. 7. Mean thicknesses (x, cm) of gyttja horizons (M) and peat horizons by mire types, with standard deviations (sd) and maximum and minimum values. Figures after the mire types are the numbers of observations.

a)



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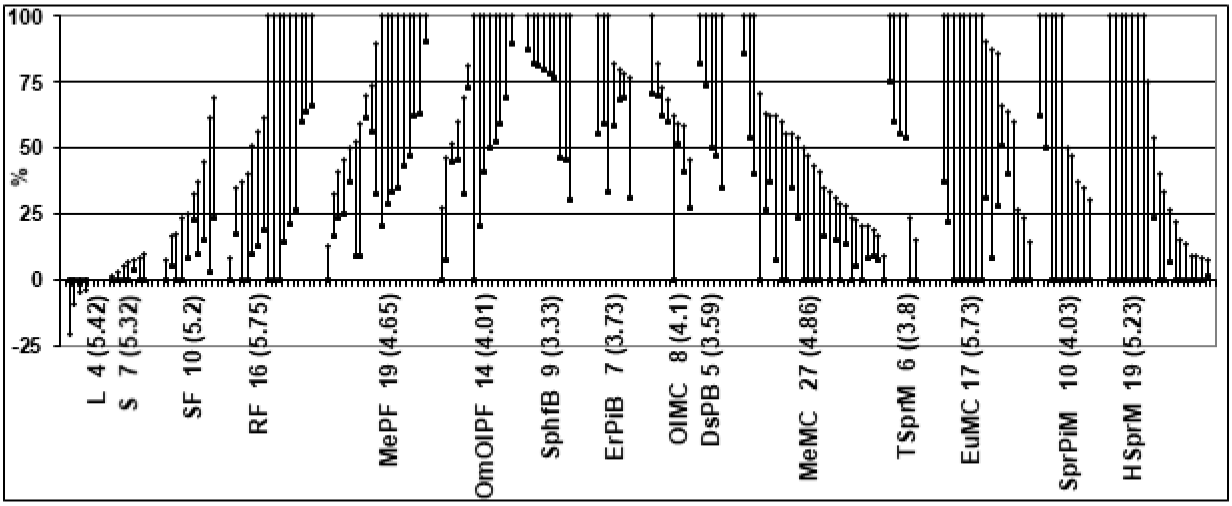
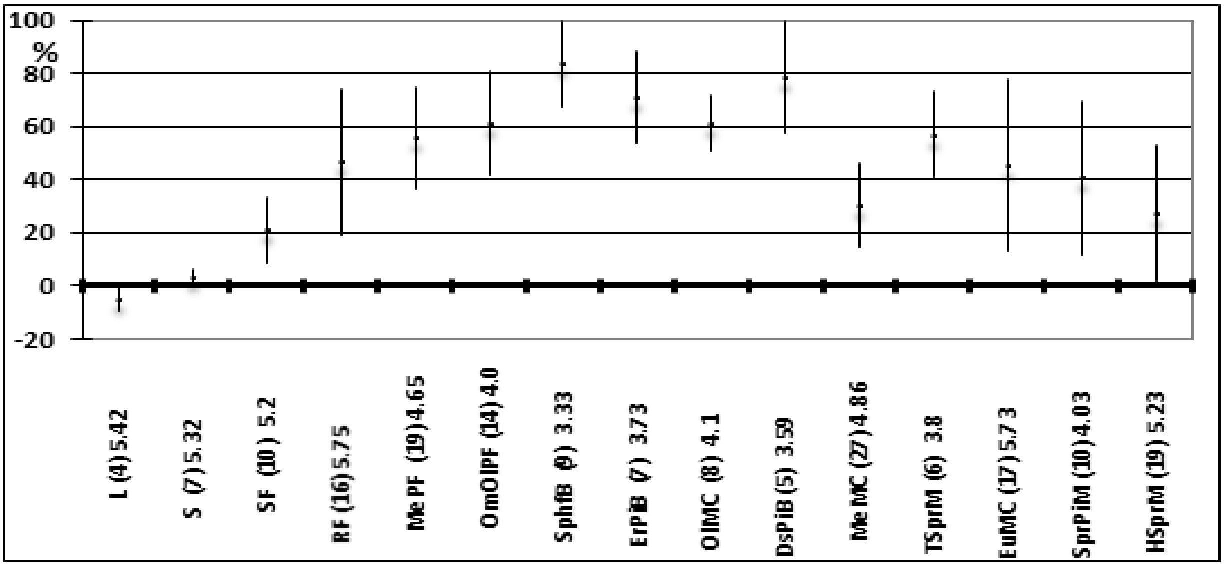


Fig. 8. Above (a): Mire type horizons defined by reference to plant species composition and geochemistry in the total material of 71 peat cores and their percentages and locations within the cores. Below (b): stratigraphy of the mire complex types. Key: **a)** L = Limnic peat, S = Swamp, SSdgF = Swampy sedge fen, SRF = Swampy rich fen, SngF = Spring fen, FlkF = Flark fen, ScFlkF = *Scorpidium* flark fen, DrFlkF = *Drepanocladus revolvens* flark fen, DrFlkPiF = *Drepanocladus* pine fen with flarks, SphwF = *Sphagnum warnstorfii* fen, MeEuF = Meso-eutrophic fen, DrintF = *Drepanocladus intermedius* fen, DrFlkF = *Drepanocladus* flark fen, MeFlkF = Mesotrophic flark fen, MudFlkF = Mesotrophic mud bottom flark fen, MinSsdgB = Minerotrophic short sedge bog, TTsdgF = True tall sedge fen, OmSsdgB = Ombrotrophic short sedge bog, SphpPF = *Sphagnum papillosum* poor fen, SphFlkF = Oligotrophic *Sphagnum* flark fen, OlSphpF= *Sphagnum papillosum* fen, SphpTsdgF = *Sphagnum papillosum* tall sedge fen, OlSsdgB = Oligotrophic short sedge bog, SphpSsdgF = *Sphagnum papillosum* short sedge fen, SphfB = *Sphagnum fuscum* bog, DsPiB = Dwarf shrub pine bog, ErPiB = *Eriophorum vaginatum* pine bog, TTsdgPiF = True tall sedge pine fen, OlFlkPiF = Oligotrophic pine fen with flarks, SsdgPiF = Short sedge pine fen, MeFlkPiF = Mesotrophic pine fen with flarks, MeTsdgPiF = Mesotrophic tall sedge pine fen, ErBirF = *Eriophorum vaginatum* birch fen, STsdgBirF = Swampy tall sedge birch fen, RPiF= Rich pine fen, BirSprRFM = Birch-spruce mire with rich fen features, MyrSprM = *Vaccinium myrtillus* spruce mire, RBirF = Rich birch fen, RPiF = Rich pine fen, BirSprRFM = Birch-spruce mire with rich fen features, SHBirSprM = Swampy herb and grass birch-spruce mire, HBirSprM = Herb and grass birch-spruce mire, RchSprM = *Rubus chamaemorus* spruce mire, EqSprM = *Equisetum sylvaticum* spruce mire, SngHBirSprM = Groundwater-influenced herb and grass birch-spruce mire, CagPiM = *Carex globularis* pine mire, CagSprPiM = *Carex globularis* spruce-pine mire, ThPiFor= Thin-peat pine forest; **b)** L = Limnic peat, S = Swamp, SSdgF = Swampy sedge fen, RF = Rich fen, MePF = Mesotrophic poor fen, OmOlPF = Ombro-oligotrophic poor fen, SphfB = *Sphagnum fuscum* bog, ErPiB = *Eriophorum vaginatum* pine bog, OlMC = Oligotrophic mire complex, DsPiB = Dwarf shrub pine bog, MeMC = Mesotrophic mire complex, TSprM = True spruce mire, EuMC = Eutrophic mire complex, SprPiM = Spruce-pine mire, HBirSprM = Herb and grass birch-spruce mire.

With the exception of the"limnic peats" laid down under shoreline conditions (see Sauramo, 1940; Nilsson 1952; Donner 1978), the environments in which the mire types occur can vary. Similarly, the same mire type will not necessarily have altered in the course of history in all cases but may even have remained consistent throughout in some cases, so that the line indicating that mire type phase in Figure 8a will extend from the bottom of the mire (0%) to the surface (100%). Figures 8a and 8b show a progression from swampy minerotrophic conditions to an ombrotrophic vegetation, with the types influenced by location on mire margins and featuring thin peat horizons placed on the edges of the diagrams while the influence of a mire centre location increases towards the inner parts of the diagrams. The same mire type can occur at different depths in different mires, of couse, e.g. in the middle of the profile or at the surface, but it is usual for the swampy mire types influenced by a mire margin location to predominate in the basal parts of the profile while the poorer oligo-ombrotrophic types are concentrated in the surface horizons. From the beginning of peat deposition it is the herb-rich spruce mires and eutrophic mire type complexes (thin-peat herb-rich forests and rich pine fens) that prove to be the most permanent mire types, i.e. they persist all the way up to the surface. At the other extreme, the last mire types in the succession, such as the *Sphagnum fuscum* bogs, dwarf-shrub pine bogs and *Eriophorum vaginatum* pine bogs (Figs. 8a, b), are not directly influenced by the mineral soil or bedrock beneath the mire, and this is seen in the mire type succession in that the thin peat types are found at developmental stages 1 and 2 and the thicker peat types generally at stages 3 and 4, while *Sphagnum fuscum* bogs reach their peak at stage 7 (Figs. 9a, b). The phases in the succession vary, as also do the mire types, depending on the thickness of the peat, the manner of mire formation and the age of the mire, with limnic peat deposited in water regarded as stage 0 in the succession. Variations attributable to the macroclimate, local surface water movements and fluctuations in the availability of nutrients will also be seen in the composition and stratigraphy of the peat.

a)



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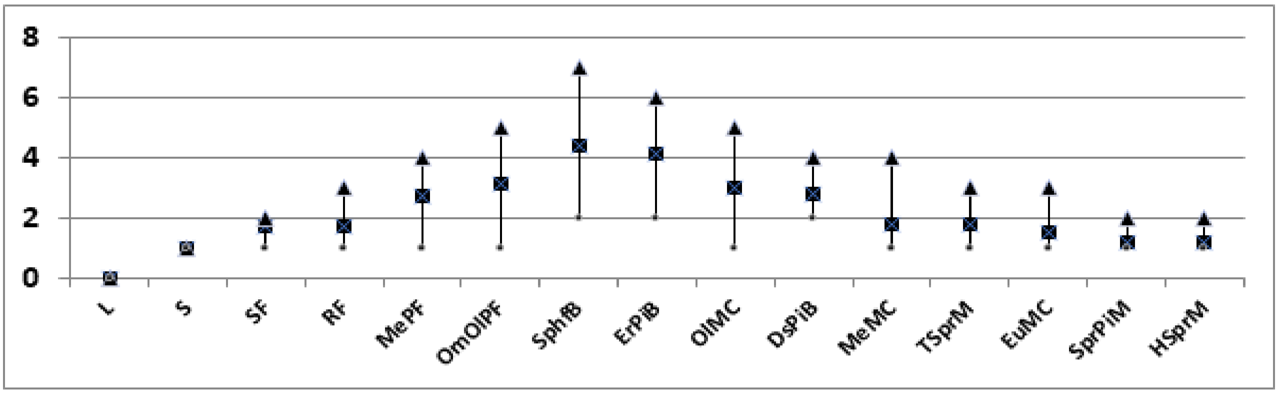


Fig. 9. Above (a): mean depths of peat horizons representing the various mire types as percentages of the mire depth, with minimum and maximum values also shown. The base of the mire is marked as 0% and the surface as 100%. The abbreviation for the mire type is followed by the number of sites at which it occurs (in parentheses) and the mean pH of the peat. Below (b): a stratigraphy-based summary of the phases in the succession that are typical of the mire types in terms of mean phase (solid line), highest phase (▲) and lowest phase (▬).

The mire types can be categorized in terms of acidity (pH) and water content as shown in Figure 10), where ombrotrophic *Sphagnum fuscum* bogs (OmSphfB), which gain their nutrients primarily from precipitation, are shown to have a pH of <3.5 while the ombro-oligotrophic types such as dwarf-shrub pine bogs (DsPiB), ombro-oligotrophic poor fens (OmOlPF), *Eriophorum vaginatum* pine bogs (ErPiB), true spruce mires (TSprM), spruce-pine mires (SprPiM) and oligotrophic complexes (OlMC) have a pH in the range 3.5–4.5. Correspondingly, mesotrophic poor fens (MePF) and mesotrophic complexes (MeMC) fall into the range pH 4.5–5. Peat formed from eutrophic swampy mire vegetation will tend to be only mildly acidic, so that pH values of 5–6 are recorded for swamps (S) and swampy sedge fens (SSdgF), rich fens (RF), eutrophic complexes (EuMC), limnic peats (L) and herb-rich spruce mires (HSprM). The mean water content figures for all the mire types, including limnic peats (L), are in the range 85–92%.

The mainstream of the vegetation succession in peat mires progresses from a spruce mire character to other manifestations of the mesotrophic complexes and flark fens and on to poor fens and bogs, although on account of variations in hydrology and trophic levels successions from rich fens and swamps towards mesotrophic conditions and vice versa can also occur. Spruce mires represent drier conditions, while flark fens, rich fens and swamps imply wetter conditions. In the case of limnic peats the high mineral content reduces the proportion of water and the result depends greatly on how carefully the sample is taken in the field and prepared in the laboratory.

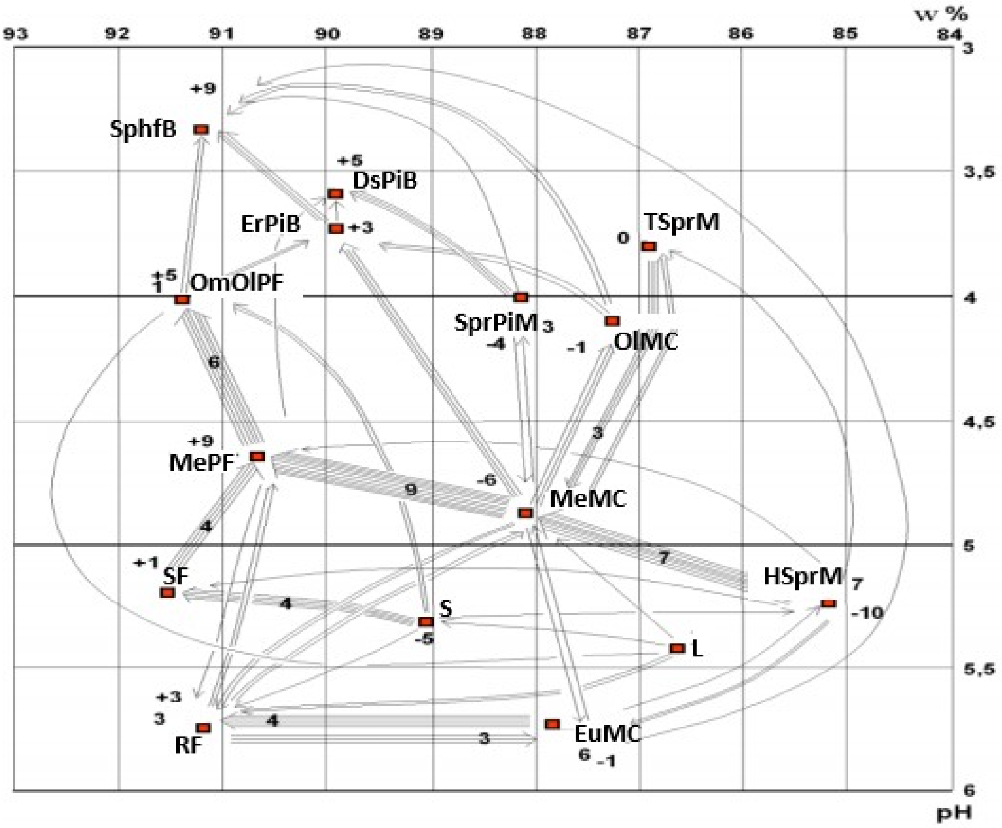


Fig. 10. Development of mire stratigraphy with respect to water content (vol %) and acidity (pH), with the succession of mire types. + development to a given phase, - progression to the next phase. The numbers of recent deposits of the given types are indicated beside their abbreviations; e.g. HSprM 7, -10 indicates that 7 deposits of this kind were observed and the balance of the succession was -10 (2 deposits had developed to this point while 12 had progressed to a new phase).

The succession and its phases as observed in aapa mires may be seen in Figure 10. Here the trend at the majority of the sites is from a rich nutrient supply towards a scarcity of nutrients, and the role of water content is less conspicuous. The dynamic nature of each mire type is reflected well in the balance between those that reach this stage (+) and those that pass on to the next stage (-). This balance is negative (the ratio of mires reaching this stage to those passing on is < 1) in peat laid down in water, swamps, mire complexes, spruce-pine mires and herb-rich spruce mires, i.e. these mire types would appear to be dynamic, readily open to change and to mire margin effects. In contrast, for flark fens of various trophic levels the ratio is positive, i.e. the deposits reaching this phase are more numerous than those passing on to the next phase, the highest ratio in this respect being found with oligo-ombrotrophic pine bogs and mesotrophic poor fens. In these cases the ratio is <10.

Peat deposition

Decomposition of mire plants

As the humification of peat progresses the structure of the plant remains is gradually destroyed and the amount of recognizable material is reduced both in absolute terms and as a proportion of the dry mass of the peat. Mire plants decompose at different rates, however, causing *Sphagnum* and *Carex* peats, for example, to differ in the manner of their deposition, so that when they have both reached a certain degree of humification this will be the result of different mechanisms (Laine & Vasander 1986; Mäkilä 1994). The progress of decomposition in certain mire plants, i.e. the percentages of their mass that can be recognized under a microscope as a function of the degree of humification determined according to von Post (1922), is presented in Appendix 4 and Figures 11 and 12, from which the equations describing the species-specific rates of decomposition quoted in Table 6 have been derived.

Lignin (L)	$y = 3.6803\,x^{1.1269}$	$r^2 =$	0.9444
Nanolignin (N)	$y = 1.3879\,x^2 - 6.0482\,x + 11.958$		0.9505
Cyperaceae (C) (total)	$y = 14.855x^{0.319}$		0.7688
Carex spp.	$y = 18.447x^{0.2666}$		0.6765
Eriophorum spp. (total)	$y = 9.4743\,e^{0.1687x}$		0.9403
E. vaginatum	$y = 0.6467\,x^2 + 0.3618\,x + 11.657$		0.8951
Trichophorum spp. (total)	$y = -0.3514\,x^2 + 0.8551\,x + 12.694$		0.7502
Poaceae (total)	$y = -0.1678\,x^2 - 0.1821\,x + 20.187$		0.1969
Herbs (total)	$y = 6.4414x^{0.5093}$		0.9364
Equisetum sp. (total)	$y = -0.2238\,x^2 + 4.1363\,x + 1.741$		0.9753
E. fluviatile	$y = 1.726\,x^2 - 3.3262\,x + 14.878$		0.9709
Menyanthes trifoliata	$y = -0.7513\,x^2 + 5.916\,x + 4.5615$		0.4238
Potentilla palustris	$y = -1.3837\,x^2 + 6.2502\,x + 6.0488$		0.2306
Scheuchzeria palustris	$y = 13.468\,e^{-0.0297x}$		0.0134
Sphagnum spp. (total)	$y = 42.194\,e^{-0.3468x}$		0.9437
S. angustifolium	$y = 43.408\,e^{-0.4044x}$		0.9342
S. fallax	$y = 37.568\,e^{-0.478x}$		0.9244
S. fuscum	$y = -5.1799\,x^2 + 17.411\,x + 39.449$		0.8798
S. magellanicum	$y = -0.5618\,x^2 + 1.8952\,x + 12.683$		0.9293
S. papillosum	$y = 66.925\,e^{-0.4576x}$		0.8502
S. riparium	$y = 85.807\,e^{-0.6505x}$		0.9614
S. teres	$y = -0.7116\,x^2 + 2.1423\,x + 8.893$		0.8973
S. warnstorfii	$y = 6.7914\,x^2 + 42.371\,x + 69.999$		0.9152
Bryidae	$y = -0.6926\,x^2 - 4.6641\,x + 3.5315$		0.48
Calliergon spp. (total)	$y = -0.0689\,x^2 - 0.3029\,x + 11.37$		0.8233
C. cordifolium	$y = -0.6948\,x^2 + 3.9928\,x + 1.1891$		0.6518
Drepanocladus spp. (total)	$y = 0.4541\,x^2 - 6.21\,x + 24.249$		0.9623
Polytrichum spp. (total)	$y = -0.098\,x^2 - 0.6368\,x + 11.002$		0.8751
Pleurozium schreberi	$y = -0.6786\,x^2 - 9.0357\,x + 25.857$		1
Straminergon stramineum	$y = -1.4908\,x^2 + 10.938\,x - 6.9947$		0.6651

Table 6. Functions depicting the rate of decomposition of mire plants. y = proportion (%) in peat, x = degree of humification (von Post 1922), r^2 = coefficient of correlation.

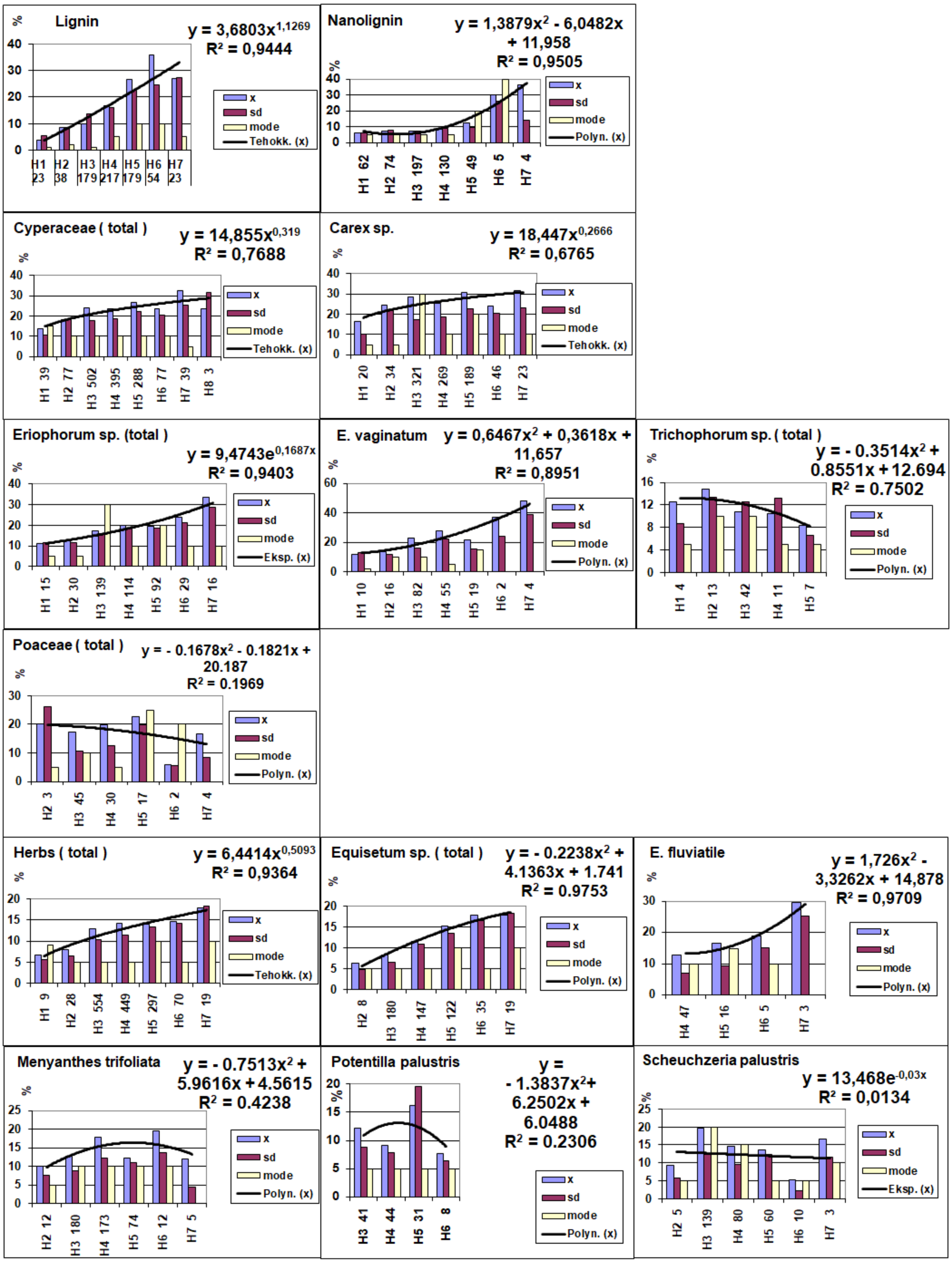


Fig. 11. Amounts of woody material from trees and dwarf shrubs (lignin and nanolignin) and remains of sedges (Cyperaceae), grasses (Poaceae) and herbs as a function of the degrees of humification as distinguished by von Post (1922) (means with sd and mode), and coefficients of correlation between mean values and the degrees of humification expressed as polynomial functions with the explanatory power (r^2) indicated.

As can be seen in Figure 11, the proportions of material derived from trees (lignin) and dwarf shrubs (nanolignin) increase markedly as the degree of humification of the peat advances on the von Post (1922) scale, while the mean proportion of sedges (*Carex* spp.) reaches a maximum of about 30% at phase H_5 and decreases to around 20% in more humified peats. Remains of the cotton-grass *Eriophorum vaginatum*, on the other hand, increase in amount relatively steadily by about 15% over the interval H_3–H_7, whereas the proportion of horsetails (*Equisetum* spp.) rises consistently as the degree of humification increases.

By contrast, the proportions of grasses (Poaceae), deer grasses (*Trichophorum* spp.), and the bogbean, *Menyanthes trifoliata*, marsh cinquefoil, *Potentilla palustris*, and Rannoch rush, *Scheuchzeria palustris,* diminish as further humification takes place. Of the herbs, only the amunt of *Menyanthes trifoliata* increases slightly along with humification, to about 10% from H_1 to H_4, from which point its proportion decreases to 4% by H_6, while *Potentilla palustris* achieves a frequency of no more than a couple of percent between humification grades H_3 and H_6. Remnants of the Rannochrush (*Scheuchzeria*) vary in amount from 10% to 20%, but decline in relative terms as humification progresses. Only very small amounts of the lesser clubmoss, *Selaginella selaginoides*, are to be found in eutrophic peats, and only at the H_3 phase, and lichens also show a incidence.

Similarly, it is shown in Figure 12 that the estimated proportion of *Sphagnum* mosses was over 60% in the least humified peats but had decreased to below 7% by H_5. *Sphagnum fuscum* and the mosses of the *Acutifolia* section reached a maximum of 22–32% in the least humified peats, phases H_{1-3}, and declined rapidly with further humification, as also did the eutrophic *Sphagnum* species, those of the *Cuspidata* section and *Sphagnum papillosum* among the *Palustria* section, all of which had a maximum occurrence of less than 10% and were difficult to detect at all beyond the H_{5-6} phases. According to Heikurainen and Huikari (1952), *Sphagnum* mosses and dwarf shrubs remain undecomposed, and therefore recognizable, even in H_{10} peats, but the present results suggest that Sphagnum mosses disintegrate almost entirely at an H_8 level of humification.

The mean proportion of Bryidae is highest at peat humification degrees H_{2-3}, where it reaches 10–12%, from which point it decreases to less than 5% in well humified peats (Fig. 12). The *Calliergon* mosses, on the other hand, gain in prominence up to the H_4stage, reaching 7–12%, although remaining below 2% in well humified peats, while the maximum figures for *Polytrichum* and *Dicranum* mosses are less than 2% even in poorly humified peats. The proportions of *Pseudobryum*, *Hylocomium* and *Rhizomnium* mosses are very small throughout (< 0.5%).

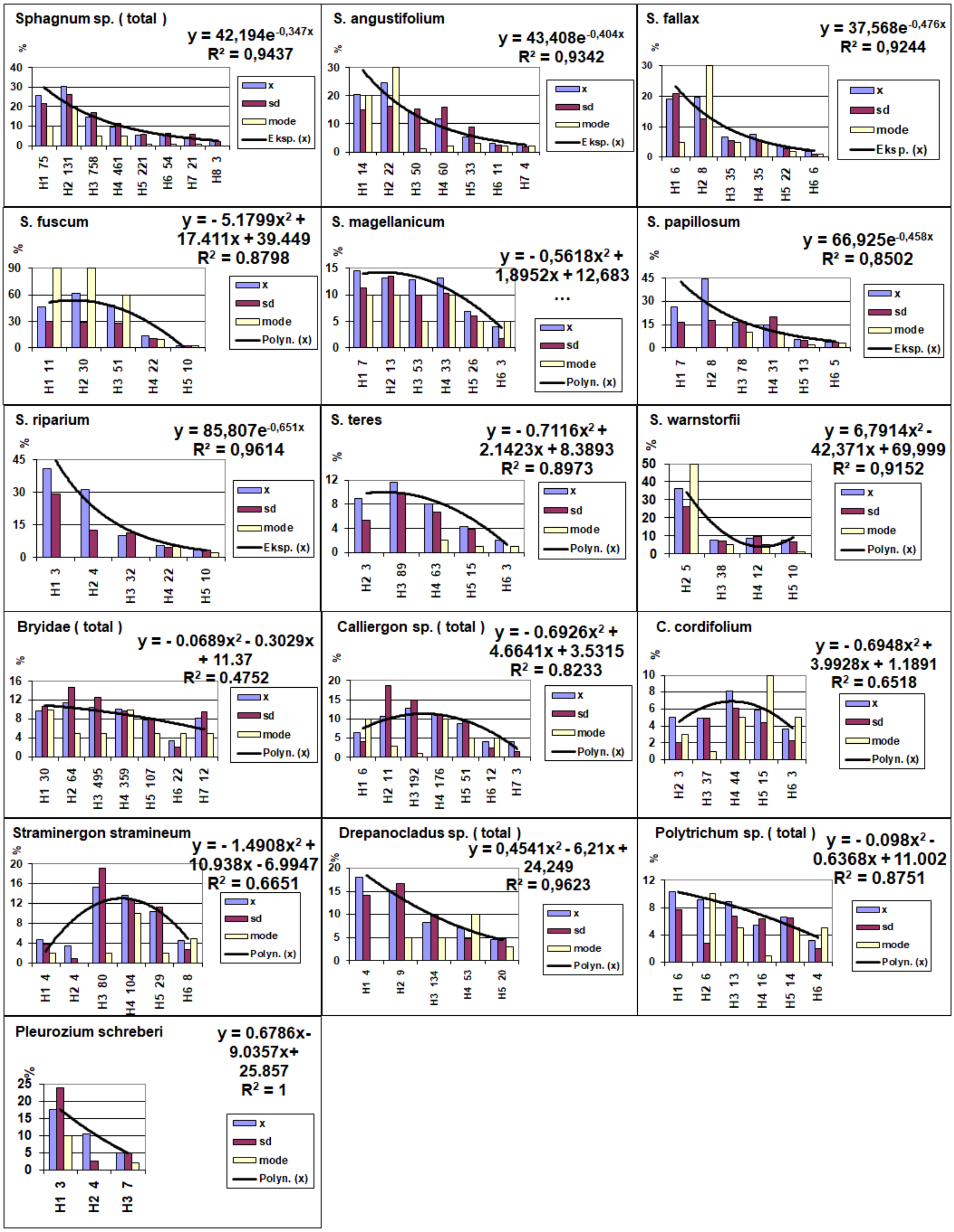


Fig. 12. Amounts of *Sphagnum* mosses and brown mosses (Bryidae) as a function of the degrees of humification distinguished by von Post (1922) (means with sd and mode), and coefficients of correlation between mean values and the degrees of humification expressed as polynomial functions with their explanatory power (r^2) indicated.

After normalization of the data to account for differences in the numbers of samples it was possible to calculate the degree of humification of a peat (x) given the proportions (%) of plant remains in it, or conversely, to predict the proportion of a given peat-forming factor (plant species, y) if the degree of humification of the peat horizon is known (Table 7).

			H1-10		**Peat factor %**		**Regression equations**	
	n	**r^2**	**x**	**sd**	**y**	**sd**		
Lignin	314	22,1	4	1,28	24,25	23,51	x = 0,02568y + 3,3805	y = 8,6283x - 10,293
Nanolignin	722	10,5	3,59	1,2	14,03	14,78	x = 0,02628y + 3,2227	y = 3,9939x -0,031479
Carex	907	0,1	3,83	1,17	28,95	20,32	x = 0,00196y + 3,7712	y = 0,5957x + 26,672
Eriophorum	327	5	3,8	1,21	22,07	19,49	x = 0,01389y +3,4915	y = 3,5946x +8,4176
Equisetum	513	11	4,08	1,11	12,01	11,78	x = 0,03128y +3,7003	y = 3,5278x -2,369
Menyanthes	454	0,6	3,79	0,97	14,67	11,25	x = 0,00656y + 3,6945	y = 0,88404x +11,321
Potentilla	117	1,7	3,98	0,97	10,52	8,06	x = - 0,0158y +4,1492	y = - 1,0818x +14,83
Scheuchzeria	301	0,8	3,84	1,04	17,2	13,06	x = - 0,00728y + 3,9624	y = - 1,1382x +21,567
Sphagnum	867	25,5	3,56	1,16	27,41	27,03	x = - 0,02172y +4,1569	y = - 11,728x +69,18
S. fuscum	133	28	2,9	1,12	42,02	31,89	x = - 0,01861y +3,6843	y = - 15,071x +85,762
S. papillosum	139	9,5	3,38	1,11	16,4	17,73	x = - 0,01937y +3,699	y = - 4,9203x +33,04
S. acutifolia sec.	311	24,1	3,29	1,28	26,45	27,72	x = - 0,02261y +3,8873	y = - 10,642x +61,457
S. cuspidata sec.	271	19,1	3,5	1,14	13,2	15,01	x = - 0,0333y +3,9415	y = - 5,7289x +33,265
Eutr. *Sphagnum*	357	10,6	3,55	0,97	10,34	10,38	x = - 0,03035y + 3,8655	y = - 3,4827x +22,706
Bryidae	545	1,4	3,57	1,05	18,68	18,13	x = - 0,00683y +3,6965	y = - 2,0243x + 25,905

Table 7. Polynomial functions for the decomposition of plant remains in the present material after normalization with respect to the numbers of samples. x = degree of humfication on the scale of von Post (1922), y = the given peat-forming factor as a percentage by volume of peat at the given degree of humification, sd = standard deviation, n = number of samples, r^2 = explanatory power.

The above results also enable the calculation of correlations between the proportions of certain commonly occurring peat-forming plants and the degree of humification of the peat. The highest negative correlation is obtained for the *Sphagnum* mosses, with an explanatory power of r^2 = 25.5%, while the r^2 value for *S. fuscum* alone reaches 28%. Lower values are recorded for the eutrophic *Sphagnum* mosses and the *Cuspidata* section, however. As humification proceeds the explanatory power of the function for the accumulation of slowly decomposing ligneous material rises to exceed 22%.

Proportions of amorphous material in peat

The distribution of degrees of humification in the total material of peat samples discussed here (n=1085) is skewed in a positive direction, with its peak at H_3–H_4 on von Post's scale (1922). The main body of fibrous peat has a grain size >0.125 mm, with the finer fraction representing amorphous material, the proportion of which increases by about 10% per degree of humification up to H_7. The results for the washed and sieved peat samples (n=531) show that the proportion of the amorphous fraction increases linearly with respect to the degree of humification (Fig. 13).

The ratio of amorphous to fibrous plant material in the structure of peat will naturally vary from one mire type to another, as the mire types differ in oxygenation (which affects humification and the activity of decomposing organisms), in nutrient levels, in acidification, and also in moisture content and temperature. This means that the mean proportion of amorphous material will serve as a direct indicator of the degree of humification of the peat. A poorly humified *Sphagnum fuscum* peat, H_{1-3} (von Post 1922), will contain only 13% amorphous material, for example, whereas well humified peat from a meso-eutrophic fen may have as much as 73%. The mean proportion of amorphous matter in the basal peat of the various surface mire types studied here was 40% (Fig. 14).

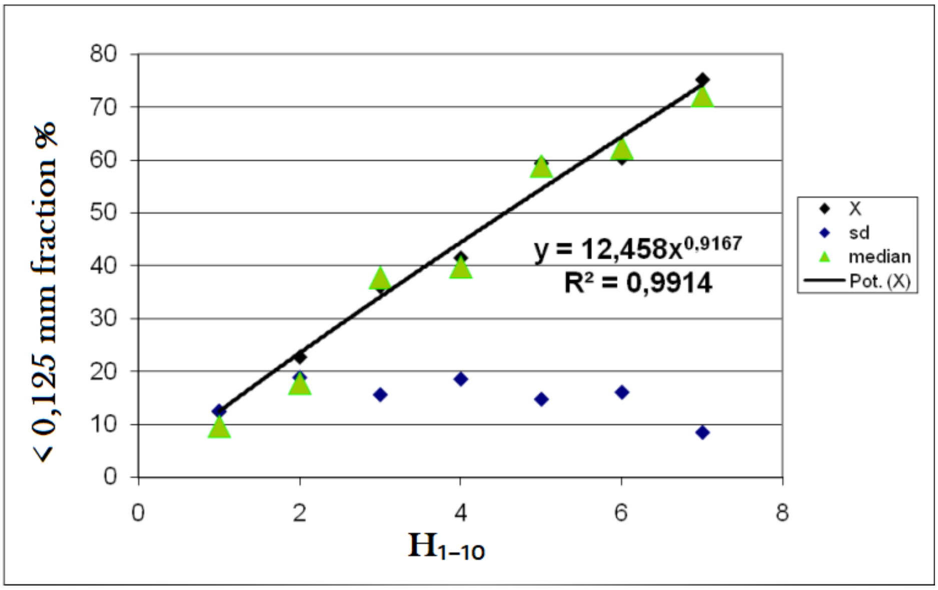


Fig. 13. A linear dependence with high explanatory power was observed between the (dry weight) percentage of the amorphous fraction (<0.125 mm) and the degree of humification (H_{1-10}) according to von Post (1922). The total number of samples was 531.

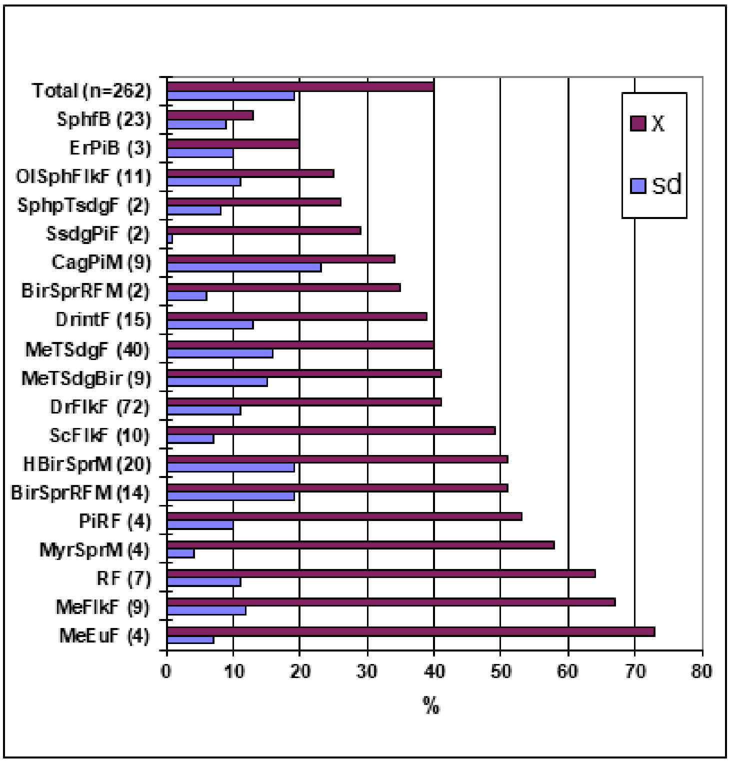


Fig. 14. Mean amorphous content (x, with sd) of the peat horizons of the mires studied, grouped according to their surface mire type (for abbreviations, see caption to Fig. 8). Numbers of samples taken are shown in parentheses.

When examined in terms of depth, the proportions of amorphous material in the spruce mires, poor fens and mire complexes are very similar, and figures of over 40% can be found even at depths of only 20–30 cm in all the major mire types. In the case of the pine bogs the mean proportion is 20%, with the maxima occurring at depths of about 40 cm. A clear correlation is seen between the lignin content of the peat and the degree of humification ($H_{1\text{-}10}$), with fairly high r^2 values (Table 8).

Swamps	n = 5	y = 12,038x-29,769	r^2 = 65.3
Oligotrophic complexes	11	y = 16,721x-37,897	51
Herb-rich spruce mires	62	y = 13,114x-14,371	41.4
Mesotrophic complexes	55	y = 11,63x-18,573	23.5
Mesotrophic poor fens	27	y = 5,4612x-3,2895	11.8
Spruce-pine mires	13	y = -5,6568x-2,7638	36.9

Table 8. Correlation between lignin content and degree of humification of the peat ($H_{1\text{-}10}$) in the various mire types.

If peat were to be classified entirely on the basis of the proportion of amorphous material (A) and the occurrence of *Sphagnum* (S), brown mosses (B) and sedges (C), the formula for defining the various mire types on the basis of the mean compositions would be a brief and concise one, although still retaining an indication of the recognizability of the plant remains, i.e. the degree of humification of the peat, by virtue of the proportion of amorphous matter, and an indication of nutrient status through the plant species present (Fig. 15). Highly acidic peats (pH <4) that are poor in nutrients will have been deposited in mires of an ombro-oligotrophic type, and will be either non-amorphous (<25% A) or amorphous (25–50% A) *Sphagnum* peats. *Sphagnum fuscum* bogs and dwarf-shrub pine bogs would not be capable of forming *Sphagnum* amorphous peat (SA). Mesotrophic and eutrophic mire types, on the other hand, would be capable of producing amorphous brown moss and sedge peats or well humified brown moss and/or sedge amorphous peats (BA, CA). The largest amounts of brown mosses are to be found on rich fens and swampy mesotrophic fens.

The definitions of peat types in terms of composition can also be filled out with additional factors (L, ER, MN, EQ etc.). In the case of extremely well humified peats the principal component may be an amorphous mass and the remainder various plant remains, recognizable or unrecognizable, and in this way peats of differing nutrient status may vary in composition according to other growing site factors, including hydrology, soils and the bedrock. Woody material is found to the greatest extent in the peats of mire complexes and spruce mires, while vascular plants and brown mosses are markedly more prevalent in rich eutrophic peats than in ombrotrophic ones, where *Sphagnum* mosses predominate. Remains of vascular plants and brown mosses are somewhat less common in mesotrophic peats than in eutrophic ones, while the incidence of *Sphagnum* mosses shows a clear negative correlation with depth. Conversely, it is the *Potentilla* species present in the early, watery stages of mire formation that show the closest positive correlation with depth. There are small amounts of the remains of aquatic plants in the most humified of the limnic peats, while the mesotrophic and eutrophic peats contain less than 10% *Menyanthes trifoliata* and only a very small proportion of *Potentilla palustris*. *Scheuchzeria* remains below 6%, and there is very little *Selaginella selaginoides* present, mainly confined to eutrophic peats. Lichens and both *Polytrichum* and *Dicranum* mosses are deposited in poor ombrotrophic peats to some extent.

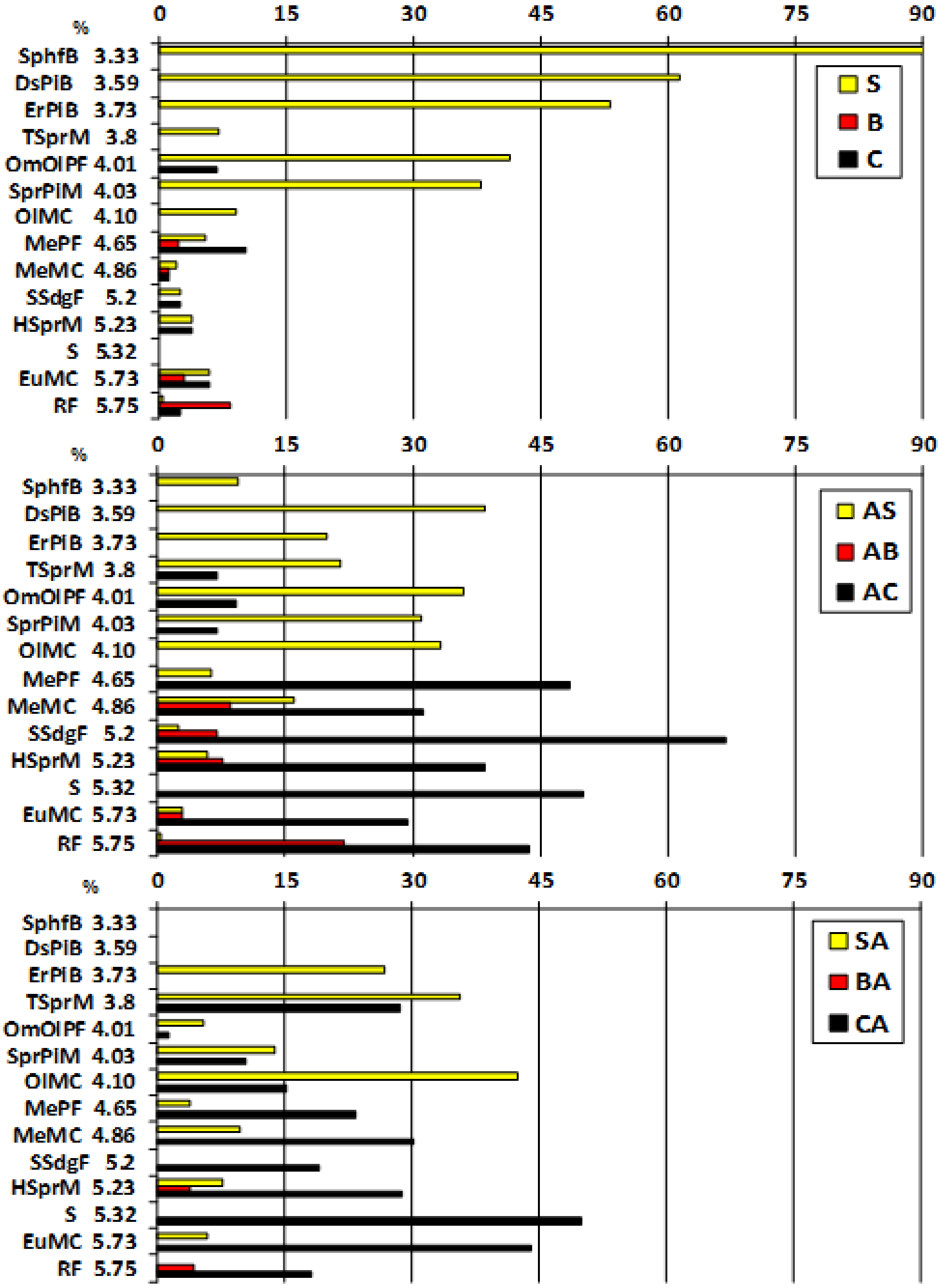


Fig. 15. Peats to be found in the mire complex types, taking into account the percentage of amorphous material (A <0.125 mm) in addition to the principal factors (S, B and C). Key to peat types: S = *Sphagnum* peat with <25% (vol.) amorphous matter; AS = amorphous *Sphagnum* peat with 25–50% amorphous matter; SA = *Sphagnum* amorphous peat with over 50% amorphous matter. The mire types are arranged in order of their mean pH.

Influence of the mire base on peat horizons

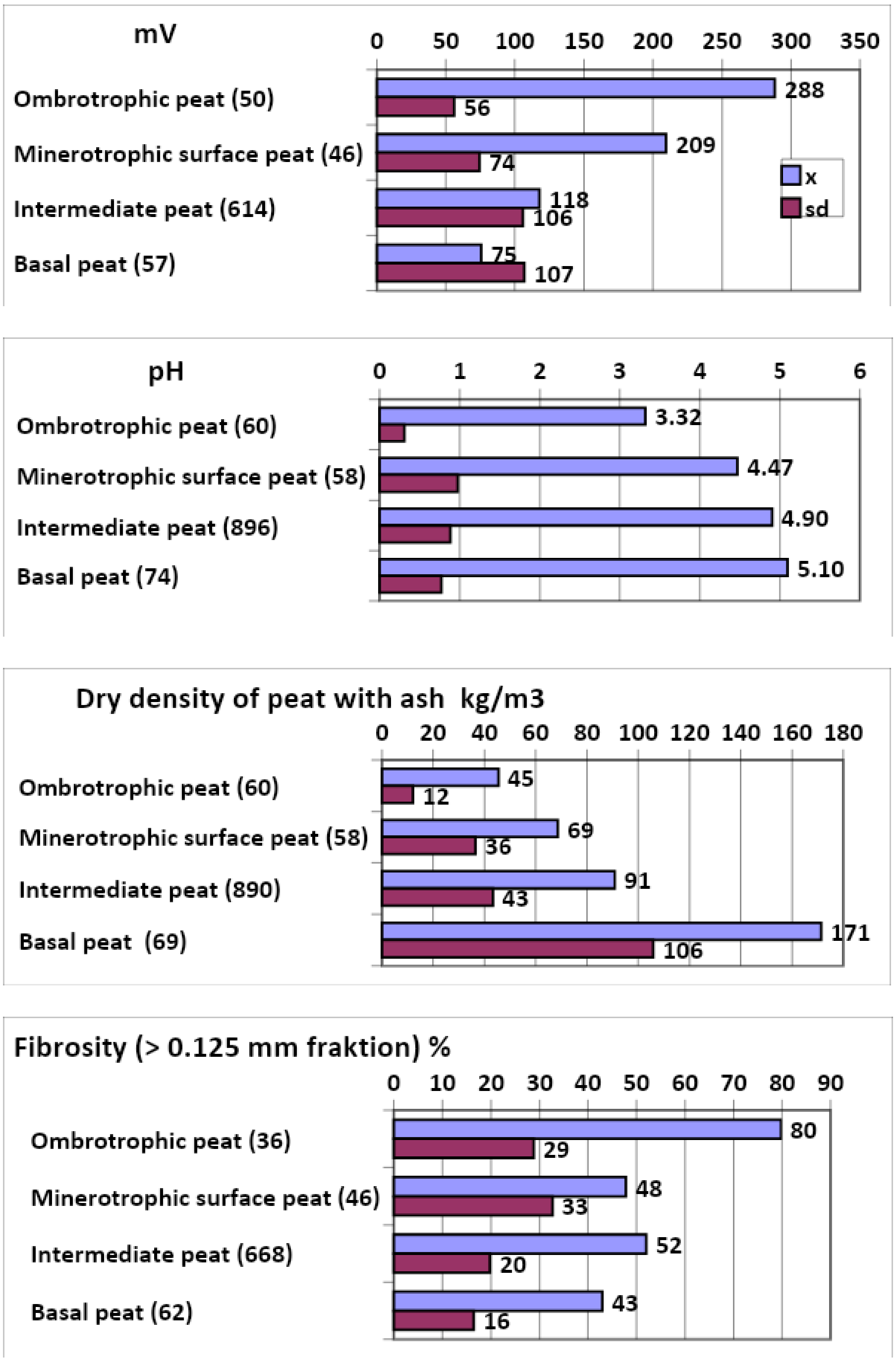
Physical properties

The plant remains recoverable from both ombrotrophic and minerotrophic acrotelm peats are only slightly humified, are coarse to the touch, do not stain and contain little lignin or remains of sedges or *Eriophorum*, while the minerotrophic intermediate and basal peats are fairly or moderately humified and thus capable of being moulded and the plant remains contained in them are partially or totally decomposed (Appendices 5 and 6).

Measurements of the redox potential of the ombrotrophic surface peats (mV, see Fig. 16) show these to be on average better oxygenated than the minerotrophic surface peats. Peat profiles tend to become more anaerobic towards the bottom of the mire, whereas acidity tends to decline towards the bottom, the pH in the ombrotrophic surface peats often being <3.5. The smaller the proportion of amorphous matter in the peat is, the lower its degree of humification will be. The mean dry density of the ash from an ombrotrophic peat is below 50 kg/m^3 of mire volume, but mineral material transported in the water draining down hills and slopes into a mire can increase this dry density of ash, as seen here in the Riissuo herb-rich spruce mire, for example (no. 10 in Fig. 1).

Geochemical properties

The Ca content of peat ash is considerably higher in areas with alkaline rocks (SiO_2 52–66%) than in those with more acidic rocks (SiO_2>66%) or sandy-based mires. K, Al and Mg concentrations vary very little between acidic and alkaline rocks, but they are markedly lower in the peats of ombro-oligotrophic or sandy-bottomed mires. Sandy-bottomed mires and those in areas with an acidic bedrock will show higher concentrations of Mn in their peat than those in areas with an alkaline bedrock (Fig. 17, Appendices 5 and 6).



Fig, 16. Redox potential (mV), acidity (pH), fibrosity (material of size >0.125 mm) and dry density of peat ash (kg/m^3) in ombrotrophic peat, minerotrophic surface peat, intermediate peat and basal peat. Numbers of samples are show in parentheses, x = mean, sd = standard deviation.

The ombro-minerotrophic character of a mire will stand out clearly in terms of the element concentrations in its peat ash (Fig. 18), especially as far as Fe, Ca, Mg, Al and P are concerned, since these will differ markedly between ombrotrophic and minerotrophic peats, whereas the differences in Mg and K will be smaller in the intermediate and basal horizons. By contrast, the

Fe:Mn and Ca:Mg ratios are both twice as high in the intermediate and basal peats than in the surface peats, and the difference is many times greater for the Ca:K, Cu:Zn and Na:K ratios.

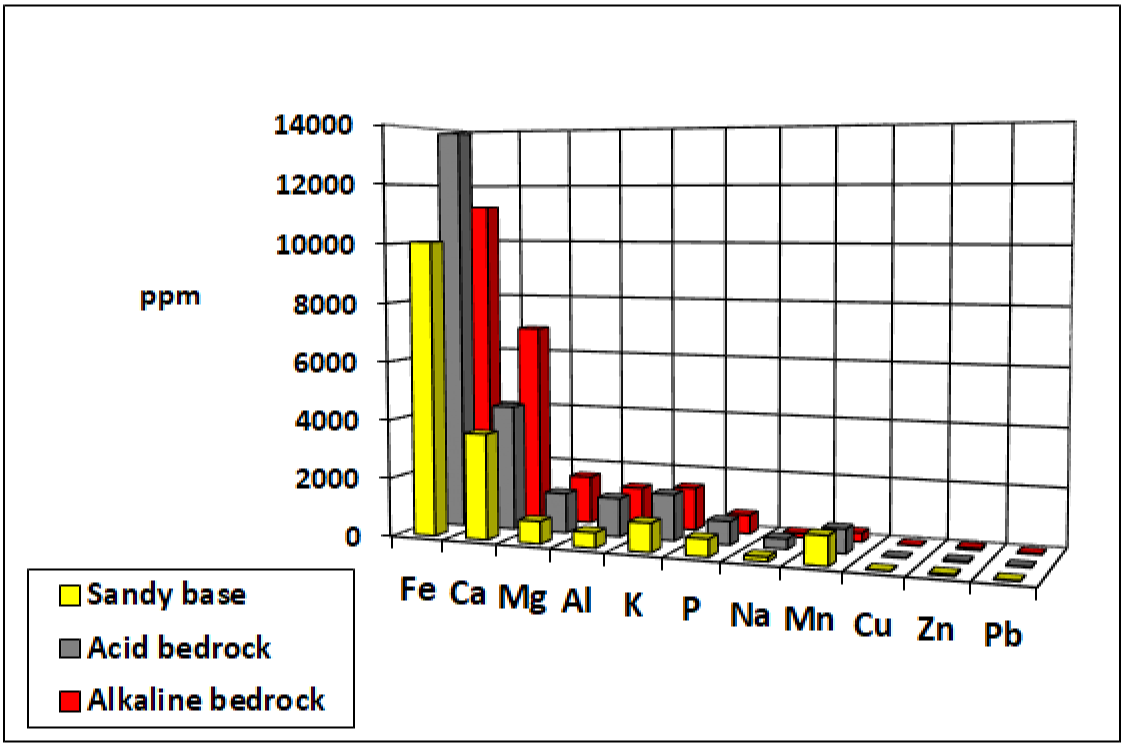


Fig. 17. Element concentrations (ppm) in mires that have developed in various alkaline or acid bedrock areas or on a sandy base.

In a previous paper based on the same material (Eurola & Holappa 1984) the surface peat was defined as the horizon in which the element concentrations undergo enrichment from the living plants (cf. also Aulio 1980, 1982). The mean thickness of this horizon in the present material was 13.7 cm, being 13.3 cm in the spruce mires, 19 cm in the pine bogs, 12.3 cm in the poor fens, 10 cm in the rich fens and 13.7 cm in the mire complexes. The ratio of this element enrichment horizon to the total thickness of all the peat horizons representing the same mire type was 1:3 in cases where the surface mire type showed a margin effect and 1:5.2 where it showed a centre effect. There were some variations in the element concentrations in the peats, however, on account of differences in acidity between the growing surfaces on the mires, the highest concentrations being found under acidic and eutrophic alkaline conditions.

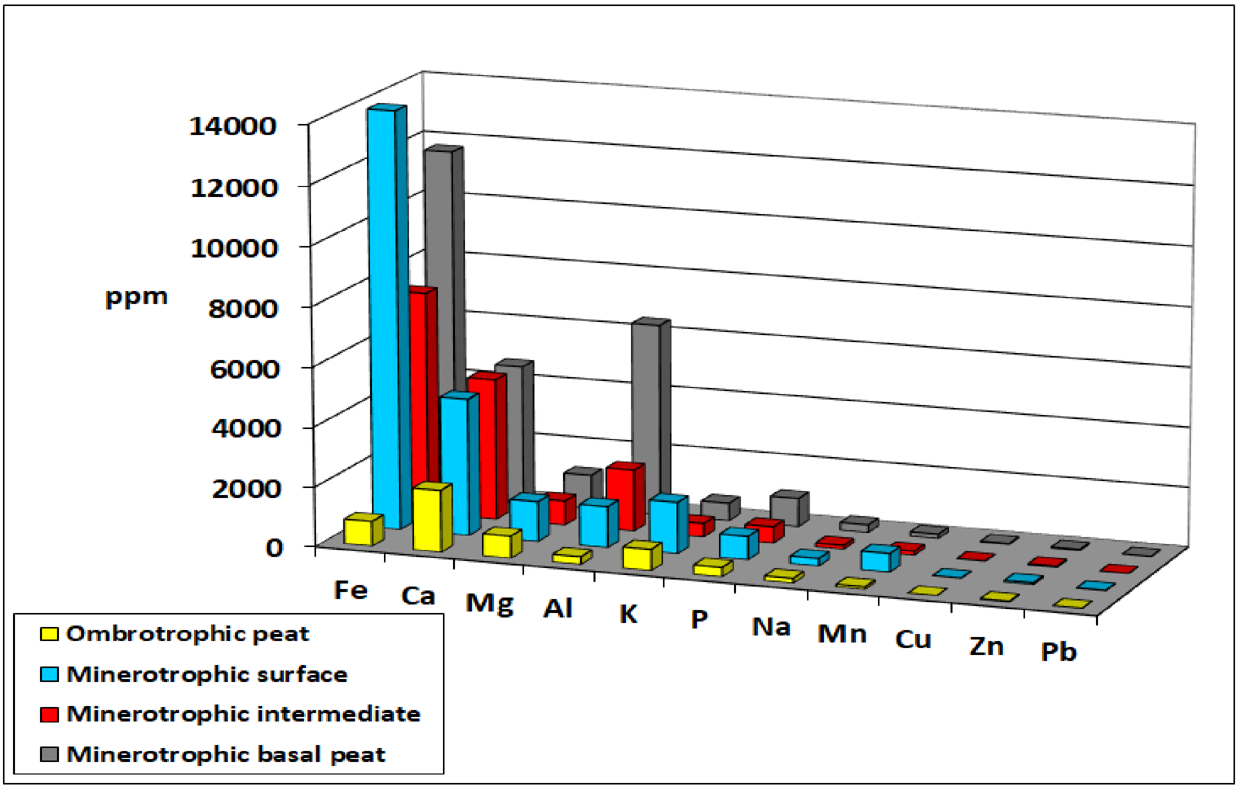


Fig. 18. Element concentrations (ppm) in ombrotrophic surface peats and the surface, intermediate and basal peats of minerogenic mires.

In particular, the concentrations of Ca, Mg and K in the peats tended to increase from ombro-oligotrophic to eutrophic conditions, and the difference was still greater where concentrations in acidic and alkaline bedrock areas were concerned. In minerotrophic surface peats it was iron, potassium and manganese that were enriched most, and in basal peats it was aluminium, but it was always the case that enrichment with additional nutrients from living plants or from environmental sources was more efficient in the surface peats of recent mires at various trophic levels than it was in the basal peat horizons of mires of the same type (Figs. 19 and 20). On the other hand, the ash from the ombro-oligotrophic surface peats contained very much lower concentrations of Fe, Al, Ca and Mg than that did that from the meso-eutrophic peats, while the eutrophic surface peats also contained large amounts of manganese. Basal peats conforming to the same recent mire types did not show the same differences between trophic levels as were evident in the surface horizons.

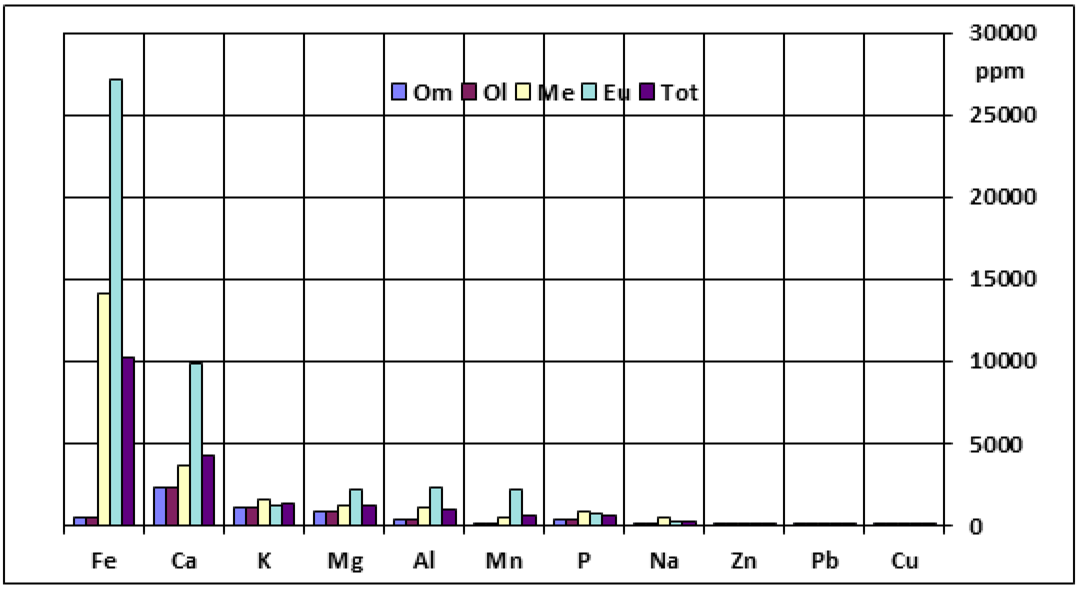


Fig. 19. Mean element concentrations (ppm) in recent mire surface peat types of different trophic levels.

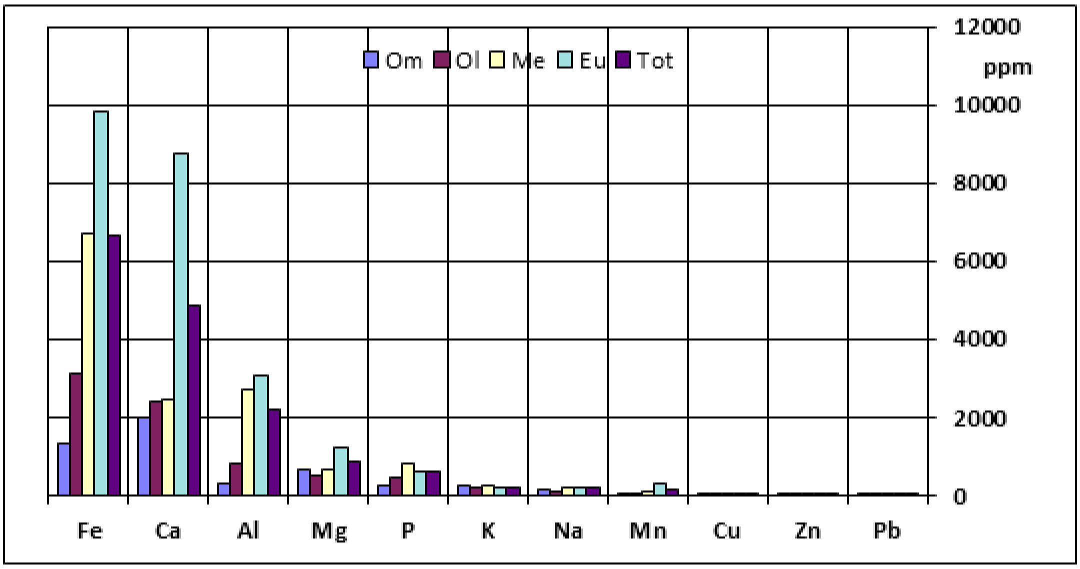


Fig. 20. Mean element concentrations (ppm) in basal peat horizons corrersponding to recent mire types of different trophic levels.

Properties of mire type horizons and correlations between them

Physical properties

Mean values for the various physical properties of the mire types are presented in Figures 21 and 22 and Appendix 7 in the order of their occurrence in the mire type succession (see Fig. 9). The mire types that are poor in nutrients and are influenced by a mire centre effect are the ones that are least well humified on the scale H_{1-10} (Fig. 21), while the greater the amorphous fraction in the peat Amorf.%), the higher its degree of humification. In alkaline bedrock areas the dry bulk densities of the peats (kg/m^3) and the amounts of organic material that have accumulated in them (Org. %) are both slightly higher. Organic material becomes enriched in the peat to the greatest extent in those mire types than involve a tree cover, especially when there is a field layer of dwarf shrubs to produce a further supply of slowly decomposing ligneous biomass. Under swampy conditions or in the presence of high runoff volumes the ash content (Ash %) of the pine bog and spruce mire types influenced by a mire margin effect is very much higher than that found in the types having a mire centre effect. The least ash is obtained from ombrotrophic peats. The wettest mire types in areas with an acidic bedrock are the rich fens and swampy sedge fens, while the mire margins that support a tree cover feature mire types that are somewhat drier than average. The poor fens and rich fens are the types in which the peat has the highest water content (H_2O%), leading to a decline in oxygen levels and a consequent lowering of the redox potential (mV). The hummocky mire types with poor nutrient levels have a low water surface, so that their redox potentials are high and their pH correspondingly very low.

Geochemical properties

Element concentrations in the mire types involving a mire margin effect are much higher than in the thick peat horizons of the types with a mire centre effect (Figs. 23 and 24, Appendix 7). In particular, more calcium (Ca), magnesium (Mg), potassium (K) and phosphorus (P) from the environment accumulates in thin-peat pine bogs with a slight mire margin effect than in pine bogs with a mire centre effect, and in addition, large amounts of iron (Fe) accumulate in peat under swampy conditions whereas very little will be found in ombro-oligotrophic peats. On the other hand, ombro-oligotrophic and mesotrophic peats will contain smaller amounts of manganese (Mn), aluminium (Al), calcium (Ca) and magnesium (Mg) than the peats that constitute rich fens and swampy fens. Element concentrations in mires with a margin effect and trees growing on them, and also in wet, swampy open mires, will be higher in alkaline than in acidic bedrock areas.

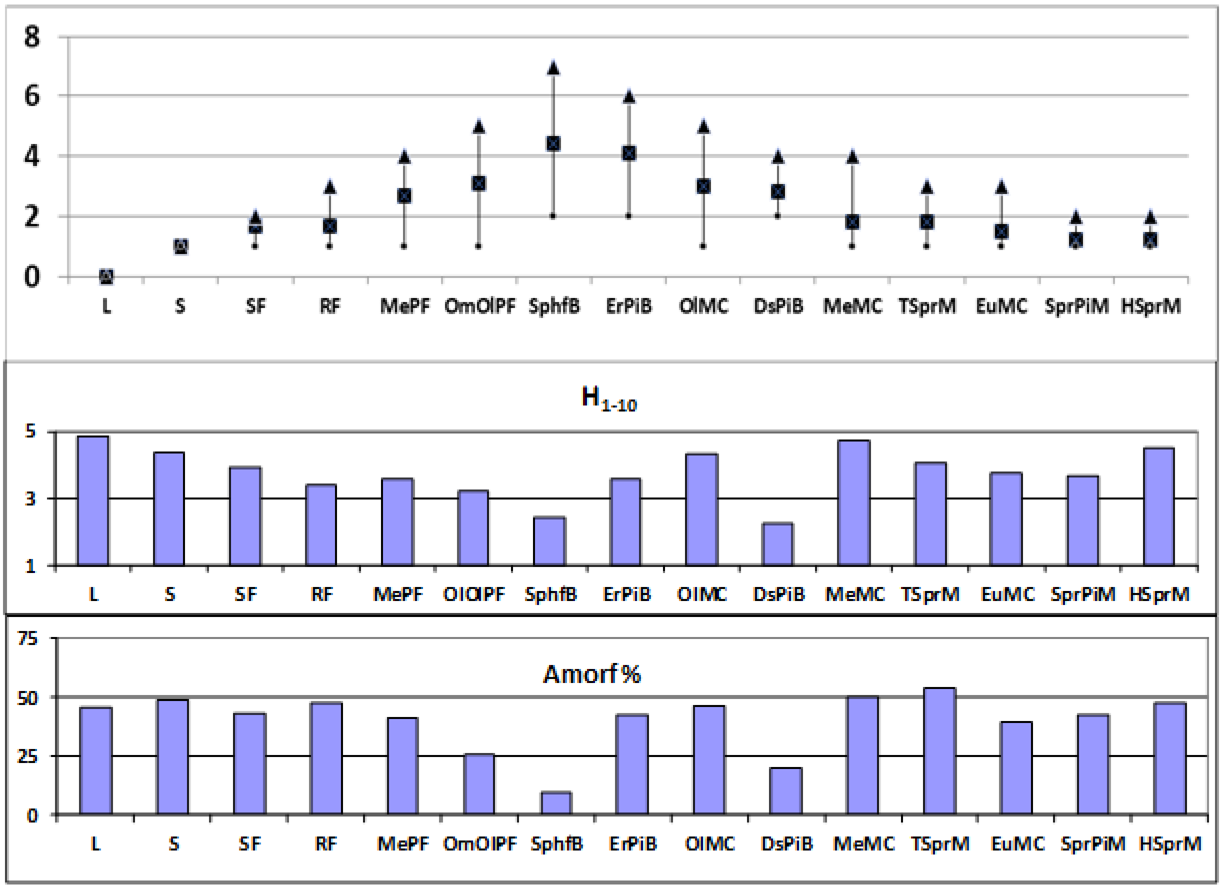


Fig. 21. Comparisons of phases in the mire succession, degrees of humification and proportions of amorphous material between the mire types.

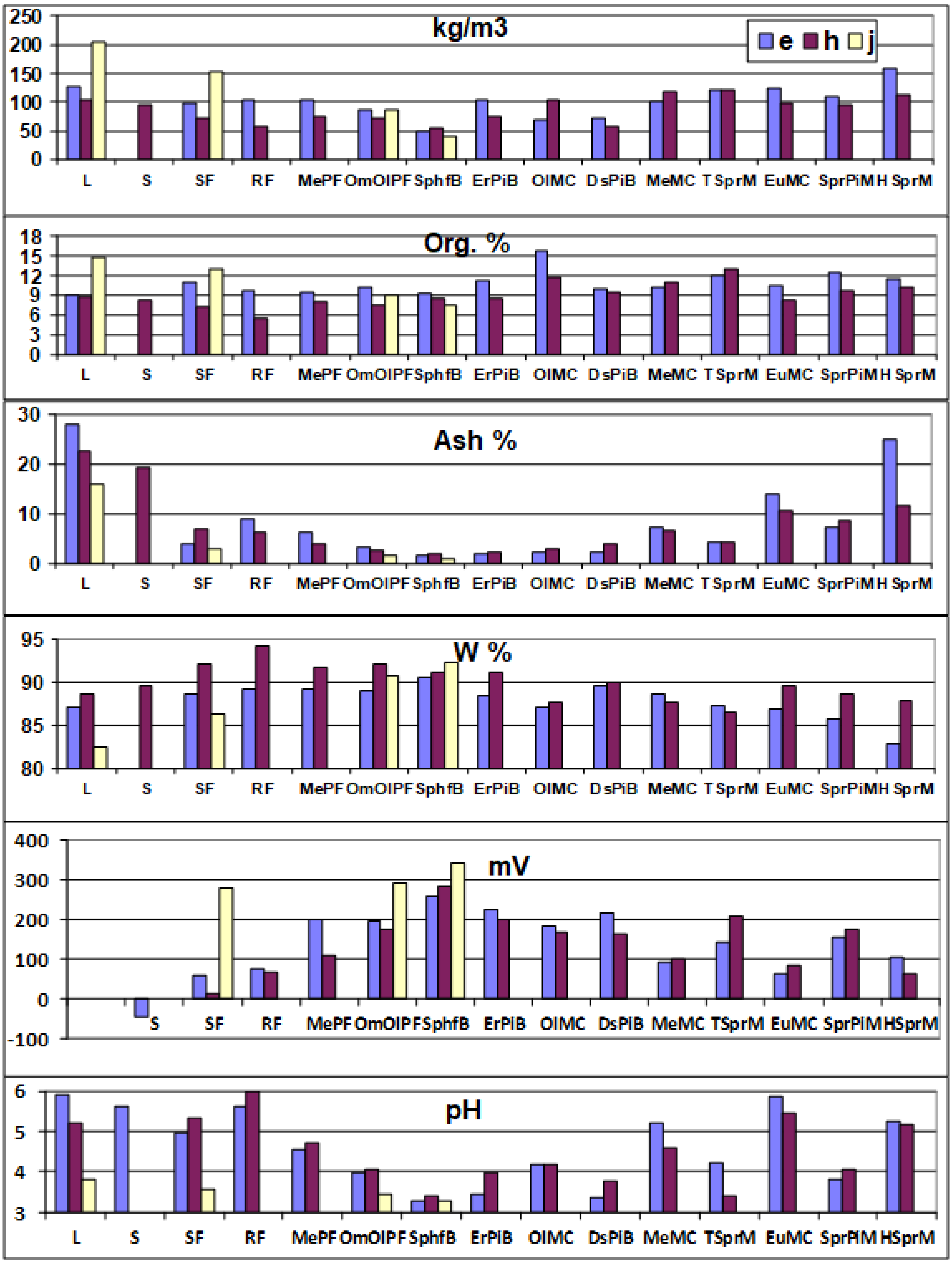


Fig. 22. Comparisons of mean dry bulk densities of the peats as a function of wet volume (kg/m^3), proportions of organic material (Org. %), ash content as a function of dry mass (Ash %), water content as a function of wet weight (H_2O %), redox potential (mV) and acidity (pH) between the mire types (e = alkaline bedrock, h = acidic bedrock, j = Jotnian sediments).

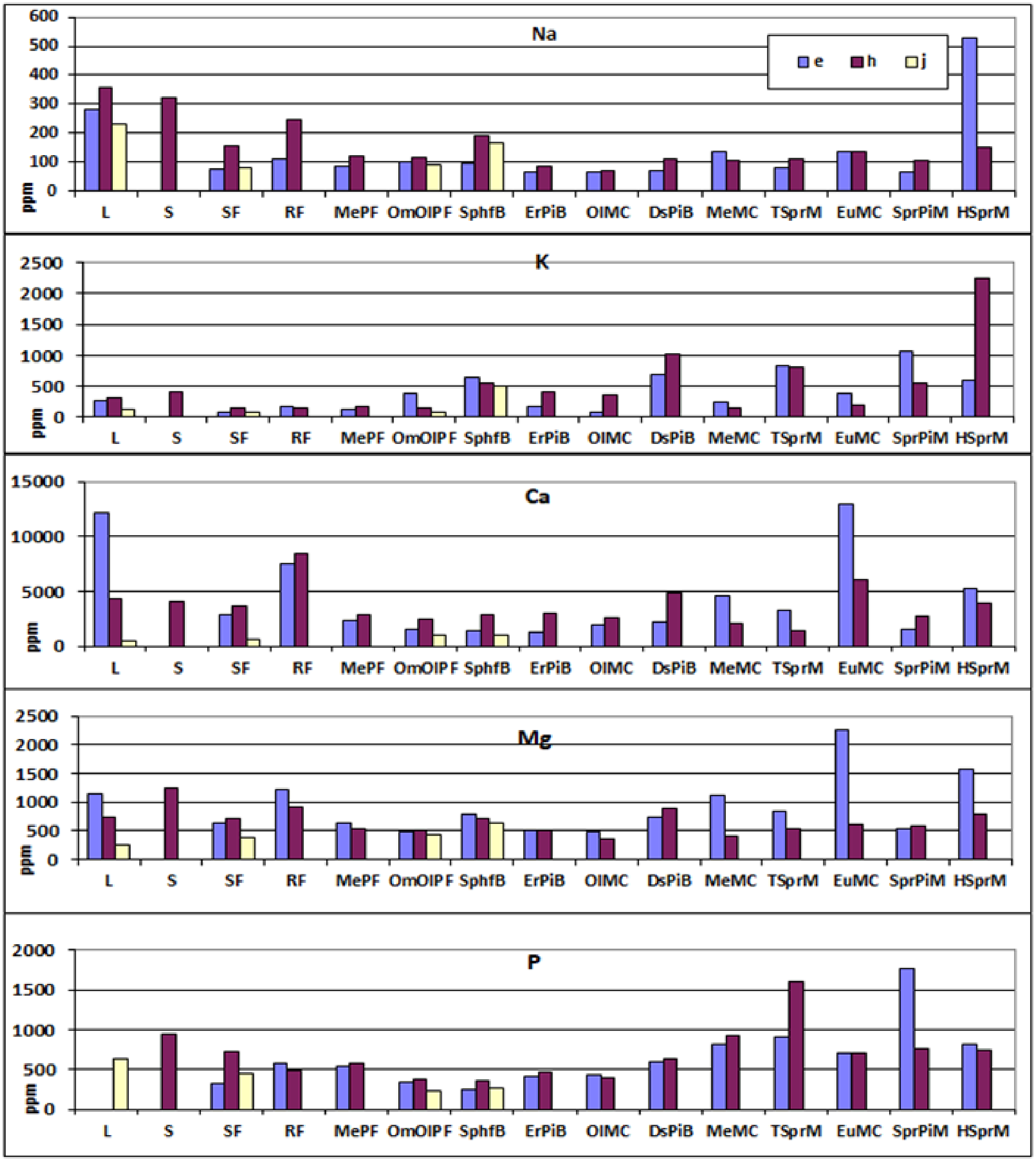


Fig. 23. Comparisons of mean Na, K, Ca, Mg and P content (ppm) between the mire types (e = alkaline bedrock, h = acidic bedrock, j = Jotnian sediments).

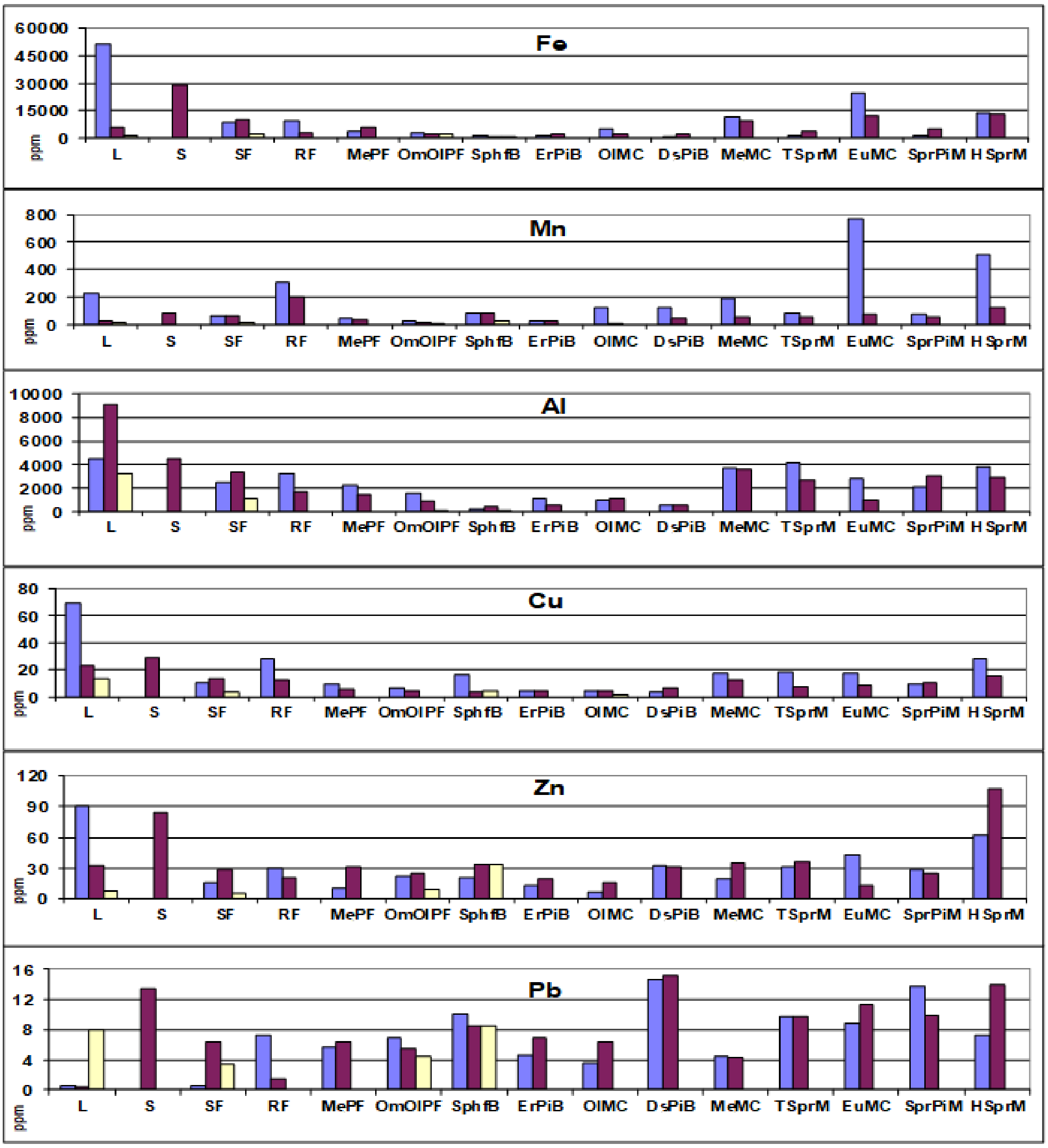


Fig. 24. Comparisons of mean Fe, Mn, Al, Cu, Zn and Pb content (ppm) between the mire types.

High element concentrations in the peat ash (Table 9) are to be found at varying depths in the mires: in the basal horizons or in thin-peat mires with a margin effect, but also in some surface horizons. The highest copper concentration of all, 257 ppm, was found in the basal peat of the Loiraskangas thin-peat meso-eutrophic fen in Utajärvi, and correspondingly, the highest lead content, 74 ppm, was detected in the Purkuputaansuo mire inv Kuusamo and the highest zinc content, 436 ppm, in the Rautuojaaapa mire in Simo. High concentrations of heavy metals were seen in samples from these same areas.

No. and name of mire		Cu	Pb	Zn	District
39	Ternuvuoma	44	40	75	Rovaniemi
26	Kilsiaapa	63	34	38	Tornio
44	Vaarajänkkä	211	53	109	Tornio
45	Karsilonmaa	54	55	75	Tornio
61	Rautuojanaapa	43		436	Simo
69	Näätäaapa	49		41	Ranua
18	Pilpasuo	50	63	347	Oulu
9	Takasuo	115	48	335	Oulu (Ylikiiminki)
2	Ruostesuo	103	59	105	Kiiminki
36	Päijännesuo		45	208	Muhos
20	Reikäsuo	46			Muhos
29	Loiraskangas	257	34	46	Utajärvi
27	Kivisuo	46			Utajärvi
70	Saarisuo			61	Pudasjärvi
58	Posonpalo			80	Pudasjärvi
50	Rytisuo/Siikavaara		41	167	Pudasjärvi
52	Lomasuo/Siikavaara	108	37	81	Pudasjärvi
51	Rytisuo/Parolanranta	44	39	98	Puolanka
47	Pihlajavaara	49		51	Puolanka
63	Mustinsuo			309	Kuhmo
64	Säynäjäsuo			162	Suomussalmi
59	Säkkisuo			53	Suomussalmi
56	Lahnaletto	48		85	Suomussalmi
66	Ulkupuro	184		109	Suomussalmi
7	Riisisuo			357	Posio
19	Purkuputaansuo	40	74		Kuusamo

Table 9. Maximum copper (Cu), lead (Pb) and zinc concentrations in peat ash, with locations of the mires concerned.

Organic material and dry densities

Organic material accounted for an average of 7–12% of the wet weight of the peat (see Fig. 25) in the main categories of Finland’s aapa mires according to the definitions of Cajander(1913), the figures being higher in the nutrient-rich mire types with a mire margin effect than in the poor fens and rich fens.

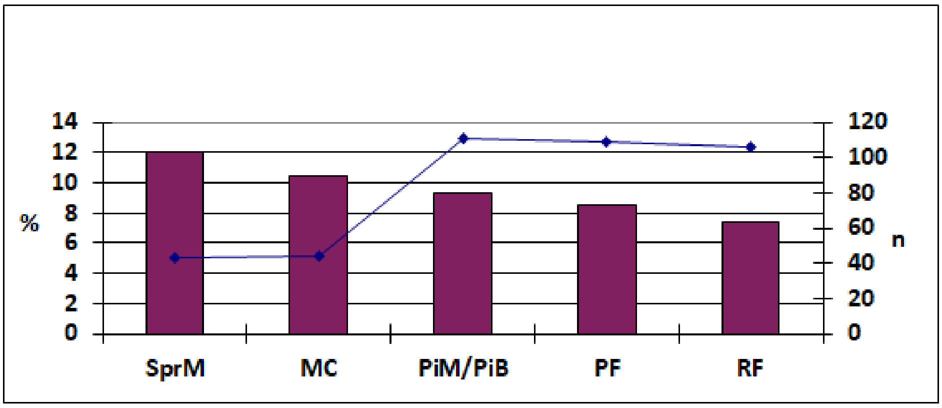


Fig. 25. The mean accumulation of organic material in mires as a percentage of the fresh weight of their peat varied in the range 7.4–12% between the mire types (classified here according to Cajander, 1913). n = number of samples in the present material.

The mean ash-free dry density of slightly humified peats from the poor ombrotrophic and oligotrophic mires was the lowest of all, while the densities recorded for the forested mire types were somewhat higher than those for the poor fens and the highest figures of all were mostly achieved in extremely well humified peats (Fig. 26). The mean ash-free dry density for all the peat types was 82 kg/m^{3}of mire.

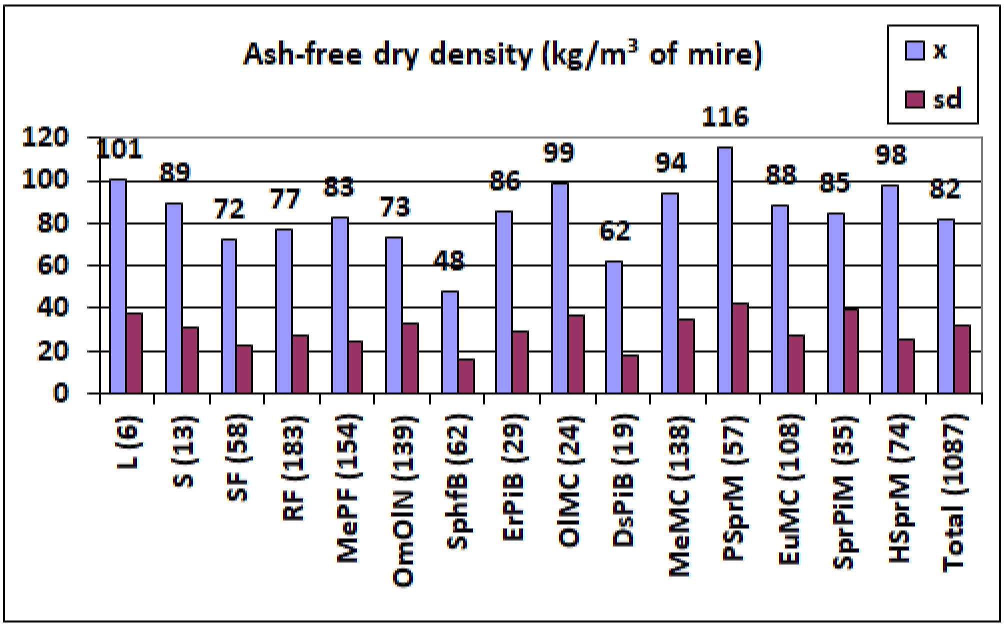


Fig. 26. Ash-free dry densities (kg/m^3 of mire) of peat samples representing the various mire types and in the total material. Numbers of samples are shown in parentheses.

Correlations between mire properties

The correlation matrix calculated for the total material points to some form of (highly significant) positive or negative correlation for every parameter with at least some other parameter, although the explanatory power (r^2) remains modest in the majority of cases.

Correlations between physical properties

Water content had its highest negative correlations, with the highest explanatory power (r^2), with the dry density of the sample and the proportion of organic matter contained in it. This negative dependence was most pronounced in the meso-eutrophic mire types. Organic matter showed a positive correlation with water content in the ombro-oligotrophic peats, while the degree of humification, the proportion of amorphous matter and ash content all showed a negative correlation with water content in peats from the majority of mire types. pH (i.e. acidity) had a highly significant dependence on the moisture content of the peat in the case of rich fens and the mesotrophic mire complexes and was correspondingly dependent on redox potential (mV) in the peats of the herb-rich spruce mires.

Dry density was highly significantly correlated with the proportion of amorphous matter in most mire types, and also with the degree of humification in the ombro-oligotrophic poor fens and most especially in the forested mires (TSprM, SprPiM, EuMC). Another highly significant positive correlation was with organic matter in the limnic peats, rich fens and poor fens at various trophic levels, true spruce mire types and spruce-pine mires. Positive correlations can also be seen with ash content in the herb-rich spruce mires, eutrophicand mesotrophic mire complexes, spruce-pine mires and poor fens. Acidity (pH) had its most significant positive correlation of all with dry density in the spruce-pine mires, but a negative correlation in the peats from rich fens, while redox potential (mV) had a positive correlation with dry density in the peats from herb-rich spruce mires.

The degree of humification of the peat had a highly significant positive dependence on the proportion of amorphous material in the case of almost all the mire types, although its most marked dependence of all was upon the proportion of organic matter in the oligotrophic mire complex types. The degree of peat humification had a highly significant maximum negative dependence on the redox potential in the *Eriophorum vaginatum* and *Sphagnum fuscum* pine bogs, and correspondingly a positive correlation with pH in the herb-rich spruce mires and with the ash content of the peat in the total material. Mäkilä (1984) also noted a clear correlation between peat humification and pH. Amorphous and organic material were positively correlated to the greatest extent in the mesotrophic and eutrophic peats, and their closest highly significant negative dependence on pH was found in the eutrophic mire complexes. The proportions of organic material in the peat showed a positive correlation with ash content in the total material and in the ombro-oligotrophic poor fens and the rich fens, but the correlation with redox potential was positive only in the peat horizons of swamps. Ash content was correlated with mV in the peat of the spruce mires and with pH in that of the pine bogs.

Correlations of physical properties with element concentrations

Water content had a (highly significant) negative correlation with phosphorus content in the poor fens and pine bogs, and copper and aluminium also correlated negatively with water content. The highest highly significant positive correlations with water content were achieved by magnesium in the spruce-pine mires and by sodium and lead in the oligotrophic mire complexes.

Aluminium in particular was highly significantly dependent on the dry density of the peat in most mire types, whereas copper correlated better with dry density in the spruce mires than in the poor fens and phosphorus did so (highly significantly) in the rich fens, ombro-oligotrophic and mesotrophic poor fens and spruce-pine mires. Meanwhile, potassium and manganese were (highly significantly) correlated negatively with dry density in the true spruce mires, copper and magnesium in the spruce-pine mires and sodium and lead in the oligotrophic mire complexes.

The degree of humification showed highly significant negative correlations with potassium, sodium, zinc and copper, whereas its correlation with aluminium was a (highly significant) positive one everywhere except in the swampy mire types. Amorphous matter was (highly significantly) positively correlated with aluminium in peat from a wide range of mire types, while organic matter was correlated (highly significantly) positively to its greatest extent with aluminium but negatively with sodium. Ash content was correlated (highly significantly) positively with all the elements studied here in all the mire types.

Redox potential (mV) had a (highly significant) positive dependence on potassium, calcium and magnesium in the eutrophic mire complex types, although it admittedly had its closest positive correlations with magnesium in the *Eriophorum vaginatum* pine bogs and with lead in the ombro-oligotrophic poor fens, while its relation to manganese in mesotrophic tall-sedge fens was a negative one, as were its correlations with iron in the *Eriophorum vaginatum* pine bogs and with calcium in the dwarf-shrub pine bogs. **Acidity** (pH) correlated (highly significantly) positively with calcium in practically all the mire types.

Correlations between element concentrations

Phosphorus (P) had a highly significant positive correlation with numerous elements, notably Na, K, Fe, Cu, Zn and Pb, in the poor fens and rich fens covering a wide spectrum of trophic levels, and with aluminium (Al) in the peats of many mire types, especially the pine bogs. Sodium (Na) was positively correlated with numerous elements (K, Ca, Mg, Fe, Mn, Cu, Zn, Pb) in the mesotrophic mire types, but only with Ca, Mg, Fe and Cu in those that were poorer in nutrients. Potassium (K) showed a (highly significant) positive dependence on magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and lead (Pb) in mires representing various trophic levels, and calcium (Ca) also exhibited its highest positive correlations with Mg, Al, Fe, Mn, Cu, Zn and Pb in peats of most mire types with the exception of pine bogs. Magnesium (Mg) had (highly significant) positive correlations with Al, Fe, Mn, Cu, Zn and Pb in peats of the oligo-mesotrophic poor fens and meso-eutrophic spruce mires, while aluminium (Al) correlated positively with Fe, Cu and Zn concentrations in the swamps and rich fens having a mire margin effect and also in the spruce mires. The positive dependence of iron (Fe) on the concentrations of Mn, Zn and Pb was most prominent in the peat horizons of the swamps, rich fens and meso-eutrophic mire complexes, and it was also (highly significantly) dependent on Cu in the dwarf-shrub pine bogs. Manganese (Mn) had a (highly significant) correlation with Zn in the peat of the true spruce mires, and to a lesser extent in the rich fens, but its positive association with Pb was seen in both rich and poor fens. Copper (Cu) correlated positively with Pb in the mesotrophic poor fens and eutrophic mire complexes, while zinc (Zn) was significantly correlated with Pb in the peat of the swampy sedge fens and to a lesser extent the rich fens and herb-rich spruce mires. Lead (Pb) showed a (highly significant) negative correlation with phosphorus (P) in the oligotrophic mire complexes and with magnesium (Mg) in the limnic peats. Pb nevertheless had positive correlations with the concentrations of more elements in the peats of rich and poor fens than it did in the spruce mires and mire complexes.

Mire types and their peat horizons

It is possible to deduce the compositions of the surface peats developing in the acrotelm of present-day aapa mires representing the various mire types from the cover percentages of the relevant plant species as set out by Ruuhijärvi (1960) and Eurola (1962). One interesting observation that arises from the findings of Ruuhijärvi (1960) is that, generally speaking, between 70% and 93% of the surface peat is made up of remains of three or four plant species or groups of species (see Table 10). Thus, although only one species, the moss *Scorpidium scorpioides*, had a coverage in excess of 10% in the *Scorpidium* flark fens (ScFlkF), for instance, the brown mosses as a whole (Bryidae) achieved a combined coverage of 67%, and the same group accounted for 60% of the vegetation cover on the *Campylium stellatum/Drepanocladus intermedius* rich fens. In the same way, four species together accounted for almost 80% of the plant cover on the short-sedge bogs (SSdgB), while *Sphagnum* mosses made up more than 60% of the vegetation on nutrient-poor bogs and fens (OlSSdgB, SphpTSdgF, FlkF, SSdgB, ErPiB, CagPiM, PiF) and more than 50% on the mesotrophic fens (MeTSdgF). In the case of the *Sphagnum fuscum* bogs (SphfB) and spruce mires (SprM), however, the proportion of *Sphagnum* mosses was no more than 30–50%, and elsewhere it was still lower. The proportion of sedges (*Carex* spp.) varied in the range 20–30% in the various mire types, except for the poorer fens and bogs. Woody material, i.e. lignin (L), and dwarf shrubs, nanolignin (N), was characteristic of the pine bogs or mires, while horsetails (*Equisetum sylvaticum*) and grasses or herbs (Hb) denoted spruce mires, and cotton-grass heads (*Eriophorum vaginatum*) short-sedge bogs or rich fens. A single species may achieve a cover of 20–70% if the mire type in question supports only a limited range of plants or is dominated by a single plant, as in *Scorpidium* flark fens.

It is clear from examinations of the macrosubfossils that the poor fen and bog mire types give rise to predominantly *Sphagnum* peat. Brown mosses are present to some extent in all the mire types, but are most conspicuous in the swamps and rich fens, while sedges are typical of wet flark fen peats. Analyses of percentage cover in the acrotelm suggest that peats with a *Carex* content greater than 10% are extremely rare or non-existent. Table 11, which is based on the incidence of plant macrofossils in peat samples, highlights the peat types in which material from the various mire complex types is to be found. It should be noted that, as previously, the additional peat-forming factors are listed first and the principal factor is the last-mentioned one. The mean distribution of macrosubfossils in all of the peat samples considered here is set out in Appendix 8.

A concise account of the compositions and properties of the peats arising from the mire types described here will be given below.

Mire type	Plant species	cover >10%		Species/groups making up the peat horizon /and designation of the peat type (principal factor mentioned last)										
	n	n	Σ %	S	B	C	L	N	ER	EQ	TR	Hb	**Tot.%**	**Peat type**
SphfB	23	3	70	**37**			**20**	**30**					87	**(L)NS**
SphfB	34	2	62	**34**			**34**	**16**					83	**(N)LS**
ErPiB	30	2	63	**56**				10	**24**				91	**NERS**
SSdgB	24	4	79	**64**					12		**15**		90	**ERTRS**
OlSSdgB	19	3	69	**67**		**25**							90	**CS**
SphpTSdgF	18	3	72	**66**		**28**							93	**CS**
FlkF	19	3	76	**64**					**14**				92	**ERS**
MeTSdgF	36	1	23	**52**		**24**							76	**CS**
PiF	61	3	37	**50**		**21**		11					82	**NCS**
RPiF	62	1	20	**20**	**14**	10							45	**CBS**
BirSprRFM	27	3	70	**52**		**25**		12					89	**NCS**
RchSprM	6	3	56	**39**								**34**	73	**HbS**
EqSprM	44	2	42	**38**						**20**		**14**	72	**HbEQS**
RBirF	47	3	34	12	**48**	**25**							85	**SCB**
ScFlkF	22	1	64		**67**	**19**							86	**CB**
DrintF	36	2	60		**62**	**19**					10		91	**TRCB**

Table 10. The percentage cover analysis of mire vegetations performed by Ruuhijärvi (1960) provided data on the composition of the potentially aereated upper layer of the peat, the acrotelm. The table shows the number of species of mire plants (n), the number with a coverage >10% and the combined coverage of these species (%). S = *Sphagnum*, B= Bryidae, C= *Carex*, L= Lignin, N= Nanolignin, ER= *Eriophorum*, EQ= *Equisetum*, TR= *Trichophorum*, Hb= Herbs (+ grasses), Tot.= total (in the whole material). For key to the mire type symbols, see caption to Fig. 8.

	Peat-forming factors %														
Mire	**S**	**C**	**B**	**L**	**N**	**ER**	**TR**	**SH**	**MN**	**EQ**	**PR**	**P**	**PO**	**PT**	**Peat composition**
SphfB	75	1	5		8	7									(ER,N)S
DsPiB	53	4	8	8	16	4				2				2	NS
OmOlPF	49	14	4	3	4	16	1	8	2						CERS
SprPiM	35	17	9	6	24	11								3	(ER)CNS
ErPiM	35	4	6	7	7	41								2	SER,ERS
TSprM	34	8	4	34	3	4		3	4	9			3	2	LC,SL
MePF	15	40	9	5	6	4		9	7	5					SC,CS
OlMC	14	26	3	12	4	33		3	2	3					(L)SCER, ERC
EuMC	14	27	14	17	5			1	3	4	1	2			(MN,S,B)LC
MeMC	10	24	6	26	3	8		4	8	11					(S,EQ)CL,LC
HBirSprM	9	16	6	44	2	1			7	8		3	2		CL
RF	9	30	25	4	3	6	3	8	6	6	3		5		BC
SSdgF	4	35	10	2	2	3		2	14	15	2	13			(B,P)MNEQC
S	3	23	2	6					22	25	2	18			(P)MNCEQ,MNEQC
L	3	22	15	5					1	29	21				(B)PRCEQ

Table 11. Mean botanical compositions (in %) of peats representing the mire types. Determinations are based on macrosubfossils: *Sphagnum* (S), *Carex* (C), Bryidae (B), Lignin (L), Nanolignin (N), *Eriophorum* (ER), *Trichophorum* (TR), *Scheuchzeria* (SH), *Menyanthes* (MN), *Equisetum* (EQ), *Phragmites* (PR), *Potentilla* (P), Poaceae (PO), *Polytrichum* (PT).

In the total material the two peat-forming plant species that competed for precedence were the *Carex* sedges (24.5%) and the *Sphagnum* mosses (21.8%), followed by another pair, the dwarf shrubs (nanolignin) and brown mosses (Bryidae), both with 9.4%. Finally, the horsetails (*Equisetum*) and bogbean (*Menyanthes*) occurred somewhat more often than the Rannoch rush (*Scheuchzeria*). The degree of humification of the peat varied in the range $H_{1\text{-}8}$, with a mean value of $H_{3.7}$ (sd 1.2; n 1089) and a median value of H_4, at which point the mean proportion of amorphous matter in the peat was 40.2% (sd 20.4; min-max 0.1–91.2; n=535). The peat had a normal moisture content and was slippery and full of *Carex* roots, accompanied by a certain amount of *Eriophorum* fibres and some lignin. It was fairly easy to shape by hand, and it left an obvious stain after handling. The mean water content of the peat was 89.6% (4.7; 45.7-96.5; 1077) and its dry density (with ash) 92.3 kg/m^{3}of mire volume (53.7; 8-717; 1077). It contained a mean of 9.3% organic matter (3.0; 3.5–26.2; 1076) and its dry matter had an ash content of 7.1% (10.0; 0.4-88.7; 1078). Its mean pH was 4.8 (0.9; 2.9–6.8; 1088) and its mean redox potential 131 mV (113; -195– +425; 767). The mean element concentrations in ash from the peat samples (ppm, rounded to the nearest integer) were: P 596 (472; 28-8540; 767), Na 142 (236; 4-5217; 1031), K 280 (511; 5-4733; 1043), Ca 4560 (5011; 89-40258; 1037), Mg 860 (745; 11-6145; 1042), Al 2204 (2783; 29-28862; 1042), Fe 7991 (17469; 32-228961; 1042), Mn 160 (908; 1-18666; 1034), Cu 13 (18; 1-257; 1040), Zn 44 (59; 0,0-1036; 995), Pb 2 (33; 0,01-1038; 997) and the principal element ratios Ca/Mg 5.6 (n 1036) and Fe/Mn 158.8 (1033), Ca/K 41.4 (1036), Na/K 22.8 (1033), Fe/P 17.1 (765) and Cu/Zn 0.9 (1038).

The peats generated by the ***Sphagnum fuscum* bogs (SphfB)** contained about three-quarters *Sphagnum* moss, the main component of which was *Sphagnum fuscum*, a brown *Sphagnum* of the *acutifolia* section, the others (*S. angustifolium, S. balticum, S. magellanicum, S. papillosum, S. recurvum* coll., *S. rubellum, S. russowii*) being of minor importance. There was also a few per cent of typical mosses forming ombrotrophic peat such as *Dicranum polysetum*, *Polytrichum strictum* and the Hepaticae. Lichens were present to a greater extent than in any other peat. Apart from the above, the only plant remains that occurred to such an extent that they could be included in the designation of the peat type were dwarf shrubs (nanolignin) and cotton-grass (*Eriophorum*), even though their mean incidence was over 8%. The proportion of amorphous plant remains was 9.7% (7.7; 0.1-29.8; 32), corresponding to a range of $H_{1\text{-}4}$ on the scale of von Post (1922), with a mean of 2.4 and a median of H_2 (sd = 0.7; n = 62). On the grounds of the mean proportions of the various macrosubfossils, the typical peat types would be *Sphagnum* peat (S), nanoligneous *Sphagnum* peat (NS) and nanoligneous *Eriophorum-Sphagnum* peat (NERS). The peat had a normal moisture content, did not stain and could not be moulded, because the plant remains were very coarse, with long fibres. There were some *Eriophorum* fibres present, but little or no *Carex* roots or ligneous material. The water content was 91.2% (2.0; 87-94.8; 62) and the mean dry density 48.7 kg/m^3 (16.5; 24-100.8; 62), of which 8.7% (2.0; 5.2-12.7; 62) was organic matter, and the ash content was 1.7% (0.7; 0.4-3.6; 62) of the dry matter. This peat was highly acidic (pH 3.3; 0.3; 2.9-4.0; 62) and had a mean redox potential of 292 mV (54; 180-400; 50). The mean element concentrations (ppm) in the peat ash were: P 285 (133; 77-747; 50), Na 151 (78; 31-398; 57), K 576 (684; 43-3534; 57), Ca 2111 (1575; 419-7576; 57), Mg 723 (230; 256-1146; 57), Al 293 (303; 48-1739; 57), Fe 918 (966; 52-5625; 57), Mn 71 (158;2-921; 57), Cu 4 (2; 1-10; 57), Zn 29 (17; 3-80; 57), Pb 10 (6; 2-31; 51) and their ratios Ca/Mg 3.1 (57) and Fe/Mn 126.9 (57), Ca/K 9.0 (57), Na/K 0.63 (57), Fe/P 4.7 (50) and Cu/Zn 0.20 (57).

The contribution of *Sphagnum* mosses (S) as a peat formation factor in the case of the **dwarf shrub pine bogs (DsPiB)** was in excess of 50%, about a third of this being accounted for by the brown *Sphagnum fuscum*, in addition to which there were remains of *Sphagnum angustifolium, S. magellanicum* and *S. russowii*. The proportion of *Polytrichum* was slightly greater than in the *Sphagnum fuscum* bogs, while that of *Dicranum* was correspondingly smaller. *Pleurozium schreberi* accounted for about 5% and there was a small input of *Pohlia nutans*. The principal additional factors in this mire type were dwarf shrubs (Nanolignin) and cotton-grass, *Eriophorum vaginatum*, but there was little *Carex globularis*. The main peat types to emerge were dwarf-shrub/*Sphagnum* (NS) and *Sphagnum* (S) peats with a degree of humification in the range $H_{1\text{-}3}$ (mean 2.3, median H_2 (sd0.8; n 19). Since the mean proportion of amorphous matter was 20.6% (14; 1-41; 9), the peat felt slightly dry and coarse to the touch, and contained little in the way of sedge roots, *Eriophorum* fibres or woody material, nor did it stain or allow moulding. The water content of the peat was 89.9% (2,7; 82.4-92.9; 19) and its mean dry density 63.7 kg/m^3 (19.2; 34.6-115.8; 19), organic content 9.8 % of fresh weight (2.7; 6.9-17.1; 19) and the ash content of the dry matter 3.3% (1.8; 1.2-9.2; 19). The pH of the peat was 3.6 (0.5; 3-4.8; 19) and its mean redox potential 197 mV (88; 15-315; 18). The mean element concentrations in the peat ash (ppm) were: P 614 (235; 308-1060; 19), Na 94 (44; 48-227; 19), K 882 (737; 254-2644; 19), Ca 3747 (2664; 1441-11262; 19) Mg 828 (244; 140-1255; 19), Al 534 (344; 164-1339; 19), Fe 1609 (2140; 122-9173; 19), Mn 81 (101; 3-388;

19), Cu 5 (3; 2-12; 19), Zn 32 (16; 8-60; 19) and Pb 15 (5; 8-27; 19), and their ratios Ca/Mg 4.7 (19) and Fe/Mn 115.7 (19), Ca/K 7.7 (19), Na/K 0.19 (19), Fe/P 2.3 (19) and Cu/Zn 0.23 (19).

The **Ombro-oligotrophic poor fens (OmOlPF)** were more obviously dominated by *Sphagnum* mosses (*S. angustifolium, S. balticum, S. cuspidatum, S. fallax, S. jensenii, S. lindbergii, S. magellanicum, S. majus, S. papillosum, S. recurvum* coll.*, S. rubellum*) than the other poor fens. About helf of their peat consisted of intermediate or flark-level *Sphagnum* mosses, of which the *cuspidata* section accounted for about 15% and the *Palustria* section roughly the same, while the proportion of *acutifolia* remained below 5%. The aapa mires of this region were found to be relatively rich in intermediate-level surfaces, with a vegetation comprising *Eriophorum vaginatum*, the sedges *Carex canescens, C. chordorrhiza, C. lasiocarpa, C. limosa, C. magellanica, C. pauciflora, C. rostrata* and *C. vesicaria* and *Scheuchzeria palustris* in addition to *Sphagnum* mosses. The Bryopsida *Calliergon cordifolium, Straminergon stramineum, Dicranum undulatum, Loeskypnum badium* and *Warnstorfia fluitans* contributed to peat formation mostly on flark surfaces and in groundwater areas. Dwarf shrubs and brown mosses were present in the peat to equal extents on average. The most common peat types formed were *Sphagnum* (S), *Carex/Eriophorum* (CERS), *Carex/Sphagnum* (CS) and *Eriophorum/Carex/Sphagnum* (ERCS) peats. The degree of humification varied in the range H_{1-8}, with a mean of 3.2 and a median of H_3 (1.1; 140), at which point the proportion of amorphous matter was 25.6% (15; 3-64; 60). The peat seemed to the touch to have a normal moisture content and slipperiness, but was difficult to mould. It contained a certain amount of *Eriophorum* fibres and *Carex* roots but no ligneous material. Its mean water content was 91.4% (3.7; 74.8-96.5; 139), its dry density 75.4 kg/m^3 (34.6; 22-195.7; 139), its mean organic content 8.3% (3.3; 3.5-20.6; 139) and the ash content of its dry material 2.7% (1.7; 0.9-9.9; 140). The pH of the peat was 4.0 (0.45; 3.2-5.0; 135) and its mean redox potential 191 mV (60; 20-310; 96). The mean element concentrations (ppm) in the peat ash were: P 355 (180; 28-1086; 101), Na 111 (68; 28-495; 136), K 193 (466; 7-3517; 136), Ca 2193 (1352; 386-7696; 136), Mg 502 (243; 90-1305; 136), Al 1020 (1648; 29-13563; 136), Fe 2424 (1393; 32-10991; 136), Mn 18 (24; 2-183; 135), Cu 5 (4; 1-27; 135), Zn 23 (28,5; 2-162; 136) and Pb 7 (8; 1-56; 117) and their ratios Ca/Mg 4.8 (135) and Fe/Mn 220.4 (134), Ca/K 31.5 (135), Na/K 1.4 (136), Fe/P 8.4 (100) and Cu/Zn 0.47 (134).

Spruce-pine mires (SprPiM) constitute a transitional mire type formed by plants typical of either spruce mires or pine bogs. The principal factor involved in their formation consisted of the

Sphagnum mosses (*S. angustifolium, S. fallax, S. fuscum, S. girgensohnii, S. magellanicum, S. russowii*), amounting to some 35%, about half of which belonged to the *acutifolia* section, while remains of dwarf shrubs, or nanolignin (chiefly *Andromeda polifolia, Betula nana, Calluna vulgaris, Empetrum nigrum* and *Vaccinium oxycoccos*) accounted for one fourth of the peat, and sedges (*Carex globularis*) almost a fifth. Bryopsida (*Aulacomnium palustre, Straminergon stramineum, Pleurozium schreberi* and *Pohlia nutans*) also occurred to some extent, as did *Polytrichum commune, P. strictum* and *Pseudobryum*. *Eriophorum vaginatum*, together with the sedges, was dominant on the intermediate surfaces, where there were less herbaceous plants. The main peat types were *Sphagnum* peat (S), *Eriophorum/Carex/*dwarf-shrub*/Sphagnum* peat (ERCNS) and *Carex/Sphagnum* peat (CS). The degree of humification varied in the range H_{1-7}, with a mean of 3.7 and a median of H_4 (1.7; 35), and the amount of amorphous material reached 42.6% on average (17.3; 16.3-72; 11). The peat had a normal moisture content, stained and was slippery but pliable. It contained some sedge roots and *Eriophorum* fibres, and also ligneous material. Its mean water content was 88.1% (5.6; 67.9-93.6; 35) and its dry density 98.4 kg/m^3 (62.1; 29.1-311.4; 35), and had a mean organic content of 10.4% (3.2; 6-19.1; 35). The ash content of its dry matter was 8.3% (11.9; 1.8-58.8; 35). The pH of the peat was 4.0 (0.43; 3.3-5.3; 35) and its mean redox potential 170 mV (76; 0-285; 30). The mean element concentrations (ppm) in the peat ash were: P 927 (706; 324-2503; 12), Na 96 (62; 33-365; 35), K 652 (760; 58-3042; 35), Ca 2526 (1905; 535-9707; 35), Mg 580 (290; 42-1614; 35), Al 2837 (2980; 206-12913; 35), Fe 4335 (6879; 589-35639; 34), Mn 67 (99; 2-467; 34), Cu 10 (11; 2-49; 35), Zn 26 (16; 5-67; 35) and Pb 13 (8; 1-33; 28) and their ratios Ca/Mg 4.8 (35) and Fe/Mn 152.9 (34), Ca/K 11.5 (35), Na/K 0.36 (35), Fe/P 5.1 (11) and Cu/Zn 0.62 (35).

The ***Eriophorum vaginatum*** **pine bogs (ErPiB)** were typically to be found winding around the centres of aapa mires. Cotton-grass, *Eriophorum vaginatum*, was the major factor in the peat, with a mean proportion of around 40%, but there was almost as much *Sphagnum* moss present, >36% (chiefly comprising *Sphagnum angustifolium, S. balticum, S. centrale, S. cuspidatum* coll.*, S. fuscum, S. magellanicum, S. papillosum, S. recurvum* coll.*, S. riparium, S. rubellum, S. russowii* and *S. tenellum*). The dwarf shrub vegetation (*Andromeda polifolia, Betula nana, Chamaedaphne calyculata, Empetrum nigrum, Vaccinium microcarpum* and *V. oxycoccos*), woody material, sedges (*Carex* spp., *C. canescens, C. globularis, C. laxa* and *C. rostrata*), bryophytes (*Aulacomnium palustre, Straminergon stramineum, Dicranum polysetum, Pleurozium schreberi, Pohlia nutans* and *Polytrichum strictum*) and *Scheuchzeria palustris* accounted for a further 5-10% each. The most common peat types were *Eriophorum* (ER), *Sphagnum* (S), *Sphagnum/Eriophorum* (SER) and *Eriophorum/Sphagnum* (ERS) peats with humification in the range H_{1-6}, mean 3.6 and median H_4 (1.1; 45) and an amorphous content of 42.6% (24.7; 2.8-69.5; 14). The peat was of a normal moisture content and rich in *Eriophorum* fibres, pliable, capable of staining and somewhat coarse and slippery, but it contained little in the way of *Carex* roots or ligneous material. Its mean water content was 89.9% (2.6; 82.9-94.8; 46) and its dry density 87.7 kg/m^3 of mire volume (29.2; 29.9-144.4; 46), of which an average of 9.8% (2.5; 5.1-16.6; 46) was organic matter. The dry matter had an ash content of 2.2% (0.9; 0.9-4.6; 46). The mean pH of the peat was 3.7 (0.5; 2.9-4.7; 45) and the mean redox potential 213 mV (32; 140-280; 40). The mean element concentrations in the peat ash (ppm) were: P 441 (204; 133-802; 41), Na 76 (42; 9-175; 46), K 301 (759; 5-4733; 46), Ca 2184 (2457; 641-11460; 46), Mg 512 (161; 229-979; 46), Al 845 (948; 107-4266; 46), Fe 2045 (1264; 535-4900; 46), Mn 33 (50; 2-244; 46), Cu 5 (4; 1-20; 46), Zn 16 (16; 3-78; 46) and Pb 8 (4; 1-17; 34) and their ratios Ca/Mg 4.6 (46) and Fe/Mn 206.4 (46), Ca/K 31.0 (46), Na/K 1.3 (46), Fe/P 6.6 (41) and Cu/Zn 0.49 (46).

Almost a third of the peat in the **true spruce mires (TSprM)** was ligneous material, and the mean proportion with dwarf shrubs included was 37%. The second most important peat-forming factor was the *Sphagnum* mosses, of which there were 12, including *S. angustifolium, S. balticum, S. centrale, S. fallax, S. girgensohnii* and *S. capillifolium*. The sedges (*Carex aquatilis, C. canescens, C. chordorrhiza, C. globularis, C. lasiacarpa* and *C. nigra*) then made up about one tenth of the peat, and horsetails, *Equisetum,* and cotton-grass, *Eriophorum*, <10% on average. *Menyanthes trifoliata*, grasses (Poaceae), *Scheuchzeria palustris* and *Polytrichum* each accounted for <5%. In general, spruce mire peats entail more peat formation factors than do poor fen peats, and in the present cases the Bryopsida (*Aulacomnium palustre, Straminergon stramineum, Warnstorfia fluitans* and *Polytrichum commune*) accounted for less than 5%. The most common peat types in the present mires were *Equisetum*/lignin/*Sphagnum* ((EQ)LS) and *Equisetum*/*Sphagnum*/lignin ((EQ)SL) peats, with degrees of humification in the range H_{1-7}, mean 4.1 and median H_4 (1.8; 16). The mean amorphous material content of the well humified peat was as high as 53.8% (22.7; 22.5-72.7; 6). The peats were of normal moisture content to the touch, slippery and stained normally, and they contained some sedge roots and ligneous material but little *Eriophorum* fibre. On the other hand, they were fairly pliable. The mean water content of the peat was 86.9% (3.2; 79.2-90.7; 16) and its dry density approx. 121.1 kg/m^3 (43.7; 59.1-201.9; 16). The mean organic content was 12.6% (3.2;

9-20.4; 16) and the proportion of ash in the dry matter was 4.3% (2.1; 1.7-10.5; 16). The pH of the peat was 3.8 (0.5; 3.2-4.7; 16) and its mean redox potential 161 mV (71; 50-305; 10). The mean element concentrations in the peat ash (ppm) were: P 1064 (446; 551-1854; 9), Na 97 (50; 40-224; 16), K 815 (1002; 40-2973; 16), Ca 2254 (1277; 572-4129; 16), Mg 675 (368; 121-1405; 16), Al 3363 (2653; 333-7973; 16), Fe 3122 (3662; 588-13990; 16), Mn 70 (79; 2-281; 16), Cu 13 (9; 3-38; 16), Zn 34 (32; 4-105; 16) and Pb 10 (8; 1-21; 15) and their ratios Ca/Mg 3.6 (16) and Fe/Mn 128.7 (16), Ca/K 17.2 (16), Na/K 0.74 (16), Fe/P 3.0 (9) and Cu/Zn 1.4 (16).

The peats in the **mesotrophc poor fens (MePF)** were some of the purest forms of *Carex* peat, in which the proportion of *Carex* remnants (*C. aquatilis, C. canescens, C. chordorrhiza, C. diandra, C. lasiocarpa, C. limosa, C. magellanica, C. nigra* and *C. rostrata*) exceeded 40% on average, or reached close to 50% if other sedge-like species were to be included in the *Carex* factor in accordance with the Finnish Geological Survey classification (Lappalainen, Sten & Häikiö, 1984). *Sphagnum* mosses (*S. angustifolium, S. cuspidatum* coll., *S. fallax, S. fuscum, S. jensenii, S. magellanicum, S. majus, S. obtusum, S. papillosum, S. recurvum* coll., *S. riparium, S. rubellum, S. russowii, S. squarrosum, S. subsecundum* and *S. teres*) accounted for another 14%, and the Bryopsida (*Bryum* spp., *Calliergon cordifolium, Helodium blandowii, Paludella squarrosa, Polytrichum strictum, Pseudobryum cinclidioides, Dicranum* spp., *Scorpidium* spp., *S. revolvens, Warnstorfia exannulata* and *W. fluitans*) for less than 10%, among which *Straminergon stramineum* was dominant. The proportions of *Potentilla palustris*, *Equisetum* and *Eriophorum* were no more than a few percent, and both dwarf shrubs and trees accounted for under 10%. The most commonly occurring peat types were *Carex* (C) and *Sphagnum/Carex* (SC) peats, the degree of humification of which varied in the range H_{1-6}, mean 3.6 and median H_3 (0.9; 154), while the mean proportion of amorphous matter was 41.6 % (19.3; 0.3-84.1; 87). The normally moist peat was slippery to the touch and contained some *Eriophorum* fibres in addition to *Carex* roots, but no ligneous material. The peat also tended to stain and was easy to mould. Its mean water content was 90.7% (3.3; 66.7-95.4; 154) and its dry density 89.1 kg/m^3 (38.2; 34.6-389.4; 154). The mean organic content was 8.7% (2.3; 4.4-16.7; 154) and the mean ash content of the dry matter 4.9% (6.8; 0.8-68; 154). The pH of the peat was 4.7 (0.43; 3.4-5.6; 154) and the mean redox potential 153 mV (108; -90 – +425; 128). The mean element concentrations in the peat ash (ppm) were: P 541 (232; 174-1485; 131), Na 104 (78; 20-488; 153), K 158 (355; 12-3166; 154), Ca 2659 (1794; 421-9876; 154), Mg 596 (395; 25-1893; 154), Al 1740 (1529; 88-9364; 154), Fe 5255 (4194;

124-26216; 154), Mn 44 (47; 1-240; 154), Cu 7 (6; 1-39; 154), Zn 23 (37; 1-309; 154) and Pb 9 (10; 1-63; 110) and their ratios Ca/Mg 5.4 (154) and Fe/Mn 232.3 (154), Ca/K 34.4 (154), Na/K 1.1 (153), Fe/P 12.6 (131) and Cu/Zn 0.94 (154).

The peats of the **oligotrophic mire complexes (OlMC)** were characterized by higher proportions of intermediate-level plants. *Eriophorum* predominated on the flarks and accounted for an average of a third of the peat, while *Carex* spp. (most commonly *C. lasiocarpa, C. rostrata* and *C. chordorrhiza*) made up about a quarter and *Sphagnum* mosses (*S. angustifolium, S. balticum, S. cuspidatum* coll.*, S. fallax, S. fuscum, S. magellanicum* and *S. papillosum*) correspondingly 14%. Ligneous matter from trees and dwarf shrubs provided about a sixth of the peat by volume, while there was just a few percent of herbaceous plants (*Equisetum, Menyanthes* and *Potentilla*) and Bryopsida (*Straminergon stramineum, Warnstorfia fluitans* and *Polytrichum strictum*). The most common peat types were *Sphagnum/Carex* (SC), *Eriophorum/Carex* (ERC) and *Sphagnum/Carex/Eriophorum* (SCER) peats, of humification in the range H_{1-7}, mean 4.3 and median H_4 (1.3; 24), so that their mean amorphous content was 46.4% (19.7; 18.7-71.6; 7). This relatively dry, staining peat with an admixture of *Carex* roots but little ligneous matter seemed to be of normal slipperiness to the touch, pliable and contained a reasonable proportion of *Eriophorum* fibres. The mean water content of the peat was 87.2% (3.2; 80.1-93; 24) and the dry density 102.2 kg/m^3 (38.1; 38.7-174.4; 24). The mean accumulation of organic matter was 12.4% (3; 6.9-18.9; 24) and the ash content of the dry matter 3.2% (1.9; 1.3-11; 24). The mean pH was 4.1 (0.5; 3.1-5.0; 24) and the redox potential 176 mV (36; 110-250; 17). The mean element concentrations in the peat ash (ppm) were: P 419 (169; 152-765; 12), Na 69 (49; 16-250; 21), K 232 (657; 7-3076; 21), Ca 2327 (2004; 481-6974; 21), Mg 409 (244; 82-1079; 21), Al 1102 (1124; 106-3834; 21), Fe 3359 (2570; 1347-12255; 21), Mn 63 (120; 3-476; 21), Cu 4 (2; 2-8; 21), Zn 12 (10; 3-35; 21) and Pb 6 (5; 1-21; 18) and their ratios Ca/Mg 6.8 (21) and Fe/Mn 257.1 (21), Ca/K 36.3 (21), Na/K 1.1 (21), Fe/P 12.5 (12) ja Cu/Zn 0.59 (21).

About one fourth of the content of the peats in the **mesotrophic mire complexes (MeMC)** was ligneous material (L) and one fourth sedges (*Care xaquatilis, C. canescens, C. chordorrhiza, C. diandra, C. globularis, C. lasiocarpa, C. limosa, C. magellanica, C. nigra, C. rhynchophysa, C. rostrata* and *C. vesicaria*), while the proportions of herbaceous plants (*Menyanthes, Potentilla palustris* and *Scheuchzeria*), *Sphagnum* mosses (*S. angustifolium, S. centrale, S. cuspidatum* coll., *S. fallax, S. fuscum, S. girgensohnii, S. lindbergii, S. magellanicum, S. majus, S. nemoreum, S.*

papillosum, S. recurvum coll., *S. riparium, S. rubellum, S. russowii, S. squarrosum, S. subsecundum* and *S. teres*), grasses (Poaceae) and rushes (*Trichophorum*) remained at around 10% each. The number of species present was more or less as large as in the peats of the eutrophic mire complexes, but the ecological differences in habitat were such that the various peat-forming factors gained quite different degrees of emphasis. Ligneous material, mainly from trees, made up more than a fourth of the peat and there was almost as much sedge material. There was somewhat more *Equisetum* present than *Menyanthes* or *Eriophorum*. The Bryopsida (*Aulacomnium palustre, Calliergon cordifolium, Straminergon stramineum, Warnstorfia exannulata, W. fluitans, Limprichtia revolvens, Hylocomium splendens, Paludella squarrosa, Pohlia nutans, Polytrichum commune, P. strictum, P. swartzii, Pseudobryum cinclidioides* and *Tomentyphnum nitens*) amounted to a few percent. The most common peat types were Lignin/*Carex* (LC), Carex/Lignin (CL), *Sphagnum* or *Equisetum*/*Carex*/Lignin (S,EQCL) or Lignin/*Sphagnum/Carex* (LSC) peats with degrees of humification in the range $H_{1\text{-}8}$, mean 4.7 and median H_5 (1.0; 147). Amorphous material made up 50.1% (21; 9.1-89.8; 66). The peat was moist to the normal extent, slippery, pliable and staining, and contained a certain amount of *Eriophorum* fibres and some ligneous material. Its mean water content was 88.1% (4.5; 56-93.8; 138) and its dry density 105.1 kg/m^3 (57.4; 29-544.8; 138). The mean organic content was 11.4% (7.3; 5.8-89.7; 138) and the ash content of the dry matter 6.6% (9.4; 1-72.8; 138). The pH of the peat was 4.9 (0.7; 3.5-6.4; 148) and the redox potential 96 mV (87; -80 – +315; 81). The mean element concentrations in the peat ash (ppm) were: P 877 (1067; 204-8540; 78), Na 120 (115; 9-658; 119), K 195 (354; 18-2632; 122), Ca 3243 (2004; 89-8332; 122), Mg 728 (544; 11-2446; 122), Al 3768 (2964; 124-17717; 121), Fe 10420 (20638; 104-217411; 122), Mn 121 (174; 2-813; 122), Cu 15 (14; 3-115; 122), Zn 28 (24; 2-131; 122) and Pb 8 (10; 1-56; 70) and their ratios Ca/Mg 5.1 (122) and Fe/Mn 146.9 (122), Ca/K 39.5 (122), Na/K 1.1 (120), Fe/P 21.9 (78) and Cu/Zn 1.0 (122).

Mires of the **eutrophic mire complex (EuMC)** type were found to form peat in which the *Carex* factor (*Carex aquatilis, C. canescens, C. cespitosum, C. chordorrhiza, C. diandra, C. dioica, C. echinata, C. flava, C. lasiocarpa, C. limosa, C. magellanica, C. nigra, C. rostrata, C. vaginatum* and *C. vesicaria*) accounted for over a fourth of the biomass and ligneous material (L) for a fifth, whereas dwarf shrubs (N) remained at around 5%. A sixth of the material consisted of *Sphagnum* mosses (S), about half of which represented eutrophic species. The main additional factor was *Equisetum* (EQ) and there were also small amounts of other herbs (*Menyanthes*, *Potentilla, Scheuczeria*) and grasses (Poaceae, *Molinia caerulea*). The most common peat types were dwarf-shrub/*Carex* (NC), *Sphagnum/Carex* (SC) and lignin/*Sphagnum/Carex* (LSC) peats. The degree of humification varied in the range H_{1-7}, mean 3.8 and median H_4 (1.0; 112), with an amorphous matter content of 39.4% (17.1; 2.5-72.8; 82). The peat was generally wet, slippery to a normal degree and fairly pliable, and contained *Carex* roots, small amounts of *Eriophorum* fibres and some ligneous material. Its mean water content was 87.8% (6.7; 45.7-93.8; 110), its dry density 114.3 kg/m^3 (88.3; 40.5-717; 109), its organic content 9.7% (2.5; 5.8-18.9; 109) and the ash content of its dry matter 12.9% (14.8; 1.1-88.7; 109). At the same time the pH of the peat was 5.7 (0.5; 4.1-6.8; 112) and its redox potential 69 mV (92; -85 – +310; 87). The mean element concentrations in the peat ash (ppm) were: P 706 (298; 89-1387; 97), Na 135 (93; 29-606; 101), K 326 (560; 44-3750; 106), Ca 10550 (9759; 1027-40258; 107), Mg 1706 (1368; 74-6145; 106), Al 2200 (3383; 84-18849; 106), Fe 20563 (40314; 271-228961; 106), Mn 518 (2303; 1-18666; 102), Cu 14 (14; 2-108; 104), Zn 33 (71; 4-436; 106) and Pb 13 (10; 1-53; 79) and their ratios Ca/Mg 6.9 (106) and Fe/Mn 133.8 (102), Ca/K 61.0 (106), Na/K 0.84 (106), Fe/P 28.0 (97) and Cu/Zn 1.0 (104).

Almost a half of the peat horizons in the **herb-rich spruce mires (HBirSprM)** consisted of ligneous material, while another prominent contributor to peat formation (>15%) was the *Carex* vegetation (*C. aquatilis, C. canescens, C. chordorrhiza, C. diandra, C. globularis, C. lasiocarpa, C. limosa, C. rostrata* and *C. vesicaria*). There were nevertheless more *Sphagnum* mosses present (*Sphagnum angustifolium, S. centrale, S. cuspidatum* coll., *S. fallax, S. fuscum, S. girgensohnii, S. papillosum, S. riparium, S. squarrosum* and *S. teres*) than either *Menyanthes* or *Equisetum*. Correspondingly, the proportion of Bryopsida (*Calliergon cordifolium, Helodium blandowii, Paludella squarrosa, Pleurozium schreberi, Polytrichum commune, Pseudobryum ciclidioides, Rhizomnium pseudopunctatum, Rhytidiadelphus triquedrus, Scorpidium trifarium, Straminergon stramineum, Warnstorfia exannulata*) was fairly low, just over 5%. The most common peat types were ligneous (L), *Carex*/lignin (CL) and *Equisetum*/lignin/*Carex*(EQLC) peats, with degrees of humification varying in the range H_{1-7}, mean 4.5 and median H_5 (1.3; 75). The mean proportion of amorphous material in the peat was 48.1% (17.4; 8.7-87.6; 48) and the moisture content, slipperiness, ligneous content, pliability and staining capacity of the peat were normal. There was a certain amount of *Carex* root material present, but little or no *Eriophorum*. The mean water content of the peat was 85.2% (6.9; 61.1-94.1; 74), its dry density 136.5 kg/m^3 (78; 31.4-489.4; 74), its mean organic content 11.0% (3.2; 5.7-26.2; 74) and the ash content of its dry matter 18.9% (18.4; 4-78.6; 74).

The mean pH was 5.2 (0.7; 3.7-6.6; 75) and the redox potential 75 mV (136; -195 – +315; 60). The mean element concentrations in the peat ash (ppm) were: P 770 (443; 4-2112; 67), Na 352 (796; 4-5217; 73), K 1527 (3455; 78-15306; 74), Ca 4684 (4381; 692-35839; 73), Mg 1211 (808; 106-5116; 74), Al 3415 (2454; 278-13074; 74), Fe 13457 (11274; 63-47467; 74), Mn 331 (934; 6-6843; 71), Cu 22 (16; 2-99; 74), Zn 90 (162; 1-669; 73) and Pb 16 (13; 1-74; 53) and their ratios Ca/Mg 4.3 (74) and Fe/Mn 129.2 (71), Ca/K 20.9 (74), Na/K 0.75 (74), Fe/P 23.7 (67) ja Cu/Zn 1.1 (73).

The rich fens (RF) were found to give rise to *Carex* (C) or Bryopsida-dominated (B) peats. Sedges (*Carex aquatilis, C. canescens, C. cespitosa, C. chordorrhiza, C. diandra, C. echinata, C. elongata, C. flava, C. lasiocarpa, C. limosa, C. magellanica, C. nigra, C. rostrata, C. vaginata* and *C. vesicaria*) normally accounted for about a third of the peat mass, while correspondingly, Bryopsida (*Aulacomnium palustre, Bryum weigelii, Calliergon cordifolium, C. megalophyllum, C. sarmentosum, Campylium stellatum, Cinclidium stygium, Limbrichtia intermedia, L. revolvens* coll.*, Loeskypnum badium, Meesia trifaria, Paludella squarrosa, Pleurozium schreberi, Polytrichum* spp.*, Pseudo-calliergon trifarium, Scorpidium revolvens, S. scorpioides, S. trifarium, S. vernicosum, Straminergon stramineum, Tomentyphnum nitens, Warnstorfia exannulata, W. fluitans, W. sarmentosa* and *W. trichophylla*) amounted to about a fourth. *Menyanthes* (MN), *Scheuchzeria palustris* (SH) and *Equisetum* (EQ) were the most common additional factors. The eutrophic species *Sphagnum subsecundum, S. teres* and *S. warnstorfii* were in the majority among the *Sphagnum* mosses, accounting for just under 7% out of the total of 9% for *Sphagnum* (*S. angustifolium, S. balticum, S. contortum, S. cuspidatum*coll.*, S. fallax, S. fuscum, S. girgensohnii, S. jensenii, S. magellanicum, S. majus, S. papillosum, S. platyphyllum, S. rubellum, S. squarrosum, S. subfulvum, S. subsecundum, S. teres* and *S. warnstorfii*). Lignin was below 5% on average, while the grasses were represented chiefly by reeds (*Phragmites australis*) and purple moor-grass, *Molinia caerulea,* and the rushes by *Trichophorum alpinum*. The most common peat types were *Carex* (C), brown moss (B), brown-moss/*Carex* (BC) and Carex/brown-moss (CB) peats, varying in humification in the range H_{1-8}, mean 3.4 and median H_3 (0.9; 182), and containing an average of 47.5% amorphous matter (17.2; 13.4-91.2; 63). The wet, fairly pliable peat was of normal slipperiness, stained to some extent and contained some *Carex* roots but little or no wood or *Eriophorum* fibres. Its mean water content was 91.2% (3.4; 78.8-96; 183), its dry density 84,6 kg/m^3 (33.8; 38.3-224; 183), the ash content of its dry matter 7.7% (6,0; 0.8-34.5; 183), its mean organic content 8.0% (2.7;

3.6-16.3; 183), its pH 5.8 (0.6; 3.4-6.8; 184) and its redox potential 76 mV (90; -150 - + 320; 93). The mean element concentrations in the peat ash (ppm) were: P 566 (362; 63-1794; 92), Na 163 (104; 4-552; 183), K 164 (182; 29-1636; 183), Ca 7783 (4642; 625-23516; 183), Mg 1098 (732; 47-4039; 183), Al 2608 (3824; 109-28862; 183), Fe 6829 (11046; 195-92579; 183), Mn 259 (1109; 6-14983; 183), Cu 22 (34; 1-257; 183), Zn 26 (36; 4-371; 183) and Pb 8 (12; 1-59; 104) and their ratios Ca/Mg 7.9 (183) and Fe/Mn 45.1 (183), Ca/K 78.5 (183), Na/K 1.4 (183), Fe/P 29.3 (92) and Cu/Zn 1.5 (183).

The **swampy sedge fens (SSdgF)** had horizons of predominantly *Carex* peat containing remains of a mesotrophic herb vegetation. About a third of the peat mass was made up of sedges (*Carex aquatilis, C. buxbaumii, C. canescens, C. chordorrhiza, C. diandra, C. lasiocarpa, C. limosa, C. pseudocyperus, C. rostrata* and *C. vesicaria*), with *Equisetum* and *Menyanthes* as the next most frequent peat-forming factors. The predominant brown mosses were *Calliergon cordifolium, Pseudobryum cinclidioides, Straminergon stramineum* and *Warnstorfia exannulata*, and these were somewhat more prolific than the *Sphagnum* mosses (*S. angustifolium, S. cuspidatum* coll., *S. fallax, S. jensenii, S. lindbergii, S. magellanicum, S. majus, S. obtusum, S. papillosum, S. recurvum* coll., *S. riparium, S. rubellum, S. russowii, S. squarrosum* and *S. teres*). Approximately the same amount as the above was also contributed by *Potentilla palustris*. By contrast, there was very little ligneous material or dwarf shrubs. The most common peat types were *Carex* peat (C), *Menyanthes/Equisetum/Carex* peat (MNEQC) in which the *Menyanthes* could be replaced by brown mosses (B) or *Potentilla palustris* (P), *Menyanthes/Carex* peat (MNC) and *Equisetum/Carex* peat (EQC). The degree of humification was in the range H_{3-6}, mean 3.9 and median H_4 (1.0; 58) and the mean amorphous content was 43.6% (13.9; 24.2-87.7; 35). Upon handling the peat was slippery to a normal extent, pliable and with a normal staining capacity. It contained large amounts of *Carex* roots, relatively little *Equisetum* fibre but some ligneous matter. The mean water content of the peat was about 91.6% (2.3; 86.1-94.7; 58) and the dry density 76.3 kg/m^3 (24; 36-142.9; 58). The mean organic content was 8.0% (2.3; 5.1-13.7; 58), the ash content of the dry matter 5.7% (4; 1.7-29.2; 58), the pH 5.2 (0.4; 4.5-5.9; 58) and the redox potential 20 mV (64; -90 - +115; 42). The mean element concentrations in the peat ash (ppm) were: P 571 (242; 236-1610; 45), Na 131 (67; 28-377; 55), K 115 (58; 27-307; 56), Ca 3545 (1205; 1386-6756; 50), Mg 680 (357; 212-1772; 55), Al 2611 (2009; 496-12022; 56), Fe 9128 (13373; 2696-13373; 56), Mn 66 (48; 8-167; 56), Cu 13 (7;

4-46; 56), Zn 20 (33; 3-201; 56) and Pb 7 (6; 1-33; 39) and their ratios Ca/Mg 5.4 (55) and Fe/Mn 172.2 (55), Ca/K 33.3 (55), Na/K 1.2 (56), Fe/P 17.1 (45) ja Cu/Zn 1.2 (56).

The **swamps (S)** had a greater proportion of herbaceous vegetation than did the mesotrophic swampy sedge fens, so that *Equisetum* made up about a fourth of the peat while the sedges (*Carex aquatilis, C. canescens, C. diandra* and *C. rostrata*) and *Menyanthes* (MN) each contributed about a fifth and *Potentilla palustris* about a sixth. There was very little in the way of ligneous material, other peat-forming factors (*Calla, Cicuta, Eleocharis, Hippuris, Juncus, Phragmites, Potamogeton* and *Scirpus*) or the brown mosses (*Calliergon cordifolium, Straminergon stramineum* and *Warnstorfia fluitans*). The most common peat types were *Carex* (C), *Equisetum/Carex* (EQC), *Potentilla palustris/Carex* (PC) and *Equisetum, Menyanthes* or *Potentilla palustris/Carex* ((EQ,MN,P)C) peats with degrees of humification in the range H_{3-6}, mean 4.5, median H_4 (0.9; 11) and an amorphous content of 50.8% (8; 37.7-64.7; 11). The peat contained large quantities of *Carex* roots, felt moderately slippery to the hands, stained and was pliable but did not contain any *Eriophorum* fibres or lignin at all. Its mean water content was 89.6% (2.3; 86.9-93; 10), its dry density 97.2 kg/m^3 (20.4; 60.4-124.4; 11), its mean organic content 8.3% (1.1; 6.6-10.1; 10) and the ash content of its dry matter 19.2% (10.7; 6-35.6; 10). The mean pH of the peat was 5.6 (0.4; 5-6.1; 11) and its redox potential -46 mV (68; -170 - +90; 11). The mean element concentrations in the peat ash (ppm) were: P 950 (403; 520-1607; 10), Na 323 (194; 109-736; 10), K 412 (307; 146-1192; 10), Ca 4043 (1608; 1983-5935; 10), Mg 1253 (833; 365-2375; 10), Al 4531 (1730; 1916-7522; 10), Fe 28925 (26077; 4324-76020; 10), Mn 90 (56; 29-181; 10), Cu 29 (10; 16-50; 10), Zn 84 (75; 14-280; 10) and Pb 14 (9; 3-31; 10) and their ratios (n 10) Ca/Mg 4.1 and Fe/Mn 520.4, Ca/K 12.5, Na/K 0.8, Fe/P 29.6 and Cu/Zn 0.54.

The **limnic peat (L)**, that deposited in water, fell fairly evenly into four categories as far as its peat-forming factors were concerned. Sedges (*Carex canescens, C. chordorrhiza, C. diandra, C. lasiocarpa, C. magellanica, C. rostrata* and *C. vesicaria*) and reeds (*Phragmites australis*) each accounted for a good fifth of the material and brown mosses for about a sixth. Among the Bryopsida it was *Calliergon giganteum, Warnstorfia exannulata* and *Scorpidium scorpioides* that were dominant, with some 10% in all. The ligneous contribution was then no more than about 5%, in addition to which debris and seeds from numerous herbs and waterplants (*Eleocharis palustris, Scirpus lacustris, Hippuris vulgaris, Menyanthes trifoliata, Myosotis, Nuphar luteum, Potentilla palustris, Potamogeton pusillus, P. gramineus, P. berchtoldii, Myriophyllum verticillatum,* *Sparganium simplex* and *Cristadella mucedo*) together with *Sphagnum* mosses (*S. fallax, S. riparium, S. squarrosum, S, subsecundum, S. teres* and *S. warnstorfii*) were to be found to some extent. The most common peat types were *Carex* peat (C), *Phragmites australis* peat (PRC), *Phragmites australis/Carex/Equisetum* peat with some brown mosses and *Menyanthes* ((B,MN)PRCEQ) and brown-moss/ *Carex* peat (BC), with a humification of $H_{4\text{-}5}$, mean 4.8 and median H_5 (0.4; 6) and an amorphous content of 46.1% (1). This peat was of normal moisture content and slipperiness, stained well and was highly pliable and contained *Carex* roots but no *Eriophorum* fibres or woody material. The mean water content of the peat was 86.9% (2.8; 82.2-89.4; 6) and its dry density 136.5 kg/m^3 (49.1; 96.8-229.9; 6), including a mean organic content of 9.7% (1.9; 8.4-13.6; 6) and an ash content of 25.6% (9.4; 13.2-41; 6). The mean pH of the peat was 5.4 (0.9; 3.8-6.1; 6). The mean element concentrations in the peat ash (ppm) were: P 587 (n=1), Na 302 (101; 157-427; 5), K 267 (121; 110-412; 6), Ca 7618 (5740; 609-14718; 6), Mg 865 (479; 254-1699; 6), Al 5836 (2754; 3403-10152; 6), Fe 27621 (30166; 1219-69732; 6), Mn 133 (112; 29-252; 6), Cu 45 (32; 16-102; 6), Zn 58 (39; 10-109; 6) and Pb 4 (4,9; 1-10; 3) and their ratios Ca/Mg 7.8 (6) and Fe/Mn 174.3 (6), Ca/K 32.2 (6), Na/K 1.1 (6), Fe/P 2.1 (1) and Cu/Zn 0.94 (6).

Indicators of the mire ecology of plant remains in peat

Water content

The peats with a moisture content of at least 91% contained remains of dwarf shrubs, sedges, herbs and a variety of mosses (*Vaccinium oxycoccos, Carex diandra*, *C. elongata*, *C. limosa*, *C. pauciflora*, *C. pseudocyperus*, *Trichophorum cespitosum*, *Caltha palustris*, *Cicuta virosa*, *Dactylorchis maculata*, *Drosera* spp., *D. anglica*, *Pedicularis palustris*, *Potamogeton natans*, *Ranunculus* spp*, Scheuchzeria palustris*, *Sparganium minimum*, *Sphagnum balticum*, *S. compactum*, *S. contortum*, *S. cuspidatum*, *S. cuspidatum* coll., *S. fallax*, *S. jensenii*, *S. lindbergii*, *S. magellanicum*, *S. majus*, *S. obtusum*, *S. papillosum*, *S. recurvum*coll., *S. rubellum*, *S. subsecundum*, *S. squarrosum*, *S. teres*, *Bryum weigelii*, *Calliergon megalophyllum*, *Dicranum* spp., *Hamatocaulis lapponicus*, *Meesia triquetra*, *Pseudo-calliergon trifarium*, *Scorpidium revolvens*, *Warnstofia* spp., *W. exannulata*, *W. trichophylla* and *Cladonia* spp.), while remains of willows and trees in general were indicative of a moisture content of less than 90% (Appendices 9 and 10). The water content of the 707 samples that contained woody material (lignin) varied in the range 45.7–96.5%, mean 88.8%, sd 5.2, while the 897 samples containing sedge material (*Carex* spp.) had a mean water content of 89.5%, sd 4.8 and range 45.7–96%. Certain species then stood out as having adapted to a particular water content in the peat: *Carex pauciflora* and *C. pseudocyperus* to levels over 93%, *Trichophorum caespitosum* and *Carex diandra* to over 91*%* and *C. limosa, C. chordorrhiza, C. rostrata, C. magellanica, C. lapponica, Eriophorum angustifolium* and *C. cespitosa* to over 90–91%. The remaining species, more than 63% of the mire species identified here, may be said to be indicative of water content values below 90%.

The mean moisture content of the 831 samples of peat containing debris from a herbaceous vegetation was 89.7%, sd 4.6 and range 45.7–96.5%. Here *Pedicularis palustris* and *Ranunculus* spp. stand out as characteristic of peats with a water content of over 95% (Appendices 8 and 9), while *Epilobium angustifolium, Pyrola rotundifolia, Caltha palustris* and *Scheuchzeria palustris* had adapted to moisture levels of 91–93%*,* and *Cicuta virosa, Potentilla palustre, Menyanthes trifoliata, Lysimachia vulgaris, Equisetum fluviatile* and *Calla palustris* occurred on average at levels of 89–91%. The mean water content of the 101 samples in which remains of grasses (Poaceae) were found was 87.9%, sd 4.5 and range 59.6–94.0%, and the mean for samples containing *Phragmites australis* was 88.7%.

Sphagnum mosses were clearly indicative of high water content, the mean figure for the 903 such samples being 89.9%, sd 4.7 (Appendices 9 and 10), but the range of values was very wide (45.7–96.5%). Most of the water content figures for ombro-oligotrophic samples were in excess of 90%, while moisture levels in the mesotrophic peats rose steadily, with wetter conditions indicated by *S. subsecundum* and drier ones by *S. centrale*. In eutrophic peats it was only *S. warstorfii* that indicated moisture levels below 92%. Most of the indifferent *Sphagnum* species in this respect had mean moisture levels of over 91%.

More than 52% of the Bryidae, which occurred altogether in 628 samples, were found at moisture levels of over 90% (90.4%, sd 4.0; 56.0–96.0%, Appendices 9 and 10) and about 15% of them at over 92%. *Calliergon megalophyllum* and *Warnstorfia trichophylla* were indicative of a water content in excess of 93%. Species to be found in the driest of all the peat samples were *Rhizomnium perssonii* and *R. pseudopunctatum.* The liverworts (Hepaticae) grew for preference on the hummock surfaces of mires, where the mean moisture content of the peat in the 7 samples studied was 87.7%. By contrast, the mean figure for the four habitats of *Potamogeton natans*, a species typical of peat horizons laid down in water, was 94.3%.

Dry density

The mean dry density of the whole series of 1077 peat samples (including ash) was 92.4 kg/m^3 (median 82.2, mode 78.7), while the values without ash were in the range 48–116 kg/m^3 (Fig. 26). There were some samples, however, with exceptionally high dry density figures (717, 540 and 440 kg/m^3) caused by an unusually high secondary mineral content. The lowest density measured here was 22 kg/m^3 (Appendices 9 and 10).

The dry densities of the peat were somewhat lower in mires where birch or pine was growing (69.2 kg/m^3 for 13 samples with *Betula pendula*, 82.4 kg/m^3 for 147 samples with *B. pubescens* and 81.6 kg/m^3 for 170 samples from mires with *Pinus silvestris*), the exception being alder (98.1 kg/m^3 for 29 samples with *Alnus*). The mean dry density of the 705 peat samples that contained woody material (Lignin) was 101.5 kg/m^3, sd 60.4 and range 26–717 kg/m^3 depending on the ash content (Appendices 9 and 10). The mean densities of the surface peat samples containing dwarf shrub material were fairly low (76.8kg/m^3 in the total set of 590 samples and 66.6 kg/m^3 in the 214 samples containing remains of cranberry plants (*Vaccinium oxycoccos*).

The mean dry density of the 894 *Carex*-dominated peat samples was 96.4 kg/m^3, sd 55.5 and range 22–717 kg/m^3 (Appendices 9 and 10). The separate *Carex* species were placed in the following order in terms of the dry density of the samples in which they occurred as the dominant species: *C. canescens* (129 kg/m^3, in 63 samples) >*C. globularis* (105 kg/m^3, in 47 samples) >*C. vesicaria* (99.4 kg/m^3, in 82 samples), *C. lasiocarpa* (99.3 kg/m^3, in 171 samples) > *C. limosa* (84.8 kg/m^3, in 134 samples), *C. rostrata* (84.8 kg/m^3 in 185 samples) and *C. chordorrhiza* (83.7 kg/m^3 in 175 samples). By contrast, the mean dry density in the 206 *Eriophorum vaginatum* peats was 75.8 kg/m^3, while the figures for the 102 samples containing remains of grasses were markedly higher than for the *Carex*-dominated ones, with a mean of 111.7 kg/m^3, sd 50.4 and range 24–444.4 kg/m^3. Those with remains of herbaceous plants, on the other hand, were only slightly higher than the overall mean, 95.4 kg/m^3 in 828 samples, sd 53.4 and range the same as in the *Carex* peats. The dry densities of the 520 peat samples containing *Equisetum*, 98.7kg/m^3, were higher than those of the 536 samples containing *Menyanthes*, 86.8kg/m^3, the 177 containing *Potentilla palustris*, 85.4kg/m^3, or the 303 containing *Scheuchzeria*, 83.5kg/m^3.

The mean dry density of the 901 samples of *Sphagnum* peats was 88.8 kg/m^3, sd 53.6 kg/m^3 and range 22–717 kg/m^3. Only 7 *Sphagnum* species were found in more than 100 peat samples and these could be placed in the following order of the dry densities of the peats in which they occurred: *S. angustifolium* (96.7kg/m^3 in 214 samples) >*S. fallax* (85.6 kg/m^3 in 118 samples) >*S. papillosum* (79.8 kg/m^3 in 149 samples), *S. magellanicum* (79.3 kg/m^3 in 155 samples) >*S. teres* (73.8 kg/m^3 in 180 samples), *S. subsecundum* (73.5kg/m^3 in 110 samples) >*S. fuscum* (68.0 kg/m^3 in 128 samples) (Appendix 10). The mean dry density of the 628 peat samples in which Bryidae occurred was 88.0 kg/m^3, sd 45.2 kg/m^{3}and range 24–544.8 kg/m^3. The densities associated with the two most common species are very similar: *Calliergon cordifolium* 83.6kg/m^3 in 108 samples and *Straminergon stramineum* 84.2 kg/m^3 in 240 samples, whereas the figures of 68.6 kg/m^3 recorded for the 86 samples containing *Pseudo-calliergon trifarium* and 75.8 for the 94 containing *Warnstorfia exannulata* were considerably lower. The mean dry density results of 64.6 kg/m^3 obtained for 7 samples of hummock surface peats containing liverworts (Hepaticae) and 136.5 kg/m^3 for 6 limnic peats must be regarded as no more than indicative of a certain trend.

Degree of humification, amorphous material and organic content

The degree of humification of the ombro-oligotrophic peat samples was in the range $H_{2\text{-}3}$ on the von Post (1922) scale, while the mean overall values for the peats formed by the most common mire plants varied in the range 2.0–4.8 and the means for the separate groups of trees and bushes (L), dwarf shrubs (N), grasses (Poaceae), sedges (C) and mosses (S and B) were in the range 3.5–4. The highest degrees of humification were found in certain individual samples, especially those containing plants that thrive under eutrophic conditions.

The mean proportions of unrecognizable amorphous material in the plant biomass were in the range 7.5–59.8% and were found to increase as humification proceeded, so that the proportions in poorly humified peats representing low trophic levels, as indicated by the presence of dwarf shrubs, were mostly below 35%, while the highest proportions were found in the mesotrophic and eutrophic peats. The largest amounts of peat had been deposited by forms of mire vegetation that had adapted to these latter conditions.

Among the groups of plants, the largest amounts of organic matter, close to 10%, were found in peat horizons with a high water content containing mostly remnants of grass, woody material and

Eriophorum, but the percentages varied greatly between species, especially between those that occurred infrequently, and the standard deviations were high.

Ash content

The ash content of the peat samples as a percentage of dry weight varied in the range 1.7–72.8%. Mineral material had been transported into the sloping mires in particular by surface water, and this was an especially prominent feature on the margins of sloping areas and in low-lying areas subject to flooding. It was also significant that the ash content of peats supporting a vegetation of dwarf shrubs and *Eriophorum* was only about half of that of peats containing grasses and woody material from trees and shrubs. Likewise, although the *Carex* and herb-rich peats had a similar mean ash content (7.8%), the *Sphagnum* peats contained 0.7%-points less ash than the Bryidae peats. In at least ten instances mean ash content figures of over 15% were recorded for peats that included remains of *Alnus incana, Carex canescens, Selaginella selaginoides, Sphagnum girgensohnii, S. warnstorfii, Campylium stellatum* or*Warnstorfia sarmentosa.* Details of the ash content of the peat samples in relation to the occurrence of certain plants are given in Appendices 9 and 10.

Geochemistry

Employing the data presented in Appendices 9 and 10 it is possible to deduce the nature of the growing conditions in each mire and the geochemistry of the resulting peat horizons. Among the groups of mire plants, the trees and shrubs (L), dwarf shrubs (N), sedges (C), herbaceous plants, *Equisetum*, *Sphagnum* mosses and Bryidae (Appendix 8) had fairly moderate element concentrations, whereas exceptional concentrations were observed in peats containing *Eriophorum*, grasses (Poaceae), liverworts (Hepaticae and *Marchantia*) and lichens. Grassy peats in particular had a high aluminium content. The cation concentrations in the peats (on a scale of 1-10) were lowest in the case of lichens, 1-2, while the level for liverworts, *Marchantia* and *Sphagnum* mosses, *Eriophorum* and the dwarf shrubs was 3, that for trees, sedges and Bryidae 4, that for herbaceous plants 5 and that for grasses 6, and the order for pH values was practically the same. Where redox potential (mV) was concerned, four groups could be distinguished: 1) lichens, liverworts and *Marchantia* > 250 mV, 2) *Eriophorum*, dwarf shrubs and *Sphagnum* mosses > 138 mV, 3) trees and bushes, sedges and Bryidae > 105 mV, and 4) *Equisetum* and grasses < 98 mV.

Where element concentrations are concerned, any decrease in the ratio Ca/Mg will reflect a change from nutrient-rich minerotrophic conditions to nutrient-poor ombrotrophic ones, in the order: > 7 grasses and Bryidae, < 7 *Sphagnum* mosses, *Carex* sedges and herbaceous plants, < 6 *Eriophorum*, dwarf shrubs, trees and bushes, and < 4.2 *Marchantia*, liverworts and lichens.

The peat horizons containing fragments of alder (*Alnus*) were rich in K, Fe, Pb and Zn, and those containing downy birch (*Betula pubescens*) and spruce (*Picea abies*) were also rich in zinc, whereas the horizons with large amounts of dwarf shrub debris generally had low element concentrations, except for the 82 samples with remains of dwarf birch (*Betula nana*), which were fairly rich in zinc (108 ppm).

Of the sedges, the presence of *Carex flava* on a mire led to high Al, Ca, Mg, Fe and Mn concentrations in the peat, *C. diandra* to high magnesium, *C. globularis* to high phosphorus, *C. lasiocarpa* to aluminium and *C. nigra* to manganese. On the other hand, *C. magellanica* led to extremely low element concentrations in the peat, *C. diandra*, *C. lasiocarpa* and *C. vesicaria* to low concentrations of lead and *C .diandra* to low zinc. All the *Carex* peats were low in manganese.

The *Eriophorum vaginatum* and *E. angustifolium* peats contained plenty of Fe and Zn, but the former were low in manganese, zinc and phosphorus. *Trichophorum cespitosum* peat was also low in phosphorus.

The grassy peats were moderately supplied with phosphorus, but contained high concentrations of Al and Na, while the highest Ca, Mg, Na, Cu, Fe and Mn concentrations were found in the *Molinia caerulea* peats. The peats containing material from common reeds (*Phragmites australis*) had more Cu in them than those based on any other plant species.

Large amounts of aluminium, calcium, magnesium, iron and manganese were found in the peat of herb-rich mires on which the clubmoss *Selaginella selaginoides* also grew, and an abundance of Al was also found in the presence of remnants of *Lysimachia vulgaris* and high concentrations of P in the presence of *Calla palustris* and *Equisetum sylvaticum*. Conversely, *E. fluviatile*, *Lysimachia vulgaris*, *Menyanthes trifoliata* and *Scheuchzeria palustris* were all markers of a low potassium concentration. Peats that supported a vegetation including stands of cowbane, *Cicuta virosa*, *Equisetum fluviatile* and *Menyanthes trifoliate* were low in manganese and zinc. It must be said, however, that the peats containing fragments of *Lysimachia vulgaris* and *Scheuchzeria palustris* were somewhat deficient in a number of cations (Table 9).

Among the *Sphagnum* mosses, those thriving in the presence of high element concentrations were *Sphagnum girgensohnii* (with respect to Ca, Mg and Na), *S. warnstorfii* (Ca and Mg) and *S. cuspidata* (K and Zn), together with some that required a high concentration of one specific element: *S. centrale* (P) and *S. riparium*, S. *recurvum* coll. and *S. teres* (Zn). Otherwise the element concentrations in the *Sphagnum* peats were in general low.

Low nutrient levels were particularly common in cases where the peat-forming factors were the following Bryidae: *Dicranum polysetum*, *Paludella squarrosa*, *Pleurozium schreberi*, *Pohlia nutans*, *Polytrichum* spp., *Pseudo-calliergon trifarium* (except with respect to calcium), *Warnstorfia exannulata* and *W. fluitans*. By contrast, *Scorpidium* spp., *Warnstorfia sarmentosa* and *Tomentypnum nitens* were markers of eutrophic peats.

Finally, the fungus *Cenococcum graniforme* occurred in a number of peat samples with high Al and P taken from the lower horizons of mires. Statistics on indicative element concentrations in peat ash are provided in Appendices 9 and 10.

5. DISCUSSION

Mire formation, mire type stratigraphy and the mire succession

Prior to the gradual melting of the ice sheet that began ca. 11 500–10 000 BP cal (Saarnisto & Salonen 1995; Eronen 1974, 1996; Saarnisto 2000) almost a half of the area of Northern Finland considered here was covered by the Ancylus Lake phase in the history of the Baltic basin. The oldest mires in this aapa mire region were naturally those that formed over 10 000 BP cal ago in the supra-aquatic eastern parts (Mäkilä & Grundström 2008, Mäkilä & Muurinen 2008), but from that time onwards the coastal plains slowly emerged from beneath the sea and created basins that were suitable for primary mire formation (Lindholm *et al.* 1989, Lindholm 1991, Munsterhjelm 1997, Rinkineva & Molander 1997, Rehell 2006).

Viewed on a global scale, the area concerned is located at the humid, oceanic western end of the Middle and Northern Boreal taiga forest vegetational zone, where optimal conditions existed for widespread mire formation. The climate in this zone fluctuated greatly over time, the warmest period occurring ca. 7000–5500 BP cal (Eronen 1996), and the current climate is such that the growing season lasts approximately 130–150 days, the total duration of the summer and autumn seasons is 170–200 days and the temperature sum is 800–1000 d.d. (Eurola 1999). The development of a mire vegetation was also influenced by the existence of certain refugia on the Norwegian coast (including nunataks in the inland mountain areas), the varying lengths of time for which given areas have been free of ice or above the water level, the macroclimate and its temperatures and the hygric effects of oceanicity and continentality. According to Damman (1979), mires are in a constant state of dynamic equilibrium with climatic conditions, which in effect constitute, alongside geological and topographic considerations, the principal factor determining the occurrence of mires (Charman *et al.* 2007).

The postglacial climatic optimum referred to above was followed by a cooling of the climate, as a consequence of which a distinct rise in water levels in the *Sphagnum* bogs of Central Europe has been detected and dated to ca. 5700–6000 BP cal (Magyari *et al*. 2000), and a change to more or less current climatic conditions has been observed from ca. 5500 BP cal onwards in the lake waters of the Baltic States, with a progressive trend towards moister conditions from just under 2000 BP cal (Harrison *et al.* 1996), from which point the development of raised bogs can be said to have commenced (Virtanen 2006). The proportion of noble deciduous trees in the forests declined and spruce became more common in the eastern parts of the area considered here from ca. 5800–5000 BP cal onwards (Miettinen 1985) as a result of the increased humidity (Lukkala 1933; Vasari 1962), and over practically the whole of the area by 4500 BP cal (Appendix 3). It has been shown, for instance, that spruce had reached the environs of the Järvenpäänsuo mire in Utajärvi (no. 12 in Fig. 1.) by the beginning of the Subboreal, ca. 5100 BP cal (Holappa 1976), at roughly the same time as a rise in lake levels is reported to have taken place in Central Europe as a consequence of climate change, 4900 BP cal (Magny *et al*. 2004). The thickest peat horizons in the present cores that date from before the spread of spruce were to be found in the north-eastern and south-eastern parts of the area, and to some extent also in the central parts, while the radiocarbon dates (Appendix 1) and pollen analyses (Appendices 2 and 3) indicate that all the mire deposits in the coastal strip and the upper peat horizons of more than half of the older mires were laid down at a time when spruce was growing in the local forests (Fig. 3). Primary mire formation was widespread in the vicinity of the coast (Huikari 1956), with sedges (*Carex*), woody material (lignin), *Sphagnum* mosses and brown mosses (Bryales) the most common peat-forming factors in the early stages (Fig. 4). *Sphagnum* peat would have been deposited in places where surface conditions were poor in nutrients, whereas certain mire plants such as *Potentilla* spp. would have been preserved in the basal peats, pointing to swampy conditions.

Under the climatic conditions described above, the aapa mires of Ostrobothnia would have characteristically gained low strings of intermediate surfaces in their central parts and pine bogs at their margins, but as the climate became cooler and more moist this would have encouraged the spread of *Sphagnum* mosses. Thus pronounced increases in these mosses have been reported at certain periods, most notably 6750-6400, 5100-4950, 4100-3850, 2950-2750, 2650-2500 and 800 BP cal (Mäkilä & Saarnisto 2008), so that the *Sphagnum* invasion in the Järvineva mire in Ruukki, for example, is reported to have begun around 4100 BP cal, i.e. at a present-day peat depth of 140 cm (Picken 2007). This increase in humidity reached its culmination ca. 2800 BP cal, leading to the observation of a number of cool/moist horizons in the mires of Denmark and North Germany that are indicative of rises in water level, dated to 2800, 1700 and 1300 BP cal, and also to the “Little Ice Age”, 1250–1350 BP cal (Barber *et al*. 2004). The formation of permafrost and palsas in Northern Fennoscandia has been shown to have begun ca. 2550 BP cal (Salmi 1972; Seppälä 2005, 2006; Oksanen 2005), and the proportion of *Sphagnum* mosses in the mires of North America evidently increased around 2000 BP cal as a consequence of a rise in the groundwater table (Janssens *et al*. 1992, Gorham & Janssens 1992). In Finland, a minor peak in *Sphagnum* spp. at a depth of 4–5 m has been detected in thick-peat mires such as Takasuo in Ylikiiminki (63 ma.s.l., depth 5 m), Riissuo in Posio (329 m, depth >3.9) and Matosuo in Kuusamo (273 m, peat depth 6.55 m+ 1.75 m gyttja). It is also possible, however, that *Sphagnum* mosses may have thrived especially well during the previous humid climatic period, when the water level in the lakes of a zone stretching into Northern Europe and Eastern Finland is similarly known to have risen (Janssens *et al.* 1992), and raised bogs developed in many places on the coasts and close to waterways, mainly after the spread of spruce.

According to inventories performed by the Geological Survey of Finland, the mean depth of the mires in the province of Oulu is 1.2 m and that in Lapland 1.3 m (Virtanen *et al.* 2003). By comparison, the cores used in the present work show the mean peat depth to be just under 1.5 m, although it should be remembered that this material was composed of both geologically and biologically defined mires, which would explain the high standard deviation in the depth figures for all the mire types studied here. The 54 mire types recognized in this analysis, together with peat deposited in water, were deposited at different heights in the mire type stratigraphy relative to the overall thickness of the peat at the sampling site (Figs. 8a and b, and 9a and b).

It was possible here by grouping the recent and subfossil mire types together on an ecological basis to reduce the number of types to 14 plus limnic peat (Table 4, Fig. 8b). In this scheme the horizons with a mire margin effect are regarded as being located at the base of a mire or as forming an entire thinnish peat horizon on the edge of a mire in places; in other words, as the peat deposit becomes thicker the types influenced by location at the mire centre lose their contact with the underlying mineral soil. The final stages in the succession of mire types are thus regarded as being the ombrotrophic and oligotrophic surface peat horizons of *Sphagnum fuscum* bogs (SphfB), dwarf shrub pine bogs (DsPiB), *Eriophorum vaginatum* pine bogs (ErPiB) and poor fens (OmOlPF).

The course of development of the mire type succession can be described with reference to the pH and water content of the peat, in terms of which the types representing different trophic levels and the progression from one type to another will operate for the most part in the following manners: 1) progressively from moist, rich eutrophic conditions towards nutrient-poor ombrotrophic conditions, 2) retrogressively at times, if the mire becomes markedly wetter for some reason, 3) oscillating in a progressive-retrogressive-progressive manner, or 4) in a stable manner, remaining almost the same right from the onset of mire formation. In the case of Kiimisuo on the island of Hailuoto in the area of pronounced land uplift (Fig. 1, no. 15; Appendix 1), the natural, autogenic succession (Magyari *et.al*. 2000) from open water to an ombrotrophic *Sphagnum* bog took place extremely rapidly in the form of a transition from an aquatic vegetation in 880 BP cal to a minerotrophic short-sedge bog and on to an ombrotrophic short-sedge bog and most recently to a *Sphagnum fuscum* bog at 11.9 m a.s.l. (Rönkä 1985). On the other hand, a regressive pattern was seen at Ruostesuo in Kiiminki from a poor birch fen to a mesotrophic tall-sedge fen followed by a mesotrophic mud-bottom flark fen (no. 3 in Fig. 1, 60 m a.s.l.; Appendix 1), and an oscillation under alternating wetter and drier conditions at Säynäjäsuo in Suomussalmi, from a flark fen to a mesotrophic tall-sedge pine fen, a true tall-sedge fen, a *Sphagnum papillosum* poor fen, a short-sedge fen and eventually a *Sphagnum* flark fen (no. 27 in Fig. 1, 191 m a.s.l.; Appendix 1). A stable situation was found at Matosuo in Kuusamo, where an aquatic vegetation gave way to a swampy rich fen and then to a flark fen (no. 35 in Fig. 1, 273 m a.s.l.; Appendix 1). An interesting case was that of Purkuputaansuo in the eastern part of the Kuusamo district, which has a continental climate but oceanic moisture conditions (Eurola &

Vorren 1980). Here the mire developed allogenically from a eutrophic state, a herb-rich spruce mire, via a birch-spruce mire with rich fen features and a rich pine fen to an ombrotrophic *Sphagnum fuscum* bog, possibly because the climate became cooler and wetter (no. 13 in Fig. 1, Appendix 1, 228 m a.s.l., 6840 BP cal, Miettinen 1983, 1985). In the case of mires that are in a natural state, this allogenic progressive succession brought about by environmental changes most commonly takes place at the margins of mire types that have developed on account of the paludification of forest land and are influenced by an increase in the thickness of the peat, causing it to dry out and acidify. The most common stimuli for this are forest fires, the digging of drainage ditches or changes in the macroclimate (Magyari *et.al*. 2004). Cyclic variations in climate over the past 6300 years (cal) have been said to have led to the development of peat horizons of the kind seen in raised bogs (Aaby 1976), in that meso-eutrophic mire types (Fig. 10) with a peat acidity in excess of pH 5 advance in a progressive succession from mesotrophic complex and poor fen stages (pH 4.5–5) to oligotrophic pine fens and complexes and eventually spruce-pine mires, *Eriophorum vaginatum* pine bogs and dwarf shrub pine bogs (pH 3.5–4). The poorest mire types of all tend to develop at the climax stage into ombrotrophic *Sphagnum fuscum* bogs (pH < 3.5), which in the present material would appear to represent at its height the seventh stage in mire type development. Correspondingly, Rybnicek & Rybnickova (1968) recognized 8 stages in the mire type succession in their model, while Walker (1970) distinguished 12 stages in the development of British mires from open water to raised bogs. Later, however, using statistical methods, Rybnicek and Rybnickova (1974) arrived at the figure of 11 stages in mire type development.

Decomposition of peats

Amorphous decomposed plant biomass can form even in recent horizons, especially in mesotrophic and eutrophic mire types with margin effects (Fig. 14.), whereupon the amount of amorphous material as a percentage of dry weight will show a linear correlation with the degree of humification on the von Post scale (Fig. 13, $r^2 = 0.9914$). Similarly the functions describing the decomposition of individual mire plants will possess fairly high explanatory powers (Table 6). On the other hand, the basal peats of the particularly rich fens in the present material were regularly found to be poorly decomposed, so that the peat contained a relatively small proportion of amorphous matter, a situation which may be attributed to the rapid deposition of peat at the initial stages in mire formation (cf. also Tolonen 1967). In any case, a positive correlation has in general been demonstrated between depth and the degree of humification (Mäkilä 1987). No biomass measurements were made during the growing season in the present work, but it has been noted previously that deep-rooted plants belonging stratigraphically to the most recent mire type are able to add both living biomass and dead necromass to that already accumulated in the previous, older mire type phase (Sjörs 1991), assuming that a change in mire type has taken place.

The organic material in peat generally decomposes to carbon dioxide, water and various salts, and at the same time this decomposition gives rise to humic substances, predominantly lignoproteins (Grosse-Brauckmann & Puffe 1965; Naucke 1976; Eurola 1992). Although there is no clear difference between pine bogs and rich fens in the mineralization of nutrients, this process is more pronounced in forested mire types than in herb-rich ones (Aerts *et al*. 1999). Cellulose and hemicelluloses decompose most rapidly during humification, so that the proportions of these in the peat decrease as humification advances (Naucke 1976). Efficient decomposition takes place in the well-aeriated surface layer of the peat in the acrotelm, above the groundwater table, where the plant biomass generated is pre-decomposed by invertebrate organisms in the soil to the extent that 80–95% of this biomass is emitted in the form of gasses, chiefly carbon dioxide (Ingram 1978). Methane is also given off, but this is oxidated to carbon dioxide under the influence of methanotrophic bacteria (Sundh *et al*. 1994, Laine *et al*. 1996), and nitrogen is produced under the influence of nutrients from the environment and as a consequence of the mineralization of organic material. Thus the peats to be found in mesotrophic and eutrophic mire types are more advanced in their decomposition, as the amount of nitrogen in the acrotelm shows a (significant) positive correlation with the degree of humification and the total nitrogen content of the peat. The total amount of nitrogen in pine bog peat types is only a half of that in mesotrophic or rich types, or in the peats of poor fens (Bayley *et al*. 2005). It was also the case in the present material that the mesotrophic and eutrophic peats were distinctly better humified, although admittedly no determinations of nitrogen content were available. It has been claimed by Malmer *et al.* (2003), however, that *Sphagnum* mosses make efficient use of nutrients, so that an imbalance between nitgrogen and phosphorus will give these mosses an opportunity to reduce the survival potential of vascular plants.

Decomposition processes continue to some extent in the less well aeriated water of the catotelm thanks to the action of anaerobic bacteria, releasing hydrogen sulphide, ammonia and nitric oxide in addition to the above-mentioned gasses (Nykänen *et al*. 1998). The more slowly decomposing mire plants become enriched in these peat horizons as the degree of humification increases, since their exceptional organic composition affects the rate of decomposition of their remains (cf. Clymo 1983). The present finding that the estimated percentages of the various plant remains in the peat samples correlated with the degree of humification of the sample is consistent with these observations, and it can thus be proposed that the decomposition of mire plants proceeds broadly speaking in such a way that the proportions of woody material (lignin), dwarf shrubs (nanolignin), *Eriophorum, Equisetum* and herbaceous plants in peat increase as its degree of humification rises, and to some extent this is also true of the sedges (Cyperaceae) (Fig. 11). This also implies that the proportions of recognizable remains of *Sphagnum mosses* and Bryidae diminish to below 10% as humification reaches or exceeds H_5 on von Post's scale (Fig. 12). By this stage the mosses and a large amount of the other peat-forming plants will have disintegrated to an amorphous mass. We can conclude, therefore, that only tree fragments, the remains of bushes and dwarf shrubs together with fibres of *Eriophorum* and silicon-containing *Equisetum* species stand any chance of occurring in H_{10} peats. Nevertheless, Heikuraisen and Huikari (1956) noted that *Sphagnum* mosses and dwarf shrub remains were still quite visible in completely humified peat, and various plants such as *Calluna*, *Eriophorum vaginatum* and *Rubus chamaemorus* are mentioned by Heal *et al*. (1978) and Clymo (1978) as having diminished in weight within the biomass as a function of time on account of its further decomposition. The equations listed in Table 7 of the present work indicate clearly that it would be possible to estimate changes in the composition of a given peat mathematically if one knew either the degree of humification according to von Post (x) or the percentage of a given plant in the peat biomass (y).

Organic content and dry density of peats

No attempt is made in this survey of aapa mires to measure the nitrogen content of peat horizons, although it has been demonstrated in experiments to determine carbon and nutrient cycles using *Carex* and *Sphagnum*-dominated samples (Scheffer *et al*. 2001) that, on account of the varying availability of nutrients and the ability of microbes to adapt to changes in the nutrient supply and other environmental factors, the cycles are not the same in these two cases, as the sedges will have decomposed more rapidly than the *Sphagnum* mosses, and the increased C/N ratio and high carbon dioxide content in the latter case will lower the concentrations of the main nutrients, K, Mg, N and P (Jauhiainen *et al*. 2004), thereby detracting still further from the competitive potential of the vascular plants. Furthermore, high concentrations of N and P in the atmosphere would appear to increase the growth and accumulation of *Sphagnum* mosses (Malmer 1990) where otherwise the leaves of these mosses would have only low N and P concentrations (Aerts *et al*. 1999). The dependence of carbon accumulation on water level would seem to take the form of a curve (Swanson 2007), which would mean that the rate of accumulation, around 40 g C $m^{-2}yr^{-1}$, would be greater in mire types that possess intermediate and hummock surfaces, and that the eventual carbon content of the catotelm would be dependent on the hydrology of the mire. Other factors explaining the fluctuations observed in the dry density of peat horizons are the nitrogen content, degree of humification, carbon loss and decomposition of the organic litter (Malmer & Wallén 2006). The long-term average net accumulation of carbon has been estimated to be 17 g $m^{-2}yr^{-1}$ in aapa mires and 21 g $m^{-2}yr^{-1}$ in raised bogs (Mäkilä & Goslar 2008), and it has also been suggested that old, swampy aapa mires may be approaching a situation in which primary production is scarcely able any longer to compensate for the carbon lost due to decomposition of the peat. Thus it is quite possible that the above estimates for the long-term accumulation of carbon may be too high and that the true combined vertical and lateral accumulation may be around 8.0 g C m^{-2} y^{-1} (Mäkilä *et al*. 2001).

The peat horizons of the mires in the present area that are in a natural state have a mean organic content of 12–7.4%, the figures for the individual mire types being arranged in the order: spruce mires > mire complexes > pine mires/bogs > poor fens > rich fens (Fig. 25). In other words, dry densities in kg/m^3 would be highest in forested mires (true spruce mires 116 > oligotrophic complexes 99, herb-rich spruce mires 98, mesotrophic complexes 94 > other mire types). Limnic peats, those laid down in water, vary greatly in their dry densities, so that no firm conclusions can be reached on the basis of the present data due to the small number of observations (Fig. 26).

Determination of the botanical composition of peats

The compositions of the surface peat horizons of recent mire types are reflected to some extent in the existing descriptions of the plant species to be found on peatlands (Ruuhijärvi 1960, Eurola 1962, Vasari 1962), and the resulting analyses of the vegetation cover may be said to provide a fairly reliable picture of the nature of the surface peat horizon in each case. The chief problem, however, is that the differing speeds with which plant remains decompose and mineralize as a function of time (Clymo 1983) cause considerable distortion in the proportions of the recognizable plant debris (Table 10). It has been proposed by the First and Fifth Commissions of the International Peatland Society (Anonymous 1972) that a general system for the classification of peats should be simple and easy to adopt and based on observations that can be made with the naked eye. The principal criteria used should be the composition of the peat in terms of plant species (*Sphagnum* mosses, Bryidae, sedges and ligneous plants) and the degree of humification (light $H_{1\text{-}3}$, dark $H_{4\text{-}6}$and black $H_{7\text{-}10}$), together with the trophic levels (eutrophic, mesotrophic and oligotrophic), the hydrology of the place of origin of the peat (terrestrial, telmatic, limnic, minerotrophic and ombrotrophic) and its coarseness (fine, medium, coarse). The Geological Survey of Finland uses one sixth of the peat sample, about 17%, as the resolution limit for assessing the botanical composition of a peat horizon, i.e. its "peat-forming factors"(Lappalainen *et al.* 1984).

The precise determination of the percentages of the various plants in peats belonging to particular mire types would nevertheless call for the performing of macrosubfossil analyses, first by eye and then checked microscopically, as mentioned in Figure 2, followed by estimation or determination of the proportion of amorphous matter in the < 0.125 mm fraction of the fully decomposed peat. A further essential would be to determine other properties of the peat, such as moisture content, the amounts of sedge roots, *Eriophorum* fibres and ligneous fragments present and the pliability, slipperiness and staining capacity, all on a scale of 1–5, although it must be admitted that the scale of 0–6 proposed by Mäkilä (1994) is able to express the moisture content of peat more precisely. The assumption is that the mean proportions of the various recognizable plant remains will represent a peat horizon typical of a vegetation that has adapted to certain environmental conditions and reflects a particular mire type, or else a limnic peat. This implies that peats belonging to the same mire type will show some degree of evident similarity in terms of their botanical composition even though the determinations may have been arrived at on the basis of either plant cover analyses of the surface peat (representing the recent mire type) or macrosubfossil analyses of older horizons (Tables 10 and 11). It would seem, however, that 10% would be a more suitable minimum limit for recognizing a plant species as a peat-forming factor, even in the case of peats which differ in their trophic level. A very well humified peat will consist mostly of entirely decomposed amorphous biomass which will be recognized as a major contributory factor alongside *Carex, Sphagnum* and Bryidae. When estimating the proportions of amorphous matter it would perhaps be sufficient to set the limits at < 25%, 25–50% and >50% (Fig. 15).

Physical properties of the mire types

The mV values in the surface peats studied here were higher than those in the intermediate level or basal peat horizons, differing from them almost by a factor of three in the case of ombrotrophic peats. Similarly, the pH was lower than in basal peats and deviations were greater than those found in mesotrophic or eutrophic mire complex types located in areas with an alkaline bedrock.

Of the various mire types, swampy poor or rich fens, those with a mire centre effect and some of the poorer *Sphagnum* bogs or fens were wetter than the spruce mire types, and the thick-peat, poorly humified, oligotrophic spruce mires and pine fens with a centre effect had high mV values, whereas their pH of 3-4 was a couple of units lower than in the eutrophic mire types with a margin effect. The proportions of amorphous matter (< 0.125 mm) in the peat correlated well ($r^2 = 0.9914$) with the distribution of degrees of humification quoted by von Post (1922), and the proportions of organic matter in the spruce mire and mire complex types exceeded those in the treeless fens in spite of the swampy or rich fen character of the latter. The huge contrast between the swampy treeless fens and spruce mires on the one hand and the types showing a mire centre effect on the other is manifested best in their ash content, especially in alkaline bedrock areas, where it is to be seen in the herb-rich spruce mires and related mire complexes and the peats of the rich and poor fens. A high ash content will lead above all to a higher dry density in the basal peat.

Geochemistry of the mire types

The peat in an uncompressed mire profile will increase in porosity towards the surface, so that its ability to conduct water in a horizontal direction will increase exponentially (Ivanov 1981, Rehell 1985, Swanson 2007), as is the case in coarse-grained mineral soils. This will allow the surface runoff and the cation-rich groundwater infiltrating via the underlying soil to transport additional nutrients from the bedrock and the surficial deposits overlying it into the peat horizons. A capillary mire margin effect will then be manifested in a spring vegetation and the effect of surface runoff in a swamp or spruce mire vegetation, which will in turn be reflected in the geochemistry of the mire types affected by this minerogenic groundwater in high Ca, Mg, P, Fe, Mn, Al, Cu, Zn and Pb concentrations in general and high Na and K in the spruce mire and pine bog types (Figs. 23 and 24). In the same way high Ca and Mg concentrations have been detected in the margins of a mire in the Italian Alps (Bragazza & Gerdol 1999, 2002). By far the highest Ca concentrations in the present material were seen in the eutrophic mire complex and rich fen mire types and in the limnic peat, while extremely high accumulations of Mn were found in the eutrophic mire complexes, herb-rich spruce mires and rich fens of the alkaline bedrock area, where they may have become enriched to toxic or deleterious levels as far as the forest trees were concerned on account of the ditching of the mires. Apart from manganese, the concentrations of Ca, Mg, Fe, Al and Cu were higher in the alkaline bedrock areas than in the areas characterized by acidic rock types.

The acidity of the peats studied here varied in the range pH 3.3–6.8, and their redox potentials in the range –110 – +310 mV. The metals concerned are not only biophyllic elements but they are also ones that are essential for the growth of plants, although there are also elements accumulating in mire plants that are unable to serve as nutrients and may be to a greater or lesser degree toxic. Under the acidity and redox potential conditions defined here the bivalent cations to be found in the peat are Ca^{2+}, Mg^{2+}, Mn^{2+}, $Pb^{2+}$and Zn^{2+}, in addition to which iron is divalent (Fe^{2+}) at low pH and mV values and trivalent (Fe^{3+}) under oxidative and less acidic conditions. Pb is likewise divalent under reducing conditions (Pb^{2+}), but can be found partly in hydroxy form ($PbOH^{+}$) in more neutral environments. Copper is divalent (Cu^{2+}) under oxidative conditions but univalent (Cu^{+}) under reducing conditions, and phosphorus occurs in peat as a soluble phosphate under all the above conditions. The readily soluble elements sodium and potassium are consistently univalent cations (Na^{+} and K^{+}).

The following percentages of the amounts of elements accumulating annually in Southern Finland have been shown to be transported into the catotelm of raised bogs: N 38%, K2.5%, P 18%, Na 15%, Ca 3%, Mg 51% and S 3.5%. Through the action of the mobile ions Na and S, the nutrients bound by the vegetation (K, N, P, Ca and Mg) and the increased volumes of dust deposited, high concentrations of cations accumulate in the acrotelm (Damman *et al.* 1993). The vegetation on a mire with a centre effect receives nutrients only from precipitation, material transported by winds or animals and decomposition of the surface peat, so that the mire itself can only be either ombrotrophic (e.g. the central parts of raised bogs, hummock surfaces possessing thick peat horizons) or minerotrophic. This means that the mire centre effect will be manifested through the presence of pine bog, pine fen or rich fen features (Eurola & Kaakinen 1978). It should also be remembered, of course, that an abundance of meltwater from snow will carry mineral matter with it into the lower parts of the slopes, those that form the mire margins, as seen here at Riissuo (no.

10 in Fig. 1) and Rytisuo at Siikavaara (no. 33), and that runoff water entering a mire (Rehell 1985) may induce a swamp nutrient effect. Where ombrotrophic and oligotrophic conditions scarcely differ in terms of surface peat analyses, there is a clearer difference between them in the catotelm, and the distinction between these and mesotrophic or eutrophic conditions is in most cases an obvious one, since the latter stand out best by virtue of their pH values and the amounts of Al, Mg, Ca, Mn and Fe present. As the plants take their nutrients from the water in the mire, the clearest direction of development to be seen in both the vegetation pattern and the growth figures is towards ombrotrophic conditions (see Vasander1981a and b, 1983; Lindholm & Vasander 1979; Eurola & Holappa 1984). Fe, Al, Mn, Ca, K, P and Mg concentrations are distinctly lower in ombrotrophic surface peats.

The highest levels of Fe, Ca, K, Mg, Al and P were found here in the surface peats of the minertotrophic mires, while the peat horizons of the sandy-bottomed mires contained rather less Al, Mg, K and P than those in the till-bottomed mires of either the alkaline or the acidic bedrock areas. Correspondingly, both the sandy-bottomed mires and the till-bottomed mires of the acidic bedrock area have the highest Mn concentrations. Thus ombro-oligotrophic conditions would seem to differ from minerotrophic ones in their geochemistry and not only in their mire water chemistry (Eurola & Kaakinen 1978; Tolonen & Hosiaisluoma 1978; Eurola *et al*. 1995; Tahvanainen 2004; Eurola & Huttunen 2006), while the margin and centre effects are manifested as special features of the physical properties and geochemical concentrations of the peats as well as the mire types.

The mean pH of ombro-oligotrophic peat in the mires of Canada is reported to be 3.85 (3.8–4.03) and that of minerotrophic peat 4.67 (4.49–5.13) (Wells & Zoltai 1985), values that are of almost the same magnitude as those obtained here for the respective aapa mires (3.3 and 4.5, Appendix 5). On the other hand, the mean Fe and Ca concentrations in both the ombro-oligotrophic and minerotrophic mires in Canada were lower than those in the peats of the present aapa mires, so that only Ca and Mg showed a correlation between the concentrations in the surface waters of the mire and those in the mosses (Malmer & Wallen 2006).

The peats of the herb-rich spruce mires, the peats laid down in water and those of the swampy mire types contained distinctly more sodium than the other types, while the herb-rich peats of the mire margins contained large amounts of potassium and the true spruce mires, spruce-pine mires and dwarf-shrub pine bogs had about half that amount. The low acidity and high calcium and magnesium concentrations of the eutrophic mire complexes and rich fens serve well to explain the species richness of the plant remains in the respective peats.

The lowest concentrations of phosphorus in this material are to be found in the peats of the ombrotrophic and oligotrophic mire types. Elsewhere, Terho (1976) reported that phosphorus concentrations in ash from peat samples representing mires in northern Satakunta decreased from the surface peat towards the bottom of the mire, whereas the concentrations in dried samples did not show any differences between the peat horizons. According to Aerts *et al*. (1999), the vegetation on a pine bog will make more efficient use of the available phosphorus than will a rich fen vegetation.

The trace metals Fe, Mn, Al, Cu, Zn and Pb tended to accumulate more markedly in the peat of mires involving a margin effect than in other mire types, and types in which swamp or spruce mire effects predominated showed particularly high Fe, Al, Cu, Zn and Pb concentrations. Amounts of trace elements in peat have been said to vary greatly on an areal basis on account of the mineral composition of the bedrock and may also vary spatially or with depth within a single mire (Salmi 1950, Tanskanen 1972, Yliruokanen 1980).
The correlations between element concentrations in peat ash and the physical properties of the peats concerned were the following:

<u>Phosphorus</u> (P) concentrations served best to explain the variations in a number of other elements in peats with swampy features, especially calcium but also aluminium in peats of various trophic levels and manganese in spruce-pine mires.

<u>Sodium</u> (Na) correlated positively with potassium and magnesium in particular in various mire types, but less obviously with iron, zinc and lead.

<u>Concentrations of potassium</u> (K) showed a clear correlation with magnesium and manganese in mire types with a mire centre effect and with zinc and lead in the presence of a mire margin effect.

<u>Calcium</u> (Ca) was (highly significantly) correlated with magnesium in the peat of various mire types and with iron and zinc in limnic peat.

<u>Magnesium</u> (Mg) correlated best with manganese, iron and lead concentrations in the peat of poor fens, rich fens and pine bogs, albeit with a low explanatory power.

Aluminium (Al) concentrations correlated with those of copper in the peats of poor fens, rich fens, spruce mires with a margin effect and mire complexes.

Iron (Fe) and zinc (Zn) showed correlations with lead in limnic peats and in the peat horizons of swampy sedge fens, swampy poor fens and rich fens.

Manganese (Mn) scarcely showed any correlations with other elements, the nearest relationships being with zinc in the peats of true spruce mires and with zinc and lead in rich fens.

Copper (Cu) correlated positively with lead in the peats of mesotrophic poor fens and eutrophic mire complexes.

Zinc (Zn) was correlated with lead concentrations in the peats of swampy sedge fens, rich fens, mesotrophic poor fens and herb-rich spruce mires.

Lead (Pb) was correlated with a number of other elements in the peats of rich fens, poor fens and also spruce mires and mire complexes.

The correlations with water content were negative and gave very high explanatory power values with respect to dry density, the proportion of organic matter, ash content, the proportion of amorphous matter and the degree of humification. Mäkilä (1987) found the water content of peat to correlate negatively (to a significant extent) with the degree of humification, dry density and ash content.

Dry densities served best to explain the positive significances of changes in the proportions of organic and amorphous matter, the degree of humification of the peat and its ash content. Correspondingly, the material of Mäkilä (1994) gave (significant) positive correlations with the degree of humification and ash content of the peat but a significant negative correlation with water content. This latter dependence was weaker in *Carex* than in *Sphagnum* peats.

The variations in the proportions of amorphous and organic matter could be explained by the degree of humification of the peat (v. Post 1922) in the case of a number of mire types, and amorphous matter had the highest explanatory power with respect to variations in organic matter. Organic matter, in turn, explained the mV and ash content values for swamps in a positive sense and the pH values of the peat in a number of mire types in a negative sense, independently of the trophic level. Mäkilä (1987) found significant positive correlations for ash content with both dry density and the degree of humification but a negative correlation with water content.

Ecological niches of mire plants

The driest peats were those containing remnants of grasses and ligneous material, whereas those formed chiefly of mosses, sedges and herbaceous plants had a water content of over 90%. It is well known, in fact, that the moisture content of peat in a natural state is over 80% of its fresh weight, but dry densities can vary considerably, largely on account of differences in ash content, the species composition of the vegetation and the degree of humification of the peat. Also, as humification advances, the proportion of amorphous material in the biomass increases. Sedge and herb-rich peats and those formed by the remains of herbaceous plants tend to have higher than average dry densities, while correspondingly these are lower than average in moss and *Eriophorum* peats. Mäkilä (1994) quotes figures of 90.8% for the mean water content of the peat in mires suitable for peat mining and 90.5 kg/m^3 for dry density, having previously estimated the mean degree of humification of peat in Finland as a whole as 4.8 and the ash content as 3.6% of dry weight (Mäkilä 1987). The present results place the mean accumulation of organic matter in the peats of the area studied here at 9.3% of dry weight and the ash content at 7.1%.

The mean pH of the peat in the present mires was 4.8, with a wide standard deviation, which means that the amounts of soluble elements contained in them varied greatly. Also, the cations Ca^{2+}, Mg^{2+}, Mn^{2+}, Pb^{2+} and Zn^{2+} were all divalent under the redox conditions encountered in these mires. In addition, the element concentrations were affected by local geological and hydrological factors and by the vegetation that had contributed to peat formation, since the geochemistry of the existing peat will have had a selective influence on the vegetation representing the recent mire type. The element concentrations in the peat ash samples (i.e. the k values), the pH, the redox potential (mV) and the Ca/Mg and Fe/Mn ratios all serve to demonstrate that various mire plants are, within certain limits and, through the medium of their concentrations in the peat ash, indicative of the geochemical composition of the bedrock and surficial deposits (Appendices 8 and 9). These indicative values can also serve to define ecologically distinct groups of mire plants, differences between substrates (hummocks, intermediate surfaces and flarks) and variations in geochemical concentrations between peats subjected to a mire margin or mire centre effect. Individual plant species reflect the geochemistry of the underlying peat better than do the main peat-forming factors (*Carex, Sphagnum* etc.). A plant that favours nutrient-rich habitats will not grow in ombrotrophic or oligotrophic peats, and the degree of minero-ombrotrophy will inevitably be reflected in the Ca/Mg ratio and the redox potential in the Fe/Mn ratio. It is thus possible to some extent using selected plant species as indicators (on a scale of minimal–indifferent–maximal) to gain a rough estimate of the geochemistry of the peat in given mires and of the bedrock and surficial deposits of plant habitats in the vicinity of these mires.

The present research (for a comparison, see Kotilainen 1927) showed that markedly acidophilic plant species occur in soils with a pH in the range 3.34–3.99 (Appendices 8 and 9). Plants that have adapted to highly acidic conditions include *Dicranum polysetum*, *Polytrichum strictum*, *Sphagnum capillifolium*, *Sphagnum compactum*, *Sphagnum cuspidatum*, *Sphagnum fuscum*, *Sphagnum magellanicum*, *Sphagnum tenellum*, Hepaticae, *Calluna vulgaris*, *Chamaedaphne calyculata*, *Rubus chamaemorus*, *Vaccinium* spp.*, Vaccinium microcarpum*, *Vaccinium uliginosum*, *Ledum palustre*, *Salix caprea*, *Dactylorchis maculata*, *Carex globularis*, *Carex pauciflora*, *Eriophorum vaginatum*, *Trichophorum caespitosum* and *Cristatella mucedo,* while indicators of practically neutral peat conditions, pH >6, in addition to water plants, are *Tomentyphnum nitens*, *Calliergon giganteum*, *Calliergon megalophyllum, Warnstorfia trichophylla*, *Calamagrostis* spp., *Filipendula ulmaria*, *Pedicularis palustris*, *Rubus saxatilis* and *Sphagnum contortum*.

The more or less indifferent species indicative of meso-eutrophic peats with a pH in the range 5–6 number well over 80. These have been studied in North America in peats located above the groundwater table in mires (Gorham & Janssens 1992), where the pH has been somewhat higher than for the *Sphagnum* species described in the present material. On the other hand, the analyses of the accumulation of heavy metals falling onto *Sphagnum* mosses in Finnish mires performed for the Finnish Forest Research Institute by Lippa & Kubin (1998) are best suited for mapping the movements of airborne pollutants rather than for studying the geochemistry of mires.

Ore-critical sites in the area

The parts of the present area that are of interest for ore prospecting can perhaps be distinguished most clearly on the basis of high copper, lead and zinc concentrations in peat ash samples from sites with an alkaline bedrock (Table 10). These peats usually also have high iron and manganese concentrations, and alkaline bedrock areas possess large amounts of calcium. In the present material increased concentrations of copper were observed in the following mires: Loiraskangas in Utajärvi, Vaarajänkkä in Tornio, Ulkupuro in Suomussalmi, Takasuo in Ylikiiminki, Siikavaara in

Puolanka and Ruostesuo in Kiiminki. Similarly, somewhat elevated levels of lead were found in Purkuputaansuo in Kuusamo and Pilpasuo in Oulu, and high levels of zinc in Rautuojanaapa in Simo, Riissuo in Posio, Pilpasuo in Oulu, Takasuo in Ylikiiminki, Mustinsuo in Kuhmo, Päijännesuo in Muhos, Siikavaara in Pudasjärvi and Säynäjäsuo and Ulkupuro in Suomussalmi. These same areas, most notably Tornio-Simo, Ylikiiminki-Kiiminki-Oulu-Muhos, Utajärvi and Kuhmo-Suomussalmi, also showed relatively high levels of several heavy metals in their peat horizons.

6. SUMMARY AND CONCLUSIONS

The western end of the globally significant taiga forest belt of northern Eurasia is climatically sufficiently damp and cool that it favours the formation of aapa mires, particularly in the land uplift areas of Finland, the northern inland parts of Scandinavia and Russian Karelia. Primary development of aapa mires was most common on the coastal plains of the Bothnian Bay, where peat formation commenced on the strength of a sedge and herbaceous vegetation. Then, as the climate became wetter and colder, the peat horizons in the mires became thicker as a consequence of the availability of *Sphagnum* mosses for peat formation.

This work has made use of pollen analyses and previously published research to trace the development of the mires and the thickening of their peat horizons in a defined area of Northern Finland in relation to the spread of spruce (*Picea*) to the area. Radiocarbon dates were obtained for three sites and a total of 20 pollen diagrams were produced for 16 mires. Mire deposits had accumulated in the supra-aquatic part of the region, i.e. the geologically ”old” terrain, and to some extent in the areas below the highest shoreline, before the arrival of spruce, and these were followed later by younger mire deposits and surface horizons of *Sphagnum* peat superimposed on the older mires.

As a consequence of variations in the topography of the region, its hydrology and geology, a peatland environment evolved that comprised numerous mire types, each covered by a vegetation appropriately adapted to its trophic status. In the course of the mire succession a stratigraphy developed at each site in which different stages of development, or mire types, could be defined on the basis of plant and macrofossil remains together with the physicochemical properties of the peat. It was then possible to combine ecologically similar mire types to reduce the total number to 14 plus a category of limnic peat, laid down directly in water. Each mire type has a distinct vegetation that has given rise to peat that has physical and chemical properties of its own, with characteristic correlations between them.

As decomposition, or ”humification”, of the peat has proceeded, the ratio of recognizable plants and fragments in the peat to unrecognizable, more or less decomposed remnants is seen to have altered so that the proportion of the completely decomposed amorphous <0.125 mm fractions within the biomass increases as the peat becomes more humified. This also leads to an enrichment of slowly decomposing lignin (L) and fibrous plant remains containing waxes and resin, such as those of dwarf shrubs (N), *Eriophorum* (ER) and *Equisetum* (EQ). The progress of decomposition as described here is based on the percentages of the plants concerned in peats at different stages in decomposition, $H_{1\text{-}10}$ (v. Post 1922). The mean degree of humification of the peat samples studied in this work is “poorly decomposed” or ”decomposed to some extent”, whereupon the amorphous fraction makes up almost a half of the peat, 47.2%.

Mire bases that differ substantially in their physical properties can develop more or less similar minerotrophic or ombrotrophic peat horizons, except, that is, for those located in alkaline bedrock areas where the pH of the peat is only marginally acidic. Element concentrations in the peats are nevertheless quite different in the cases of sandy-bottomed mires and mires located in acidic or alkaline bedrock areas. Also, ombrotrophic conditions will stand out in terms of the geochemistry of the peat ash as well as the water chemistry of the mires.

Since the vegetation on a mire will be ecologically well adapted to the trophic level of its substrate, the plant composition of the peat in the acrotelm normally conforms well to the results of plant coverage analyses performed on the mire vegetation. Organic material from the biomass of this mire vegetation will account for an average of 7.4–12% of the fresh weight of the peat, with higher values reached on the poorer mire types than on the more luxuriant rich fens, where mineralization is more efficient. Mean dry densities range from a minimum of 48 kg/m^3 in *Sphagnum fuscum* bogs to a maximum of 116 kg/m^3 in the peat of true spruce mires, while the highest accumulations of dry matter without ashing are to be found at the meso-eutrophic mire type stage.

Element concentrations in mire types with a mire margin effect are distinctly higher than those in types with a mire centre effect, and the nature of the base gives rise to some variation in the physical properties as well as in the moisture content of the peat and its redox potential (mV). The correlations between the various properties of the peats in each mire type differ from the correlations in the other types, so that a statistical analysis based on the total data alone would show a highly significant correlation, either positive or negative, between almost any of the properties.

The peats containing large amounts of ligneous matter were slightly drier than average, since the mean of the water content values indicated by the various mire plants is in the region of 90%. The mean densities of the ligneous, sedge and herbaceous peats are all higher than the mean for all the peat samples, while the lowest dry densities were recorded for liverwort, *Eriophorum* and dwarf-shrub peats.

Ash content also varied greatly, so that a wide standard deviation existed in the densities of the various peats. The high Cu, Pb and Zn concentrations in the peat ash samples point to interesting sites for ore exploration in the Tornio-Simo, Kiiminki-Ylikiiminki-Oulu-Muhos, Utajärvi and Kuhmo-Suomussalmi areas in particular.

The present material and the findings yielded by it, when combined with earlier published macrosubfossil and pollen data, offer an opportunity for reconstructing the vegetation history of the area concerned and the stages in the development of its forests with greater precision than previously. Furthermore, it would be possible to estimate the state and quality of the mire environments of the area on the basis of mean values of the various mire plants as ecological indicators. Another potential tool for studying the region's mire ecology would be a model of the succession of mire types based on the pH and water content of the peat horizons. Additional tools suitable for use in the study of mire ecology would include the functions depicting the decomposition of mire plants and the accumulation of debris from them, the data on the biomass produced at the various stages in the development of the mire types, the proportions of the amorphous fraction in peats and the indicator values of given mire plants with respect to the ecology of their growing sites.

The results presented here allow the following conclusions to be drawn:

1. All the peat horizons of the mires in the coastal areas of Northern Ostrobothnia and the younger ones further inland, together with the majority of the horizons of the older inland thick-peat mires, have formed since the spread of spruce (*Picea*) to the area, i.e. since

about 5700 BP cal in its eastern parts and 500–1000 years later in the central and western parts.

2. At the early stages in mire formation the peat consisted mainly of debris from a *Carex* vegetation (C), ligneous material (L) and the remains of dwarf shrubs (nanolignin, N), *Sphagnum* mosses (S) and Bryidae(B), with only a small proportion of herbaceous plants.
3. A distinct peak in the occurrence of *Sphagnum* mosses can be observed in the lower horizons of the deep thick-peat mires, marking the cool, moist period that preceded the climatic optimum. Another possible explanation for the scarcity of *Sphagnum* mosses in the middle parts of the peat profiles could be that the peat was better humified during the climatic optimum so that there was much less visible evidence of *Sphagnum*.
4. The cooling of the climate and the increase in humidity led to a pronounced increase in *Sphagnum* in the acrotelm, with the proportion of the total thickness of the peat containing evidence of this effect increasing towards the coast. Thus the youngest mires in the coastal strip may consist almost entirely of *Sphagnum* peat, while in some places further inland the acrotelm may consist of a *Sphagnum* layer almost a metre thick.
5. The proportions of the various plant remains in the peat tend to be dependent on the sampling depth, enabling the contribution of particular species to peat formation to be estimated as a function of depth in the mire.
6. A set of mire types which are distinct in their plant species composition and the physical and geochemical properties of their peat horizons can be proposed on the basis of ecological similarities between recent and subfossil mires. This process of combination and generalization will work best when the plants are determined to species and their proportions in the peat assessed taking into account changes in the physical properties of the peats, the geochemical composition of the peat ash and the ratios between the element concentrations. In this way a set of more than 80 mire types was reduced to 15 generalized types.
7. The whole peat stratigraphy, or mire type succession, includes more horizons in aapa areas with a mire centre effect than it does in areas with a margin effect, even to the extent that thin-peat horizons with a mire margin effect may have been formed during a single phase of mire development, although it is also the case that mire types with a margin effect are more apt to form a new mire type than are those with a centre effect. As a peat horizon gains in thickness the surface vegetation on the mire will alter (succession), just as the

moisture and nutrient balances of the peat will alter and its pH will decline. Progressive succession features of this kind can be seen in the deposition of peat both at the stage of primary mire formation and during paludification of forest land. The normal pattern is for the vegetation on a mire to revert to a lower trophic level as the peat deposit becomes thicker.

8. The above mire type succession is clearly visible in the water content of peat horizons and their pH. The mainstream of a progressive succession is from eutrophy via mesotrophy to oligo-ombrotrophic conditions, although deviant patterns can be seen in the aapa mires of both the coastal strip and the eastern part of the area studied here, in which rapid changes occur and an entirely new mire type emerges. The mire succession nevertheless mostly operates either progressively, towards a poorer nutrient level, or regressively, towards wetter conditions. Other possibilities include a stable situation in which no succession occurs or an oscillation between alternate periods of drying out and flooding.
9. The decomposition of mire plants follows certain mathematical models calculated on the basis of the present data regarding the degrees of humification of the peat horizons (von Post 1922) and the proportions of the plants and their remains in the peat samples. Once these functions have been normalized with respect to the numbers of samples, they enable the degree of humification of a peat to be estimated if the percentage of a given plant is known, or *vice versa* (Tables 6–8).
10. The proportion of the amorphous <0.125 mm fraction in the peat was found to increase linearly ($r^2 = 0.9914$) by about 10% with each degree of humification on the von Post (1922) scale.
11. The traditional classification of peats in terms of the estimated amounts of amorphous material (A) and plants or remains of *Carex* (C), *Sphagnum* (S) and Bryales (B) gives a more accurate picture of their true composition, as classifications of highly humified peats in terms of their composition can easily become distorted if they are based only on the amounts of the slowest of the recognizable plants to decompose and do not take account of the largest component in relative terms, the amorphous material, which will already have formed from the more easily decomposable plants. This source of error can be reduced by using a microscope to identify possible plant remains in the best humified peats.

12. Ombrotrophic peats were found to differ from minerotrophic ones on account of their high mV (~300) and fibre content (80%) and also their low pH, ash content, dry densities and element concentrations. Also, although the nature of the bedrock will have a minor influence on the peat geochemistry of otherwise similar mire types, these mire types will always be distinguishable one from another by their element concentrations regardless of whether they occur in alkaline or acidic bedrock areas.
13. Trophic differences beween peats will be reflected in differing Fe, Ca, Al, Mg and P concentrations, while in the case of recent mire types the influence of the vegetation on the surface peat horizons will mean that element concentrations are higher than in the lower parts of the same mire type.
14. The peats of mire types incorporating a centre effect are less well humified and contain little amorphous material. They have a low ash content, dry density and pH and their element concentrations are low, but their water content and mV values are high.
15. The mean physical properties of peats and the element concentrations in their ash can be used to construct a set of boundary values for use as indicators of mire ecology that could be of assistance when drawing up environmental reports concerned with mire areas (Appendices 9 and 10).
16. Extremely high heavy metal concentrations in peat ash may be treated as clues to areas of possible interest for ore exploration.

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Appendix 1

Mires studied previously in the same area and neighbouring districts, with dates (BP) of mire formation, isolation of lakes and the appearance and maximum of spruce (*Picea*)

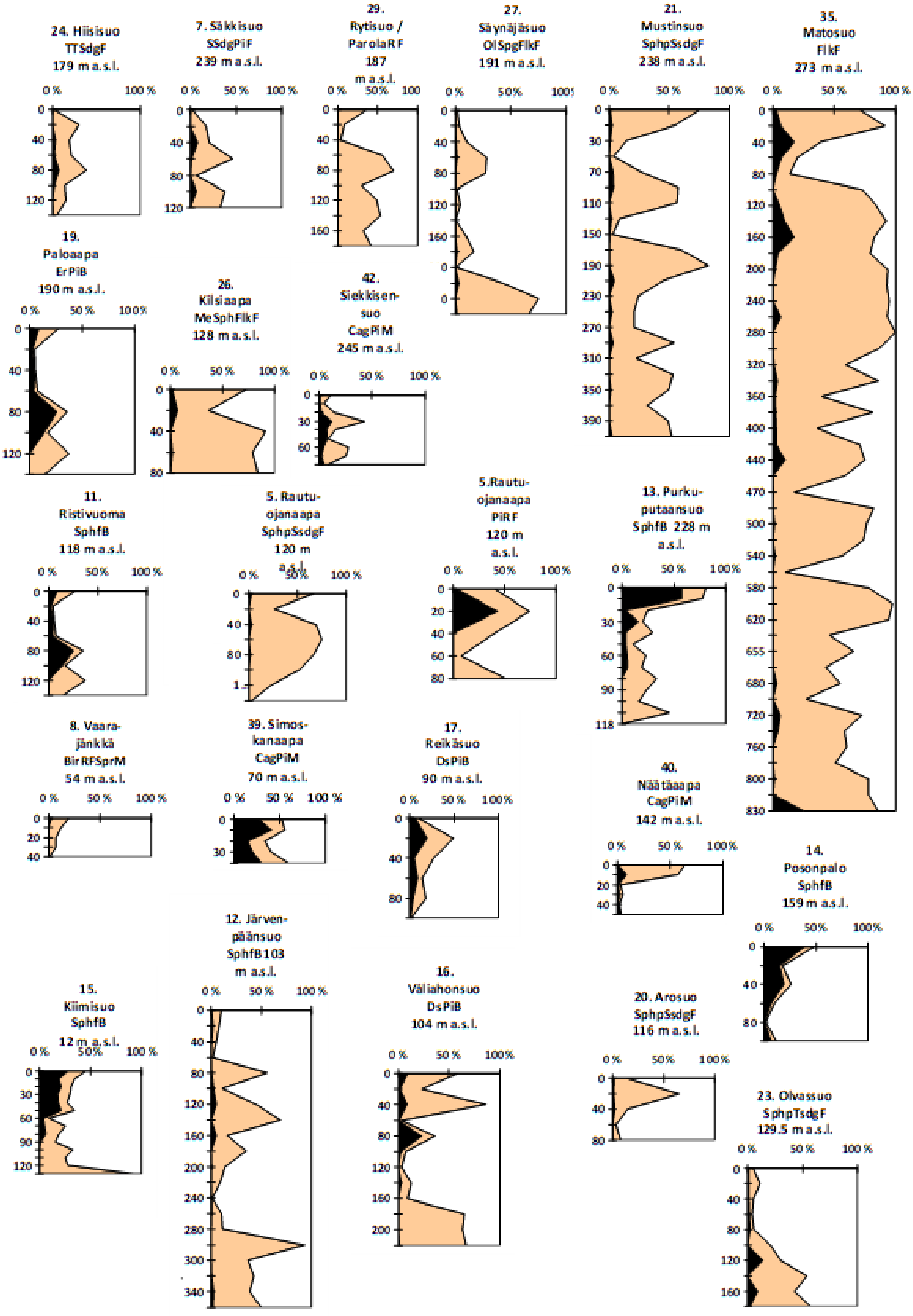
District Mire / Lake	m a.s.l.	Peat cm	Gyttja cm	Isolation / paludification BP	*Picea* appeared BP	*Picea* maximum BP	Author(s) C^{14} date no.
Alatornio							
Leväjänkkä	94,5			Peat 6000±130 BP			Eronen, 1974
Varevuoma	116			8400±190	640±260 Peat		Eronen, 1974
Hailuoto							
Kiimisuo	11,9	130		950±130			Rönkä, 1983
Kittilä	9			970			Hicks, 1988
Kaisto	10			1080			Hicks, 1988
Sipola	7,5			800			Hicks, 1988
Isoaukionsuo	4			400			Hicks, 1988
Keminmaa							
Kiimajänkkä	40	132		2590±140			Reynaud, Hjelmroos, 1980, Hel-888
Kiimajänkkä	40			Decreace of spruce 1260			Reynaud, Hjelmroos, 1980, Hel-956
Kestilä							
Törmäsensuo	139.1	230			4500		Keskitalo, 1982
Ritikansuo	88.9	300			4500		Keskitalo, 1982
Kärsämäki							
Kaatiaisneva	122.9	340	10		4500		Keskitalo, 1982
Kuivaniemi							
Kaupinsuo	101-108	210		7340+/-100			Picken, 2007
Kaupinsuo	101-108	180		6780+/-140			Picken, 2007
Kuusamo							
Purkuputaansuo	228			7750±170			Miettinen, 1985
Maanselänsuo	257	170		9100±220	1900		Vasari 1963, 1965
Kangerjoki	288	142		8240±190	4980±140		Hicks, 1975
Liippasuo I	357			8040±180		3120	Seppälä, Koutaniemi, 1985
Liippasuo 2	357	334	194	7640±160	4830±90	3940	Seppälä, Koutaniemi, 1985, Hel-1249
Oulu							
Pilpajärvi	40		122		4000±60		Reynaud, Hjelmroos, 1976
Paltamo							
Isosuo	145.7	470	70		4800		Keskitalo, 1982
Likasuo	174.3	340	10		4800		Keskitalo, 1982
Laattaansuo	187	370	30		4800		Keskitalo, 1982
Pello							
Valkiajärvi	188		140	9260±220			Saarnisto 1981
Purajärvi	142.3		50	8650±180			Hyvärinen, Sepponen, 1988
Lupojärvi	91.8		7	7860±150			Saarnisto 1981, Hel-797
Posio							
Kolimiloukkonen	344				3620±140		Vasari 1962
Maaselänpuro	248			8440			Heikkinen, 1975, Hel-785

Puolanka							
Vasikkasuo I	270	220	65	8610±80	4680±70		Vuorela, 1990
Vasikkasuo II	270	130		5000	4000		Vuorela, Kankainen, 1991
Raahe							
Merijänjärvi	30			2640±55			Reynaud, Hjelmroos, 1980
Rantsila							
Kärenahonkortteikko	90.9	320			4400		Keskitalo, 1982
Huhanneva	87-93	350		5820±90			Picken, 2007
Huhanneva	87-93	180		4420±90			Picken, 2007
Rovaniemi							
Alempi Silmäslampi	197.3		67	8780±160			Juola-Helle 1982
Ylempi Silmäslampi	206.7		180	9030±200			Saarnisto 1981, Hel-781
Kuprujänkä	91			6800			Juola-Helle 1982
Kaakkurilampi	79.2		10	5950±110			Saarnisto 1981, Hel-1334
Kaakkurilampi	79.2		10	6220±121			Saarnisto 1981, Hel-1335
Ruukki							
Tervasneva	49.5	180			4300		Keskitalo, 1982
Järvineva	50-52	220		4130+/-80			Picken, 2007
Järvineva	50-52	210		3490+/-100	3240+/-90 *Sph* started		Picken, 2007
Salla							
Kaakkurilampi	180			9075±160			Sorsa 1965
Simo							
Peurasuo	17,6			1500			Lukkala 1933
Tervola							
Kivalo A	305	63		6790±100	2580±90		Hyvärinen & Sepponen 1988
Kuprujänkä	91			6800±			Juola-Helle 1982
Utajärvi							
Ahmasjärvi	98			8370±280			Eronen, 1974
Ahmasjärvi	98.5		366		4740±150		Reynaud, Hjelmroos, 1980, Hel-884
Järvenpäänsuo	103	292		7330±150	4480±120	3760±125	Holappa, 1975
Sotkasuo	81	95		5090±170	3320±180	2720±170	Reynaud, Hjelmroos, 1980
Vaala							
Nimisjärvi	135.5		254	10950±210	4750±230*		Reynaud & Hjelmroos 1980,
Vihanti							
Järvelänjärvi	100		192	5850±190	4830±170	4150±190	Reynaud, Hjelmroos, 1980, Hel-887, Hel-960
Ylikiiminki							
Vähä-Vuotunki	93.5			6480±150	6980±220 *Clypeys* -limit		Eronen,1974
Lapinlampi	86.9		15		3930±110		Saarnisto, 1981, Hel-1332 "clypeus"
Lapinlampi	86.9		10	6430±90			Saarnisto, 1981, Hel-1333
Ylitornio							
Kaakonlantto	50			920			Reynaud & Hjelmroos 1980
Kivilompolon jänkä	110			7590±230			Eronen, 1974
Iso-Mustajärvi	75			5380±65	3910±60		Reynaud, Hjelmroos, 1980, Lu-1431
Iso-Mustajärvi	70		6	4820±170			Saarnisto, 1981, Hel-938

* hard water effect

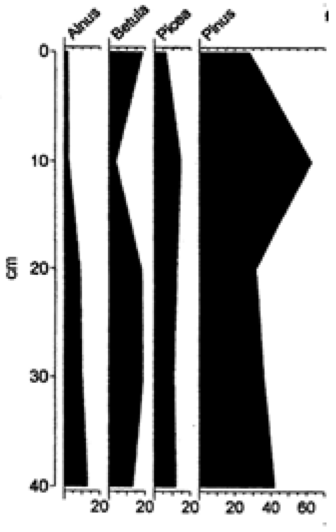
Appendix 2

Percentages of dwarf shrub and herb pollen and spores in various mires. Black: dwarf shrubs, beige: herbs, white: spores. For C^{14} dates from Järvenpäänsuo (12) and Purkuputaansuo (13), see Appendix 1.

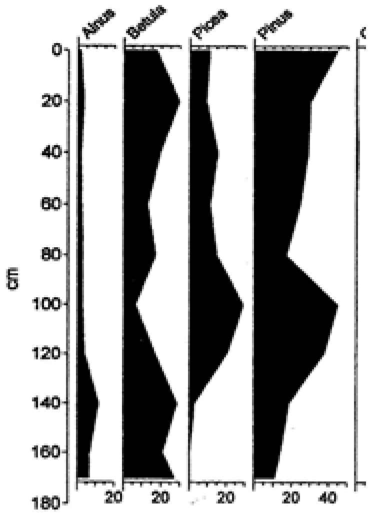


Appendix 3

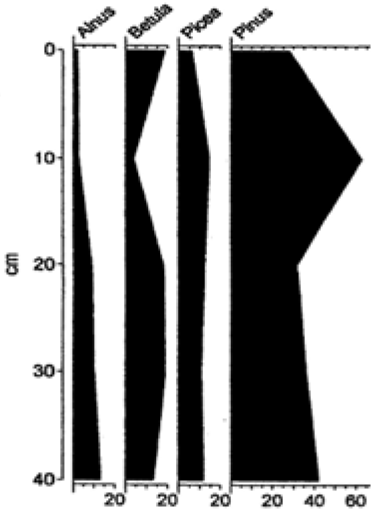
Pollen diagrams for *Alnus, Betula, Fagus, Fraxinus, Picea* and *Pinus* from mires in the area studied here. For site locations, see Fig. 1.



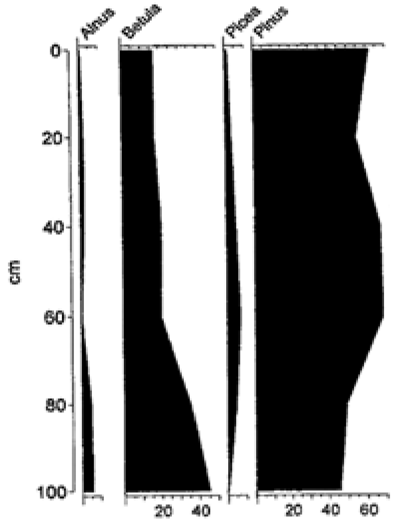
8. TORNIO, Vaarajänkkä
54 m a.s.l.,
N 7329933, E 3377064
(Analysed by Eira Hiukka)



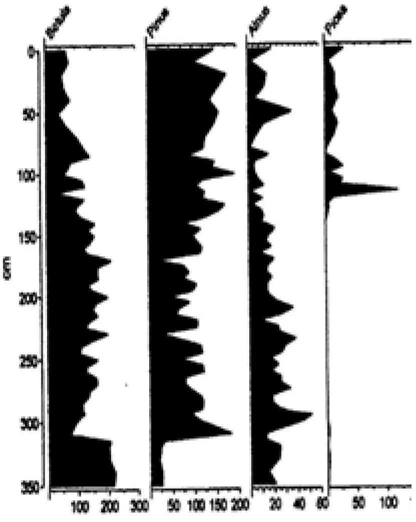
8. TORNIO, Vaarajänkkä
54 m a.s.l.,
N 7329767, E 3377159
(Analysed by Eira Hiukka)



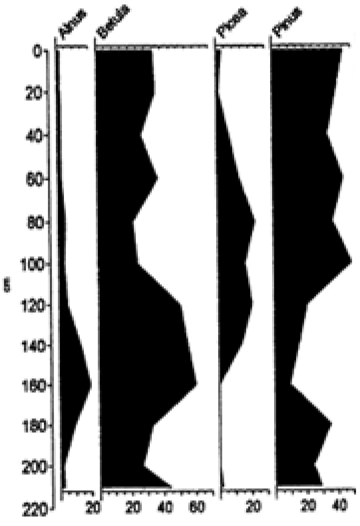
39. SIMO, Simoskanaapa
70 m a.s.l.,
N 7307418, E 3419597
(Analysed by Eira Hiukka)



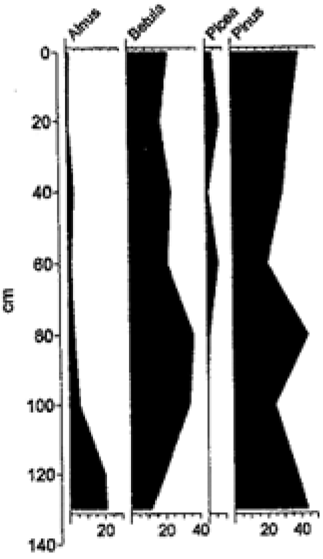
17. UTAJÄRVI, Reikäsuo
90 m a.s.l.,
N 7175125, E 3468601
(Analysed by Eira Hiukka)



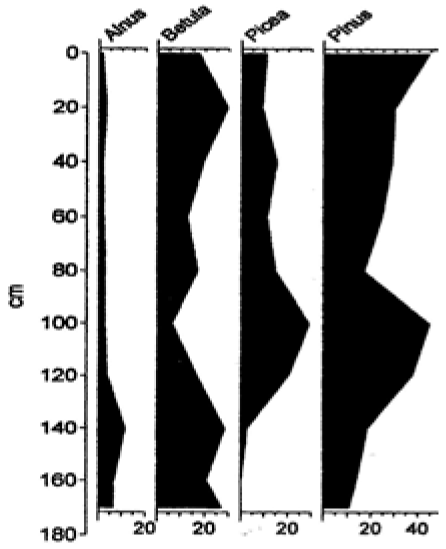
12. Utajärvi, Järvenpäänsuo
103 m a.s.l.,
N7193937, E 3483399
(Analysed by Holappa, 1976)



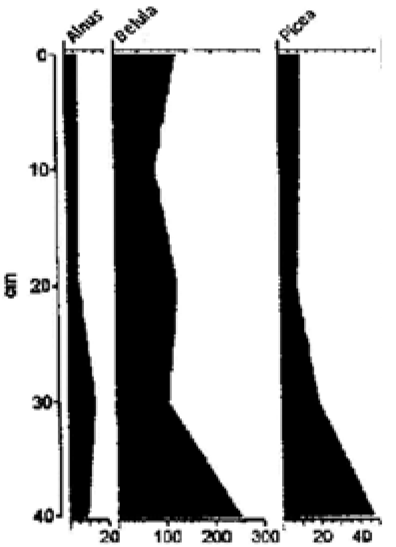
16. Utajärvi, Väliahonsuo
104 m a.s.l.,
N 7197200, E 3484001
(Analysed by Eira Hiukka)



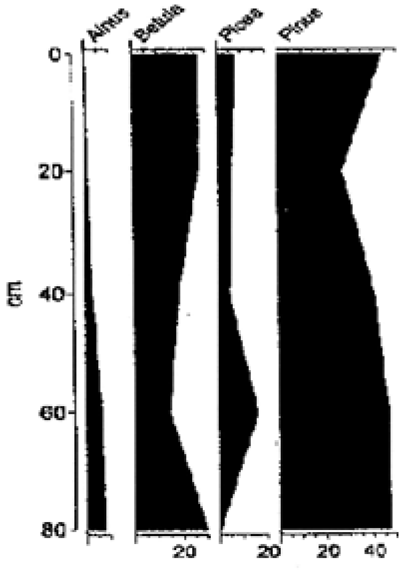
5. SIMO, Rautuojanaaapa
109 m a.s.l.,
N 7332999, E 3431991
(Analysed by Eira Hiukka)



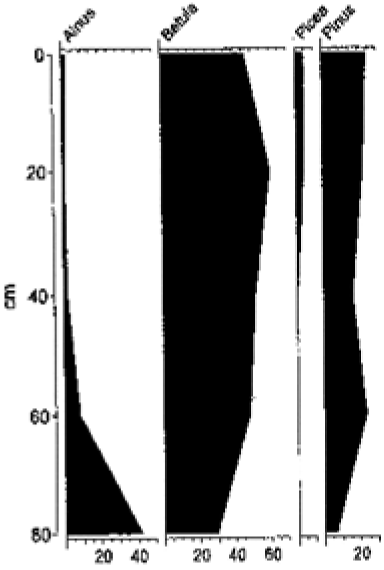
20. PUDASJÄRVI, Arosuo
116 m a.s.l.,
N 7235696, E 3470804
(Analysed by Eira Hiukka)



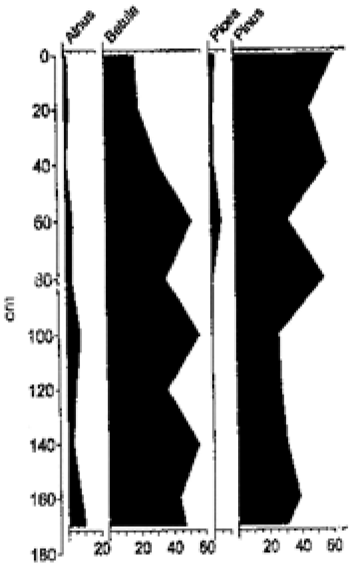
11. TERVOLA, Ristivuoma
118 m a.s.l.,
N 7358390, E 3403595
(Analysed by Eira Hiukka)



5. SIMO, Rautuojanaaapa
120 m a.s.l.,
N 7332490, E 3433678
(Analysed by Eira Hiukka)

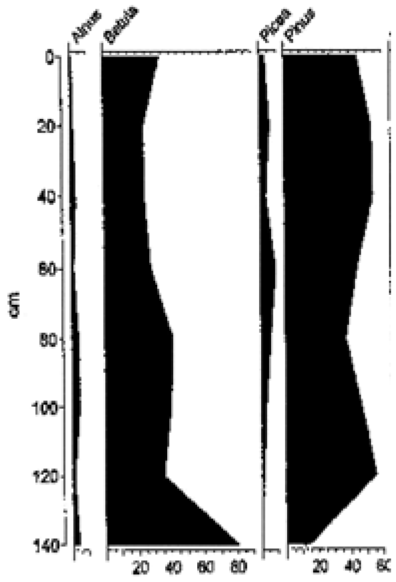


26. TERVOLA, Kilsiaapa
128 m a.s.l.,
7360705, E 3402084
(Analysed by Eira Hiukka)

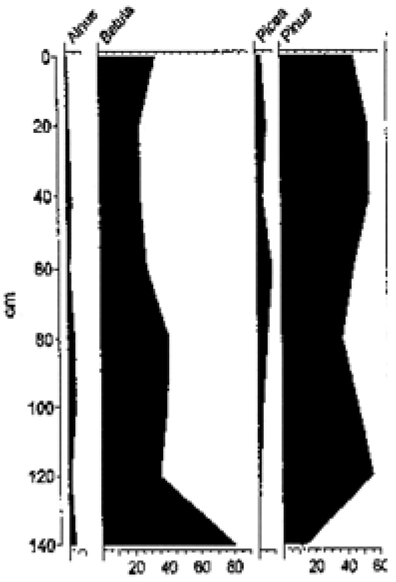


23. UTAJÄRVI, Olvassuo
129,5 m a.s.l.,
N 7219740, E 3511340
(Analysed by Eira Hiukka)

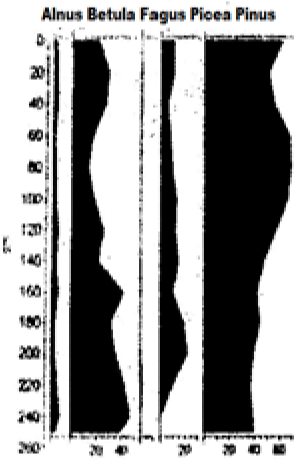
40. RANUA, Näätäaapa
142 m a.s.l.,
N 7316386, E 3460463
(Analysed by Eira Hiukka)



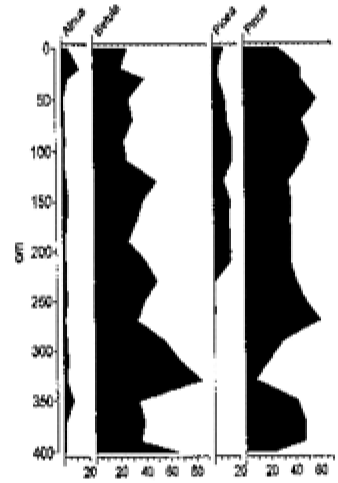
24. RANUA, Hiisisuo
179 m a.s.l.,
N 7330291, E 3502250
(Analysed by Eira Hiukka)



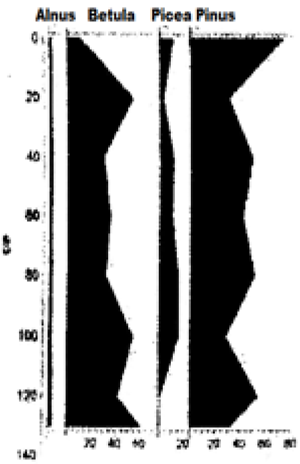
19. RANUA, Paloaapa
190 m a.s.l.,
N 7339209, E 3479708
(Analysed by Eira Hiukka)



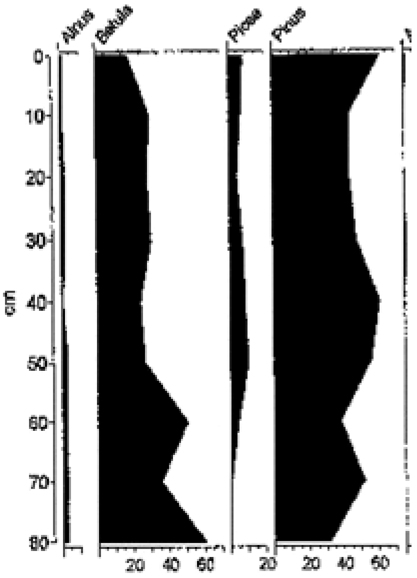
27. SUOMUSSALMI, Säynäjäsuo
191 m a.s.l.,
N 7191934, E 3599077
(Analysed by Eira Hiukka)



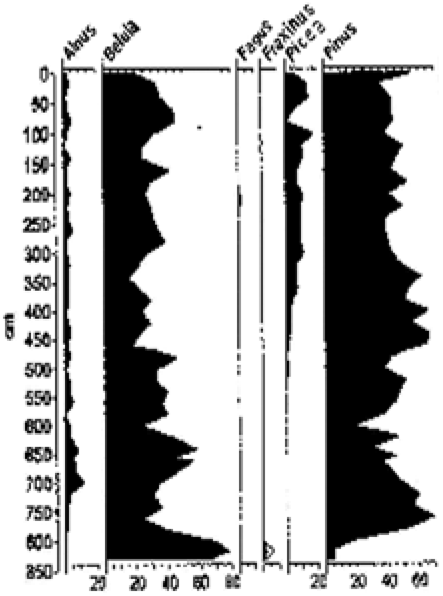
21. KUHMO, Mustinsuo
238 m a.s.l.,
N 7153412, E 3589122
(Analysed by Eira Hiukka)



7. SUOMUSSALMI, Säkkisuo
239 m a.s.l.,
N 7218571, E 3597833
(Analysed by Eira Hiukka)



42. TAIVALKOSKI, Siekkisensuo
245 m a.s.l.,
N 7281482, E 3554138
(Analysed by Eira Hiukka)



35. KUUSAMO, Matosuo
273 m a.s.l.,
N 7295721, E 3637611
(Analysed by Eira Hiukka)

Appendix 4

Mean proportions of plant species identified in the macrosubfossil analyses performed on the peat samples (n = 1079), by degree of humification on the scale of von Post (1922). x = mean, sd = standard deviation, mo = mode, n = number of observations, *= species identified.

v. Post (1922)	H_1				H_2				H_3				H_4				H_5				H_6				H_7				H_8				H_9			
	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n	x	sd	mo	n
Lignin	3,9	5,3	1	14	8,4	8,5	2	26	9,8	13,6	1	163	16,8	15,9	5	168	26,6	22,4	10	152	35,8	24,7	10	48	26,8	27,3	5	22	37,5	46,0		2				
Alnus spp.									9,0			1					32,7	22,6		3	30,0	14,1		2												
Betula spp.	1,5	0,5	1	6	5,0	4,7	1	7	7,8	5,4	15	10	11,1	12,0	8	13	17,5	18,4	10	22	55,0	35,4		2	35,0	7,1		2								
Picea abies	1,0			1	4,0	1,4		2	2,8	1,7		4	2,9	1,7	1	8	6,3	5,8		6																
Pinus sylvestris	1,6	0,7	1	8	2,0	0,8	2	4	4,2	5,7	1	11	6,6	7,6	3	5	8,0	9,9		2																
Nanolignin	6,1	6,4	5	62	7,2	7,7		74	7,5	7,5	5	197	8,8	9,2	5	130	12,5	9,8	20	49	30,2	26,1	40	5	36,3	14,3		4					3,0			1
Andromeda polifolia	4,0	2,7	5	8	6,0	5,1	3	8	1,9	1,0	2	8	6,7	2,9	5	3																				
Betula nana	2,4	1,1	2	5	1,2	0,4	1	5	3,9	3,9	2	12	3,0	1,7	5	12	4,5	3,5		2																
Calluna vulgaris	5,0			1	4,0	5,2	1	3	1,0			1					2,0			1																
Empetrum nigrum	7,0	6,2	10	9	2,2	1,6	1	6	1,0		1	3	5,0			1	1,0			1																
Ledum palustre	2,0	1,4		2	2,0			1	3,5	2,1		2																								
Rubus idaeus																	1,0			1																
Vaccinium microcarpum	2,8	2,1	1	4	3,8	3,8	1	5	1,5	0,7		2	1,0			1																				
V. myrtillus	2,0	1,4		2	10,0			1																												
V. oxycoccos	6,3	5,4	1	9	3,6	3,2	1	8	5,9	3,2	5	46	4,2	3,0	2	20	2,0	0,0		2																
V. uliginosum	4,0	3,2	3	6	1,0			1																												
V. vitis-idaea	2,0			1																																
Cyperaceae, **total**	13,9	10,7	15	39	18,2	18,1	10	77	24,1	17,9	10	502	23,5	18,8	10	395	26,8	22,1	10	288	23,7	20,5	10	77	32,6	25,3	5	39	23,7	31,7		3	15,0			1
Carex sp., **total**	16,5	10,4	5	20	24,5	22,2	5	34	28,7	17,6	30	321	25,6	18,6	10	269	31,0	22,6	20	189	24,3	20,3	10	46	31,7	23,3	10	23	34,5	36,1		2	15,0			1
Eriophorum **spp.**	11,2	11,4	5	15	12,5	11,7	5	30	17,4	15,8	30	139	20,0	18,8	10	114	19,4	18,8	20	92	24,0	21,4	10	29	33,8	28,8	10	16	2,0			1				
E. angustifolium	20,4	14,9		13	10,0	7,1		2	8,3	6,5		3	8,8	7,7		4	3,5	2,1		2																
E. latifolium					3,5	2,1		2	40,0			1																								
E. vaginatum	11,6	13,1	2	10	13,7	11,9	10	16	22,5	16,1	10	82	27,8	21,9	5	55	21,7	15,3	15	19	37,0	24,0		2	48,0	38,9		4								
Poaceae, total	15,0			1	20,0	26,0	5	3	17,1	10,7	10	45	19,7	12,5	5	30	22,6	19,8	25	17	6,0	5,7	20	2	16,6	8,4		4								
Galamagrostis spp.									25,0			1																								
Molinia caerulea	15,0			1	5,0			1	18,2	8,3		5	13,0	9,9		2	1,0			1																
Phragmites australis					5,0			1	16,1	11,1	10	34	19,9	12,3	15	15	25,1	23,6	10	7					3,0			1	20,0			1				
Trichophorum **spp., total**	12,5	8,7	5	4	14,8	13,3	10	13	10,7	12,6	10	42	10,5	13,3	5	11	8,4	6,5	5	7	6,5	4,9		2												
T. alpinum					20,0	7,5		4	15,6	17,3	10	18	35,0	14,1		2	20,0			1																
T. cespitosum	15,0	8,7	20	3	5,5	3,0	5	6	9,1	6,7	3	9	3,5	2,1		2																				
Herbs, total	6,6	5,5	9	9	8,1	6,4	5	28	12,8	10,2	5	554	14,1	11,4	5	449	14,1	13,3	10	297	14,7	14,3	5	70	17,8	18,3	10	19	23,0	13,9	15	3	18,8	7,5	15	4
Calla palustris	5,0			1					5,3	5,2	2	6	2,0	1,4		2	11,1	8,8	5	7	12,0	10,4	5	5	2,0			1								
Cicuta virosa									10,0			1	1,0	0,0		2																				
Equisetum spp., total	4,0			1	6,3	4,7	5	8	8,4	6,5	5	180	11,5	10,8	5	147	15,2	13,4	10	122	17,8	16,5	5	35	17,8	18,3	10	19	15,0	0,0		2	30,0			1
E. fluviatile									13,3	7,6	20	57	12,8	6,9	10	47	16,6	9,3	15	16	19,0	15,2	10	5	29,7	25,5		3								
E. sylvaticum	4,0			1	3,7	2,3	5	3	4,8	1,8	5	5	8,5	9,2		2	10,6	6,2		5	15,0	7,1		2												
Filipendula ulmaria													1,0			1																				
Lycopodium inundatum	20,0			1																																
Menyanthes trifoliata	6,0	1,4	5	2	10,0	7,7	5	12	12,7	8,8	10	180	17,8	12,3	10	173	12,1	10,9	10	74	19,5	13,8	10	12	12,0	4,5		5					15,0			1
Pedicularis palustris					5,0			1																												
Potamogeton pusillus													1,0	0,0		2	1,0			1																
P. alpinus													1,0	0,0		2																				
Potentilla palustris	8,0			1	2,0			1	12,2	8,8	5	41	9,2	7,8	5	44	16,2	19,6	5	31	7,6	6,4	5	8									15,0			1
Rubus chamaemorus	5,0			2	2,0			1																												
Scheuchzeria palustris					9,2	5,9	5	5	19,8	12,4	20	139	14,5	9,6	15	80	13,7	12,3	5	60	5,3	2,2	5	10	16,7	11,5	10	3	39,0			1	15,0			1
Selaginella selaginoides									1,1	0,4	1	7																								

***Sphagnales*, total**	**25,8**	21,7	10	75	**30,5**	26,4	20	131	**14,8**	17,0	5	758	**9,5**	11,3	5	461	**5,5**	5,9	1	221	**5,2**	6,5	1	54	**4,5**	5,7	1	21	**2,7**	2,1		3
Sphagnum angustifolium	**20,4**	14,9	20	14	**24,5**	16,2	30	22	**13,9**	15,3	1	50	**11,8**	15,9	2	60	**5,4**	8,8	3	33	**3,2**	2,5	2	11	**2,5**	1,7	2	4				
S. balticum	**12,6**	12,4		5	**16,6**	13,6	20	13	**23,7**	14,9	30	39	**6,6**	5,9	5	8	**10,0**			1												
S. capillifolium	**7,0**			1	**10,0**			1	**30,0**	21,2		2	**2,5**	0,7	10		**5,7**	4,0		3												
S. centrale									**11,5**	14,8		2	**7,3**	6,8		3	**15,0**			1	**1,0**			1								
S. compactum													**10,0**	0,0		2	**10,0**	0,0		1												
S. contortum									**7,3**	5,9		4																				
S. cuspidatum coll									**18,9**	19,6	3	30	**13,6**	18,2	2	25	**13,3**	8,5	20	11	**10,0**	0,0		2								
S. fallax	**19,2**	20,8	5	6	**19,6**	12,5	30	8	**6,8**	5,3	5	35	**7,5**	5,5	5	35	**3,7**	2,9	2	22	**1,8**	1,0	1	6					**2,0**			1
S. fuscum	**46,9**	30,4	90	11	**62,0**	28,6	90	30	**48,4**	28,1	60	51	**13,3**	10,3	10	22	**2,9**	2,8	2	10	**12,5**	3,5		2								
S. girgensohnii	**35,0**	35,4		2	**25,0**	15,8		4	**4,4**	3,2	2	8	**11,0**	4,9	15	6	**3,8**	4,4	2	9	**13,0**	7,7	15	4	**20,0**			1				
S. jensenii	**5,0**			1	**10,0**			1	**26,5**	17,5	40	11	**2,0**			1	**1,0**			1	**1,0**			1								
S. lindbergii	**10,0**			1					**23,1**	20,5	15	14	**8,0**	3,2	10	6	**4,5**	1,0	5	4												
S. magellanicum	**14,6**	11,4	10	7	**13,2**	13,5	10	13	**12,9**	9,9	5	53	**13,2**	10,3	10	33	**7,0**	6,1	5	26	**4,0**	1,7	5	3	**1,0**			1				
S. majus	**15,5**	10,6		2	**9,3**	9,3		3	**12,1**	10,0		20	**15,0**	5,8	1	15	**4,3**	4,2	1	15												
S. obtusum	**25,0**			1					**2,0**	0,0		2																				
S. papillosum	**26,3**	16,6		7	**44,4**	17,6		8	**16,5**	17,1	10	78	**14,9**	19,8	10	31	**5,5**	4,6	2	13	**3,8**	3,6	3	5								
S. platyphyllum	**5,0**			1					**8,5**	9,2		2					**9,0**	5,7		2												
S. recurvum coll					**20,0**			1	**8,2**	7,4	5	58	**11,7**	13,7	3	26	**5,0**			1												
S. riparium	**41,0**	29,2		3	**31,3**	12,5		4	**10,1**	11,6		32	**5,5**	4,8	5	22	**3,8**	3,5	2	10	**1,0**	0,0		2								
S. rubellum	**42,5**	24,7		2	**29,0**	15,6		2	**11,0**	7,4	10	24	**4,3**	3,1	2	8	**10,2**	5,6	15	5												
S. russowii	**27,6**	15,1		5	**10,7**	10,7		6	**18,3**	19,1	1	14	**9,9**	6,7	15	9	**2,9**	2,3	2	7	**4,0**	3,0		3	**1,0**			1				
S. squarrosum	**40,0**			1	**22,5**	3,5		2	**12,3**	13,0	3	9	**6,3**	5,2	5	29	**4,5**	4,5	5	8	**3,0**			1	**3,0**			1				
S. subfulvum	**10,0**			1					**9,1**	7,4	2	7	**11,0**	7,7	10	6	**4,7**	4,7		3												
S. subsecundum	**5,0**			1	**7,0**	5,3		3	**6,0**	5,2	2	80	**3,7**	2,4	1	18	**2,2**	1,2	2	6	**1,0**			1								
S. tenellum	**10,0**			1	**5,0**	0,0		1	**11,6**	9,7	10	89	**3,0**			1																
S. teres					**9,0**	5,3		3	**11,6**	9,7		89	**8,0**	6,7	2	63	**4,3**	3,9	1	15	**2,0**	1,0	1	5					**1,0**			1
S. warnstorfii	**35,0**	21,2		2	**36,0**	26,1	50	5	**7,7**	7,0	5	38	**8,8**	9,6	5	12	**7,6**	6,7	1	10	**9,0**	1,4		2	**2,0**			1				
S. acutifolia- type									**9,0**			1	**35,0**			1	**3,0**			1	**3,0**			1	**1,0**			1				
S. cuspidata- type									**10,0**	5,0		3	**2,6**	1,6		9	**5,0**			1												
S. palustria- type																	**4,0**	1,4		2												
S. squarrosa- type													**3,8**	2,8		4	**5,0**			1												
Bryidae, total	**9,8**	10,7	10	30	**11,6**	14,8	5	64	**10,5**	12,7	5	495	**10,1**	9,8	10	359	**7,9**	8,2	5	107	**3,4**	2,2		22	**8,2**	9,6	5	12	**10,4**	12,4	1	5
Aulacomnium palustre	**3,0**	1,4	2	4	**3,6**	2,4		5	**3,8**	3,3	2	6	**5,3**	4,4	2	13					**1,0**			1								
Bryum sp.									**5,0**			1																				
Bryum weigelii													**15,0**			1																
Calliergon spp., total	**6,5**	4,0		6	**10,7**	18,8		11	**12,7**	14,9	1	192	**11,5**	11,1	10	176	**8,9**	9,3	5	51	**4,1**	2,5	5	12	**4,0**	1,5		3				
C. cordifolium					**5,0**	2,0	3	3	**5,0**	4,9	1	37	**8,1**	6,1	5	44	**5,9**	4,4	10	15	**3,7**	2,3	5	3								
C. giganteum																	**15,0**			1												
C. megalophyllum					**67,0**			**1**	**51,5**	2,1		2																				
C. richardsonii									**11,6**	2,2		5	**2,3**	2,3	1	3																
Campylium stellatum					**12,2**	5,2		**5**	5,0	0,0	2	5	**12,5**	3,5		2	**7,5**	3,5		2												
Cinclidium stygium					**5,0**	2,8		**2**					**1,0**			1	**3,5**	2,1		2												
Dicranum sp, total	**5,0**			1	**26,8**	24,3		4					**1,0**			1																
D. polysetum					**26,8**	24,3		**4**	**20,2**	19,7	10	11																				
Drepanocladus spp., total	**18,0**	14,1		4	**15,1**	16,7	5	9	**8,2**	10,1	5	134	**7,2**	4,8	10	53	**4,6**	4,8	3	20									**3,0**	2,8		2
D. fluitans					**7,0**			1	**8,0**	10,5	5	15	**6,5**	3,7	10	19	**2,6**	1,2	3	9									**1,0**			1
Hamatocaulis lapponicus									**10,3**	3,6	10	8																				
H. vernicosa									**14,0**	8,4	10	7	**10,0**			1	**3,0**			1									**5,0**			1
Helodium blandowii									**1,8**	1,0	1	4	**5,4**	4,3	10	7					**1,0**			1								
Hylocomium splendens													**10,0**			1	**3,7**	2,3	5	3												
Loeskypnum badium	**28,5**	12,0		2	**40,0**			1	**15,0**	7,0		2	*				**3,5**	2,1		2												
Meesia trifaria									**3,0**	1,0		3	**1,0**			1																
M. triquetra									**9,0**	5,9	5	56	**5,9**	4,1	10	7																
Paludella squarrosa									**4,2**	3,3	2	12	**15,9**	10,7	10	34	**6,5**	5,0		2					**3,0**	2,8		2	**1,0**			1
Pleurozium schreberi	**17,5**	24,0		3	**10,5**	2,5	10	4	**4,9**	4,8	2	7	3,5	2,1		2	**1,0**			1	**2,0**			1								
Pohlia nutans	**4,4**	3,4	2	5	**2,9**	2,5	1	8	**2,2**	1,3	1	5	**2,0**	0,0		2																

***Polytrichum* spp., total**	**10,3** 7,6		6	**9,2** 2,8	10	6	**8,9** 6,8	5	13	**5,4** 6,3	1	16	**6,6** 6,5	5	14	**3,3** 2,1	5	4	**1,5** 0,7		2			
P. commune				**11,5** 2,1		2	**17,0**		1	**6,5** 5,0		2	**15,0** 10,5		3	**4,0** 1,7	5	3						
P. strictum	**7,4** 2,9	7	5	**8,0** 2,4	10	4	**8,6** 6,9	5	11	**9,5** 8,4		2	**3,5** 2,1		2				**2,0**		1			
P. swartzii													**5,0**		1									
Pseudobryum cinclidioides							**15,1** 19,4	5	12	**6,0** 4,6	5	15	**9,2** 7,4		6	**2,0** 0,0	2	2	**2,0**					
Pseudo-calliergon trifarium				**7,3** 2,5		**3**	**13,4** 9,8	10	62	**13,7** 8,4	15	15	**6,5** 7,8		2				**5,0** 0,0		2	**30,0**		1
Rhizomnium magnifolium							**17,0**		1															
R. pseudopunctatum				**5,0**		1				**3,0**		1												
R. punctatum										**7,5** 3,5		2	**5,0**		1									
Rhytidiadelphus triquetrus										**15,0**		1												
Sanionia uncinata										*														
Scorpidium cossonii				**2,0**		1				**16,7** 10,4		3	**11,0** 8,5		2									
S. revolvens							**11,5** 14,3		22	**4,0** 4,1		4	**5,5** 6,4		2									
S. revolvens coll				**8,3** 5,8	5	3	**11,6** 12,3		39	**6,0**		1												
S. scorpidioides				**29,2** 21,6		5	**15,8** 16,3	5	20	**34,3** 11,8	30	6	**19,6** 9,5	25	5				**23,3** 5,8		3	**15,0**		1
Straminergon stramineum	**4,8** 3,8	2	4	**3,5** 1,0		**4**	**15,3** 19,2	2	80	**13,6** 12,8	10	104	**10,3** 11,3	2	29	**4,5** 2,7	5	8	**2,0**		1			
Tomentypnum nitens							**4,0** 4,4	1	9	**9,4** 8,5	5	12												
Warnstorfia badius	**28,5** 12,0		2	**40,0**		1	**15,0** 7,1		2				**3,5** 2,1		2									
W. exannulata	**7,5** 3,4		2	**17,3** 24,0		3	**6,6** 6,9	5	47	**7,0** 3,9	5	25	**8,0** 7,9		3	**5,0**		1	**5,0**		1			
W. sarmentosa	**10,0** 0,0		2				**5,0** 5,0	1	5	**9,5** 7,8		2	**9,3** 6,8	15	4	**2,0**		1						
W. trichophylla				**1,0**		1	**29,8** 11,1		4															
***Hepaticae* spp, total**	**3,0**		1	**2,0** 1,4		2	**1,0**		1															
Marchantia spp.				**9,0**		1	**2,0**		1															
Lichenes				**2,0**		1	**1,0**		1															

Appendix 5

Physical and chemical properties of ombrotrophic and minerotrophic peats based on field estimates and laboratory analyses.

(x = mean, sd = standard deviation, n = number of samples)

Physical properties		Moisture 1-5	Slipperiness 1-5	Staining 1-5	Pliability 1-5	Lignin 1-5	Sedge roots 1-5	*Eriophorum* fibres 1-5	Water content %	Dry density kg/m^3	$H_{1\text{-}10}$	Amorph. < 0,125 %	Organic matter %	Ash content %
Ombrotrophic peat	x	**2.9**	**1.4**	**1.0**	**1.1**	**1.1**	**1.0**	**1.4**	**91.0**	**45.4**	**2.3**	**9.6**	**8.9**	**1.7**
	sd	0.7	0.6	0.2	0.3	0.2	0.1	0.6	2.5	12.3	0.7	7.8	2.4	0.7
	n	58	58	58	58	58	58	58	60	60	60	30	60	60
Minerotrophic surface peat	x	**3.1**	**1.5**	**1.5**	**1.2**	**1.3**	**2.1**	**1.2**	**90.0**	**68.6**	**1.9**	**32.2**	**8.9**	**9.9**
	sd	0.6	0.7	0.9	0.5	0.7	0.9	0.6	3.8	36.5	0.9	21.8	3.5	8.8
	n	59	59	59	59	59	59	59	58	58	59	29	58	58
Minerotrophic intermediate peat	x	**3.2**	**3.0**	**2.4**	**2.8**	**1.3**	**2.9**	**1.6**	**90.1**	**90.9**	**3.8**	**41.0**	**9.2**	**6.1**
	sd	0.5	0.9	1.2	0.9	0.8	1.1	0.9	3.9	43.3	1.0	18.6	3.9	8.0
	n	890	890	890	890	890	890	890	889	890	898	434	889	80
Minerotrophic basal peat	x	**3.1**	**3.6**	**4.0**	**3.7**	**2.2**	**2.9**	**1.3**	**82.7**	**171.2**	**5.6**	**58.8**	**12.2**	**22.4**
	sd	0.6	0.9	1.0	0.9	1.2	1.0	0.6	8.5	105.9	4.8	17.4	3.5	19.2
	n	73	73	73	73	73	73	73	70	69	73	42	69	70

Chemical properties		pH	P	Na	K	Ca	Mg	Al	Fe	Mn	Cu	Zn	Pb	Fe/Mn	Ca/Mg	Ca/K	Cu/Zn
Ombrotrophic peat	x	**3.3**	**313**	**156**	**707**	**2067**	**738**	**256**	**827**	**85**	**4**	**30**	**9**	**90**	**3**	**7**	**0.2**
	sd	0.1	165	76	769	1544	224	234	982	161	2	14	7	118	2,9	10	0.2
	n	60	50	55	55	55	55	55	55	55	55	55	55	55	55	55	55
Minerotrophic surface peat	x	**4.5**	**779**	**250**	**1716**	**4579**	**1337**	**1370**	**13970**	**620**	**13**	**62**	**20**	**74**	**3**	**5**	**0.4**
	sd	0.97	448	237	1246	4180	946	2549	32702	2028	15	105	16	120	2	6	1.1
	n	58	39	57	57	56	57	57	57	57	57	57	55	57	57	57	57
Minerotrophic intermediate peat	x	**4.9**	**547**	**125**	**456**	**4712**	**814**	**2057**	**7436**	**134**	**12**	**46**	**7**	**166**	**6**	**46**	**1.0**
	sd	0.88	462	197	1723	5115	694	2330	16380	838	15	129	11	202	4	50	2
	n	896	630	854	863	859	862	863	863	857	864	863	863	855	857	857	863
Minerotrophic basal peat	x	**5.1**	**951**	**261**	**590**	**4642**	**1146**	**6410**	**11714**	**147**	**33**	**43**	**13**	**162**	**5**	**25**	**1.5**
	sd	077	717	540	2019	5651	1154	4863	18224	287	38	85	36	245	3	45	2
	n	74	48	66	68	67	68	67	67	67	68	68	67	66	67	67	67

Appendix 6

Physical properties and geochemistry of surface peats in acidic and alkaline bedrock areas and sandy-bottomed minerotrophic mires with high element concentrations. Ombrotrophic samples are excluded.

	Acidic bedrock			Alkaline bedrock			Sandy-bottomed			Total		
	n	mean	sd	n	mean	sd	n	mean	sd	n	mean	sd
Dry density kg/m^3	53	62	34	15	77	0	17	66	27	85	65	32
Water content %	53	90	5	15	89	2	17	89	3	85	90	4
Ash content %	53	9	10	15	8	7	17	8	8	85	9	9
pH	51	4	1	15	5	1	17	4	1	83	4	1
Amorphous matter%	40	30	21	10	33	22	9	29	18	59	30	20
H_{1-10}	53	2	1	15	2	1	17	2	1	85	2	1
Elements (ppm)												
Al	53	1 315	2 456	15	1 347	1 972	17	517	369	85	1161	2124
Ca	52	4 297	4 299	15	6 893	6 663	17	3 605	2 729	84	4620	4635
Mn	53	811	2 727	15	301	204	17	981	3 614	85	755	2673
Cu	53	11	9	15	11	10	17	9	7	85	10	9
Mg	53	1 362	973	15	1 630	1 230	17	759	245	85	1289	965
Na	53	345	724	15	140	92	17	151	96	85	270	581
Pb	53	17	14	15	25	18	17	19	9	85	19	14
K	53	1 575	1 084	15	1 463	1 047	17	971	674	85	1435	1026
Zn	53	42	23	15	58	30	17	51	46	85	47	30
Fe	53	13 780	40 393	15	11 226	23 761	17	10 059	22 676	85	12585	34707
P	51	792	365	15	644	192	17	589	264	83	724	330

Appendix 7

Physical and chemical properties of mires in the acidic and alkaline bedrock areas and the areas of Jotnian sediments by mire type (alk = alkaline bedrock, acid = acidic bedrock, j = Jotnian sediments, x = mean, sd = standard deviation, n = number of samples). For mire type symbols, see Fig. 8.

Site type		mV	pH	Ash %	w %	kg/m³	Org.%	Al	Ca	Mn	Cu	Mg	Na	Pb	K	Zn	Fe	P	Fe/Mn	Ca/Mg	Ca/K	Cu/Zn	Fe/P
alk HSprM	x	**106**	**5.27**	**25.0**	**82.8**	**158.9**	**11.5**	**3837**	**5266**	**505**	**28**	**1564**	**526**	**7**	**607**	**62**	**14096**	**815**	**122.1**	**3.5**	**22.7**	**1.2**	**26.9**
	sd	140	0.74	21.7	7.5	90.2	3.8	2878	5361	1255	19	884	1063	9	619	80	12448	416	127.3	1.6	45.8	1.7	30.8
	n	40	41	40	40	40	40	40	39	38	40	40	39	35	40	40	40	36	35	40	40	40	36
ac HSprM	x	**61**	**5.19**	**11.6**	**87.9**	**111.7**	**10.3**	**2916**	**4005**	**130**	**15**	**791**	**152**	**14**	**2253**	**108**	**13053**	**739**	**150.0**	**5.4**	**19.8**	**0.9**	**20.0**
	sd	93	0.63	9.7	5.0	50.4	2.2	1750	2815	92	8	434	79	12	4580	207	9592	454	135.1	3.0	25.0	0.8	12.8
	n	24	34	34	34	33	34	34	34	33	34	34	34	34	34	33	34	31	33	34	34	33	31
alk TSprM	x	**140**	**4.21**	**4.3**	**87.3**	**120.8**	**12.1**	**4191**	**3253**	**85**	**19**	**847**	**82**	**10**	**832**	**31**	**1935**	**912**	**50.7**	**4.0**	**25.5**	**2.4**	**2.3**
	sd	58	0.38	0.9	2.4	38.0	2.2	3011	1112	96	10	341	36	8	1124	40	797	349	33.7	1.1	25.7	2.0	1.0
	n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
ac TSprM	x	**208**	**3.41**	**4.3**	**86.5**	**121.3**	**13.0**	**2719**	**1477**	**58**	**7,7**	**541**	**108**	**10**	**801**	**36**	**4046**	**1596**	**124.7**	**3.3**	**10.8**	**0.6**	**5.2**
	sd	89	0.21	2.8	3.8	49.9	3.9	2309	760	66	4,0	346	58	8	967	27	4741	365	137.7	1.2	12.4	0.8	3.3
	n	3	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	2	9	9	9	2
alk SprPiM	x	**156**	**3.81**	**7.3**	**85.8**	**108.6**	**12.7**	**2185**	**1550**	**81**	**10**	**536**	**63**	**14**	**1066**	**29**	**1723**	**1769**	**20.4**	**2.9**	**2.5**	**0.4**	**0.8**
	sd	24	0.27	11.1	5.3	76.2	2.8	2022	530	66	8	198	15	9	983	8	899	1039	2.8	0.3	2.1	0.3	0.5
	n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	2	2	7	7	7	2
ac SprPiM	x	**174**	**4.08**	**8.5**	**88.7**	**95.9**	**9.8**	**3000**	**2770**	**63**	**10**	**591**	**104**	**10**	**548**	**25**	**5013**	**759**	**160.0**	**5.3**	**13.8**	**0.7**	**5.5**
	sd	86	0.45	12.3	5.6	59.5	3.1	3184	2048	107	12	310	67	9	675	18	7587	548	87.0	3.5	15.5	0.9	3.6
	n	23	28	28	28	28	28	28	28	27	28	28	28	28	28	28	27	10	9	28	28	28	10
alk DsPiB	x	**217**	**3.36**	**2.3**	**89.7**	**71.5**	**10.1**	**573**	**2238**	**126**	**3**	**744**	**72**	**15**	**681**	**33**	**752**	**591**	**47.2**	**3.8**	**4.7**	**0.2**	**1.1**
	sd	21	0.33	0.8	2.8	22.5	2.7	335	561	125	1	291	14	6	633	20	616	282	102.6	2.7	2.2	0.1	0.6
	n	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
ac DsPiB	x	**161**	**3.75**	**3.9**	**90.1**	**57.5**	**9.5**	**506**	**4845**	**48**	**7**	**889**	**110**	**15**	**1029**	**31**	**2232**	**630**	**165.5**	**5.3**	**9.8**	**0.3**	**3.1**
	sd	93	0.47	2.1	2.8	16.0	2.8	364	3066	66	3	196	52	4	801	14	2639	208	178.5	2.7	12.8	0,2	2.7
	n	11	11	11	11	9	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11

alk SphfB	x	261	3.29	1.8	90.5	47.8	9.3	230	1901	84	3	793	96	10	647	21	1441	245	156.2	2.5	9.6	0,3	8.0
	sd	42	0.33	0.5	1.7	19.4	1.6	101	680	141	2	261	51	8	881	18	1370	112	190.3	0.9	7.9	0.4	8.9
	n	20	25	25	25	25	25	20	20	20	20	20	20	18	20	20	20	20	20	20	20	20	20
ac SpgfB	x	286	3.40	1.9	91.3	55.1	8.6	444	2940	84	4	714	192	9	554	33	671	356	97.8	4.5	12.2	0.1	2.3
	sd	48	0.39	0.8	2.3	15.0	2.2	424	2072	207	2	231	89	4	644	15	335	144	100.1	4.1	15.6	0.1	1.8
	n	16	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	16	16	23	23	23	16
j SphfB	x	344	3.29	1.1	92.3	39.8	7.6	135	1051	33	5	640	164	9	509	34	575	262	129.7	1.6	2.9	0.1	2.7
	sd	35	0.12	0.4	1.8	6.2	1.7	47	499	58	3	148	33	6	407	12	658	123	172.8	0.5	1.7	0.1	3.2
	n	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
alk ErPiB	x	225	3.43	2.1	88.4	104.4	11.3	1162	1255	33	5	511	66	5	168	13	1676	412	164.1	2.5	26.7	0.7	7.6
	sd	22	0.26	0.9	2.6	31.3	2.5	1267	458	43	3	131	27	6	302	16	978	242	157.4	0.7	35.0	0.7	8.3
	n	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
ac ErPiB	x	200	4.00	2.3	91.2	73.6	8.6	579	2965	33	4.76	514	84	7	412	19	2354	470	240.1	6.4	34.5	0.4	5.5
	sd	36	0.50	0.9	1.7	18.3	1.7	430	3123	56	4	185	50	5	988	15	1406	157	177.6	6.6	34.8	0.3	2.4
	n	19	24	25	25	25	25	25	25	25	25	25	25	25	25	25	25	20	20	25	25	25	20
alk OmOIPF	x	198	3.99	3.2	89.0	86.8	10.3	1603	1550	27	7	478	101	7	377	22	3206	344	222.7	3.6	17.5	0.6	10.1
	sd	58	0.44	2.2	4.2	42.6	3.2	1558	1131	36	4	281	82	8	782	17	1881	164	85.9	1.7	15.1	0.6	4.9
	n	17	32	32	32	32	32	28	29	29	29	28	28	29	28	29	28	17	20	28	28	28	16
ac OmOIPF	x	176	4.07	2.7	92.2	70.6	7.6	934	2497	17	5	516	116	5	151	24	2234	371	231.5	5.3	37.3	0.4	7.9
	sd	50	0.44	1.6	3.3	31.7	3.1	1703	1349	20	4	242	67	8	344	32	1210	188	173.2	2.9	23.8	0.4	3.9
	n	70	94	99	98	98	98	99	98	99	97	99	99	98	99	99	99	75	92	98	98	98	75
j OmOIPF	x	294	3.47	1.6	90.9	86.5	9.0	155	966	8	2	424	90	4	83	9	2073	238	278.1	2.3	12.2	0.4	9.4
	sd	13	0.11	0.6	2.1	22.9	2.0	58	104	2	1	50	16	2	22	6	403	89	94.3	0.1	2.4	0.3	2.8
	n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
alk MePF	x	200	4.57	6.3	89.3	104.9	9.6	2285	2333	50	9	633	88	6	129	11	4086	534	155.4	4.8	37.8	1.3	8.8
	sd	118	0.48	10.3	4.5	50.2	2.6	1764	1088	54	8	350	67	8	171	11	3868	206	109	3.6	28.7	1.3	10.9
	n	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
ac MePF	x	110	4.72	3.8	91.7	76.3	8.0	1465	2845	37	6	540	119	6	180	32	5647	574	259.4	6.0	35.0	0.7	13.4
	sd	74	0.40	1.7	1.8	20.6	1.7	1247	2139	36	3	405	82	10	447	45	3648	249	219.6	2.5	25.5	1.0	7.4
	n	62	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	65	79	88	88	88	65
alk SSdgF	x	59	4.96	4.1	88.7	98.5	11.0	2488	2885	64	10	633	74	1	77	16	8973	314	135.4	4.5	42.1	0.8	38.0
	sd	32	0.32	1.6	1.7	29.7	1.8	1376	1236	52	6	183	21	2	25	13	6242	70	12.9	1.1	19.4	0.4	14.4
	n	8	16	16	16	16	16	14	13	14	14	14	14	14	14	14	14	8	8	13	13	14	8
ac SSdgF	x	14	5.31	7.0	92.2	73.0	7	3319	3650	67	14	706	154	6	139	28	10251	719	224.2	5.6	29.9	1.3	13.7
	sd	67	0.39	7.1	2.0	22.1	1.4	5291	1252	46	8	419	107	6	105	60	16518	750	294.7	2.9	15.0	1.7	9.5
	n	36	46	46	46	46	46	46	40	46	46	45	45	46	46	46	46	41	46	45	45	45	41
j SSdgF	x	280	3.55	2.8	86.4	151.9	13.2	1139	654	16	4	368	81	4	78	6	2031	443	128.0	1.8	9.7	0.8	4.9
	sd	0	0.07	2.0	3.0	40.4	2.6	911	221	3	1	45	25	1	30	4	161	173	12.6	0.4	6.7	0.4	1.6
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

alk RF	x	75	5.61	8.8	89.2	104.5	9.8	3207	7500	303	28	1231	108	7	172	30	9504	572	65.5	7.2	80.6	2.1	30.8
	sd	93	0.58	6.7	2.8	29.9	2.0	4789	5179	1442	42	884	65	12	166	46	13606	380	47.9	4.0	89.7	3.6	59.6
	n	85	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	85	94	108	108	108	85
ac RF	x	66	5.98	6.2	94.2	56.1	5.5	1695	8397	200	12	918	246	1	159	21	2840	483	63.4	9.1	76.6	0.6	9.6
	sd	53	056	4.4	1.5	13.2	1.3	1229	3577	112	10	347	96	3	209	12	2597	44	2.5	2.4	43.2	0.3	1.6
	n	5	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	5	5	73	73	73	5
ac S	x	-46	5.64	19.2	89.6	96.5	8.3	4531	4043	90	29	1253	323	14	412	84	28925	950	520.3	4.1	12.5	0.5	29.6
	sd	67	0.42	10.7	2.3	21.4	1.1	1730	1608	56	10	833	194	9	307	75	26077	403	730.0	1.6	6.2	0.5	25.1
	n	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
alk OIMC	x	183	4.20	2.4	87.1	68.7	15.9	1015	1958	125	4	492	67	4	67	6,8	4926	424	177.0	4.0	48.6	0.7	14.9
	sd	49	0.43	2.1	1.9	41.5	15.8	970	971	165	2	195	28	3	36	2,3	3384	195	152.2	1.0	56.5	0.4	13.5
	n	9	24	24	24	24	24	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
ac OIMC	x	168	4.18	3.0	87.8	103.7	12	1167	2603	15	4	347	70	6	355	16	2184	402	637.8	8.9	27.1	0.5	5.3
	sd	8	0.47	0.8	4.0	40.9	4	1265	2534	23	2	266	61	6	863	12	407	62	102.7	8.3	23.1	0.4	0.6
	n	8	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	3	3	12	12	12	3
alk MeMC	x	93	5.19	7.3	88.7	101.9	10	3751	4568	190	17	1108	136	5	236	19	11754	810	85.7	5.5	53.3	1.4	25.8
	sd	90	0.55	8.1	3.3	39.9	3	3356	1772	209	17	539	123	8	463	22	8791	1202	45.0	7.8	50.7	1.3	25.5
	n	57	73	63	63	63	63	57	58	58	58	58	56	58	58	58	58	48	53	58	58	58	48
ac MeMC	x	99	4.60	6.7	87.7	119.0	11	3598	2142	61	13	413	104	4	156	35	9632	916	204.6	5.5	27.5	0.7	19.6
	sd	78	0.63	10.8	5.6	66.1	3	2664	1387	101	10	290	104	9	205	25	26733	802	209.3	2.2	20.9	1.0	31.3
	n	28	67	67	67	67	67	67	67	67	67	67	65	67	67	67	67	33	64	67	67	67	33
alk EuMC	x	64	5.86	14.0	86.9	123.2	10	2812	13005	766	17	2268	136	9	391	43	24894	711	90.6	6.1	66.3	1.1	35.4
	sd	94	0.59	14.2	6.8	91.1	3	4026	10992	2863	17	1386	101	11	660	85	48635	321	113.4	2.8	59.7	1.2	58.2
	n	64	72	72	72	70	70	70	70	65	68	70	65	64	70	70	70	61	65	70	70	70	61
ac EuMC	x	83	5.46	10.7	89.6	96.8	8	995	6093	82	9	621	135	11	194	13	12039	699	147.1	8.7	51.5	0.7	15.5
	sd	87	0.24	15.7	6.4	82.7	1.4	420	4949	51	5	162	79	7	282	8	10293	248	100.0	5.6	39.2	0.3	11.0
	n	23	39	38	38	38	38	35	36	35	35	35	35	35	35	35	35	35	35	35	35	35	35
alk L	x		5.93	28.1	87.1	128.1	9	4451	12107	235	69	1151	283	1	256	90	51069			10.9	53.7	0.9	
	sd		0.35	14.0	2.2	19.4	0.2	1211	4139	15	28	499	136	1	151	24	24877			3.0	169	0.6	
	n		4	3	3	3	3	3	3	3	3	3	3	3	3	3	3			3	3	3	
j L	x		3.80	15.8	82.5	205.7	15	3295	476	21	14	245	234	8	125	9	1382	633	84.7	1.9	4.2	1.7	2.2
	sd			10.9	0.4	34.2	2	228	188	13	3	13	100	3	81	2	231	64	62.3	0.7	1.2	0.1	0.1
	n		1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
ac L	x		5.20	22.8	88.8	102.6	9	9105	4388	32	24	741	358	1	325	33	5649			5.9	14.3	0.7	
	sd		0.0	3.7	0.9	8.1	0	1481	126	4	2	6		1	114	1	279			0.2	4.6	0.03	
	n		2	2	2	2	2	2	2	2	2	2	1	2	2	2	2			2	2	2	
Gyttja (total)	x	- 220	6.48	74.0	75.6	295.3	5	4846	6767	382	40	2583	1033	28	2715	247	644	0.6	0.3	4.0	8.1	0.3	77.8
	sd		0,33	17.6	25.6	361.2	2	2346	3453	209	11	1852	129	49	3380	275	528			3.0	7.0	0.2	
	n	1	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	3	3	3	1

Composition of peats representing the various mire types, based on percentages in the macrosubfossil analyses and numbers of seeds/spores and leaves observed.

Plant species	**L** %	**S** %	**SF** %	**RF** %	**MePF** %	**OmOlN** %	**ErPiB** %	**DsPiB** %	**SphfB** %	**SprPiM** %	**OlMC** %	**TSprM** %	**MeMC** %	**EuMC** %	**HSprM** %
Lignin (tot.)	**5,7**	**10,4**	**1,7**	**1,3**	**5,3**	**2,8**	**6,7**	**8,1**	**0,6**	**6,3**	**11,6**	**35,3**	**25,6**	**16,5**	**43,8**
Alnus spp.															1,7
Alnus glutinosa													0,2		0,12
Betula spp.			0,16	0,24				0,28	0,02			0,32	1,2	1,35	
B. pendula												0,32	+		5,47
B. pubescens		1,45	0,02	0,03				0,11		0,17			0,1	0,01	0,28
Picea abies				0,01						0,03	0,03		0,2		0,64
Pinus sylvestris				0,02	0,01	0,01	0,02	0,89	0,02	0,31	0,71			0,14	0,31
Rubus idaeus													0,01		
Nanolignin (tot.)			**1,6**	**5,2**	**5,5**	**3,7**	**5,8**	**16,9**	**10,3**	**23,9**	**4,0**	**2,2**	**2,6**	**4,9**	**1,7**
Andromeda polifolia				0,09	0,18	0,17	0,28		0,19	0,29					
Betula nana				0,02	0,17	0,11	0,22	0,17	0,02	0,26	0,31			0,24	
Calluna vulgaris						0,02			0,24	0,14					
Chamaedaphne calyculata							0,13								
Empetrum nigrum				0,01	0,01	0,01	0,04	0,11	1,02	0,49					0,07
Ledum palustre				0,04				0,33							
Vaccinium spp.				0,01											
V. microcarpum							0,22	0,67	0,13		0,03				
V. myrtillus									0,06	0,03					
V. oxycoccos			0,61	0,01	1,22	1,02	0,11	0,61	0,04	0,86			0,1	0,24	
V. uliginosum								0,28	0,22	0,23					
V. vitis-idaea									0,04						
***Carex* spp. (tot.)**	**22,7**	**23,1**	**35,2**	**29,8**	**39,5**	**13,9**	**3,7**	**4,7**	**1,3**	**16,8**	**25,8**	**8,4**	**22,5**	**27,1**	**15,4**
C. chordorrhiza				0,26							0,71				
C. globularis								4,11		3,71		0,64			
C. lasiocarpa				0,33											
C. limosa				0,31											
C. rostrata							0,04								
C. vaginata														0,01	
***Eriophorum* spp. (tot.)**	**0,9**		**2,5**	**1,1**	**4,1**	**15,5**	**41,0**	**3,7**	**7,2**	**10,9**	**33,4**	**4,5**	**7,3**	**0,1**	**0,7**
E. angustifolium				0,02	0,34				0,28		0,57		0,1	0,04	
E. latifolium				0,26										0,02	
E. vaginatum			0,03	0,2	0,39	11,44	32,76	3,67	5,83	4,49	11,51	2,87	1,9	0,01	
***Trichophorum* spp. (tot.)**	**0,7**			**3,0**		**1,2**			**0,6**	**0,1**	**0,1**	**0,6**	**0,2**	**0,3**	**0,1**
T. alpinum				2,49										0,1	
T. cespitosum						0,78			0,56	0,06	0,14				
Poaceae spp. (tot.)	17,1	6,4	0,4	1,4								2,9	0,2	3,5	1,5
Calamagrostis spp.				0,14											
Molinia caerulea				0,2										0,54	0,07
Phragmites australis	**17,1**	**6,4**	**0,2**	**3,4**									**0,1**	**1,2**	**0,1**
Herbae (tot.)	**35,6**	**79,0**	**52,3**	**20,9**	**21,9**	**10,5**	**1,6**	**3,5**	**0,1**	**1,6**	**8,3**	**19,2**	**27,2**	**20,8**	
Calla palustris			0,39	0,02		0,07							0,1		1,56
Cicuta virosa			0,16										0,01		
***Equisetum* spp. (tot.)**	**33,4**	**22,5**	**14,8**	**5,8**	**4,6**	**0,5**		**1,6**	**0,1**	**0,8**	**2,7**	**8,7**	**11,4**	**4,2**	**5,0**
E. fluviatile		22,45	7,64	0,9	1,39	0,17				0,03			2,3	1,72	3,31
E. sylvaticum								1,61		0,63		2,55	0,2	0,13	
Filipendula ulmaria				0,01											
Lycopodium inundatum														0,18	
Menyanthes trifoliata	**1,6**	**17,7**	**14,3**	**6,1**	**6,7**	**1,7**					**2,1**	**4,5**	**8,2**	**12,9**	**7,4**
Pedicularis palustris														0,04	
Potamogeton alpinus		0,1											0,01		
P. pusillus	0,29												0,02		
Potentilla palustris	0,29	16,27	12,69	0,2	0,28	0,02							0,9	0,58	2,72
Rubus chamaemorus								0,28	0,04	0,14					
Scheuchzeria palustris			**2,3**	**7,8**	**8,9**	**8,0**	**1,6**				**3,4**	**3,5**	**4,1**	**1,1**	**0,1**
Selaginella selaginoides				0,03										0,01	
Hepaticae spp.								0,22	0,07						
Marchantia spp.									0,17						
***Sphagnales* (tot.)**	**0,7**	**8,3**	**4,2**	**9,0**	**14,7**	**48,9**	**34,5**	**56,1**	**74,9**	**34,9**	**13,7**	**25,9**	**9,7**	**13,5**	**9,4**
Sphagnum spp.		4,09											9,54	0,12	
S. angustifolium			0,2	0,18	0,28	2,04	12,41	10,28	6,48	14,80	3,69	6,51	0,9	0,12	1,15
S. balticum				0,01		7,43	0,37	0,44	1,61		0,31	1,28			
S. centrale							0,04					2,36	0,1		0,09
S. compactum						0,23									
S. contortum				0,16											
S. cuspidatum		0,18	0,08			3,64	0,22				0,43		0,1	0,18	
S. cuspidatum coll.			0,06	0,55	0,82	0,12	0,09				1,17		1,2		0,17
S. fallax	0,14		0,81	0,11	1,8	2,64				0,77	0,29	2,62	0,5		0,17
S. fuscum				0,02	0,04	0,19	8,74	36,00	64,65	5,26	0,63		0,3	2,74	0,01
S. girgensohnii				0,04						0,06		4,91	0,1	1	2,15
S. jensenii			0,02	0,01	0,11	2,33									
S. lindbergii			0,05			2,74						0,64	0,1		
S. magellanicum			0,14	0,09	0,29	6,81	5,00	5,44	0,2	4,37	1,2		0,7		
S. majus			0,02	0,05	0,96	2,04							0,7		
S. nemoreum											1	2,87	0,1		
S. obtusum			0,03		0,05	0,19									
S. papillosum			0,22	0,4	2,64	13,09	0,65		0,19		0,31		0,4		0,04

S. platyphyllum				0,01											
S. recurvum coll.			0,28		1,38	2,74	2,30		0,2		1,94		0,1	0,15	
S. riparium		0,45	1,31		1,95	0,05	0,11						1,1	0,47	1,84
S. rubellum			0,02	0,06	0,26	2,55	1,09		0,04				0,4	0,05	
S. russowii			0,02		0,08	0,02	3,07	3,94	0,02	8,23	0,14	0,45	0,4	0,04	
S. squarrosum		3,27	0,05	0,07	0,23								0,8	0,53	2,8
S. subsecundum	0,29			1,63	1,57								0,2	0,33	
S. subfulvum				0,61								0,06		0,3	
S. tenellum						0,08	0,41								
S. teres	0,29	0,27	0,89	3,82	2,22	0,01							1,7	2,76	0,31
S. warnstorfii				1,2										4,72	0,64
Bryidae (tot.)	**29,7**	**4,2**	**9,7**	**24,9**	**9,2**	**2,8**	**5,7**	**8,4**	**4,8**	**8,7**	**3,1**	**3,6**	**5,6**	**17,1**	**6,3**
Aulacomnium palustre				0,03			0,17			1,23		0,13	0,02	0,16	
Bryidae spp.														0,32	
Bryum spp.					0,03										
B. weigelii				0,09											
Calliergon spp.					0,07								0,04	1,32	0,01
C. cordifolium	15,71	0,45	0,8	0,53	0,65	0,02							1,1	1,44	1,25
C. giganteum	2,14														
C. megalophyllum				0,97											
C. richardsonii														0,64	
C. trifarium				6,3										0,16	0,01
Campylium stellatum				0,4										0,13	0,47
Cinclidium stygium				0,06										0,07	
Dicranum spp.					0,01										
D. undulatum						0,02	2,11		4,35						
Drepanocladus spp.			0,02	0,01	0,01	0,08							0,01	0,2	
D. badius				0,4		0,16									
D. exannulatus	0,43		0,11	2,23	0,49	0,08							0,6	0,11	0,07
D. fluitans		0,09		0,09	0,52	0,92	0,04				0,37	0,77	0,1		
D. intermedius				0,07										0,42	
D. lapponicus														0,72	
D. revolvens				2,05	0,01								+	1,77	
D. trichophyllum				0,68											
D. vernicosus				0,21										0,69	
Helodium blandowii					0,22									0,83	0,16
Hylocomium splendens													0,1		
Meesia triquetra				2,54										0,96	
Paludella squarrosa				1,01	0,29								0,1	3,25	
Pleurozium schreberi				0,01			0,83	4,94	0,04	0,60				0,03	
Pohlia nutans							0,15	1,28	0,24	0,40			0,01	0,01	
Polytrichum spp. (tot.)				0,01	0,27		1,50		0,11	3,15	0,46	2,17	0,4		
P. commune										1,29		2,11	0,1		2,63
P. strictum					0,2		1,39	2,22	0,09	1,80	0,4		0,1	0,03	
P. swartzii													0,04		
Pseudobryum cinclidioides			0,5		0,44								0,5	0,16	
Rhizomnium perssonii															0,23
R. pseudopunctatum														0,09	0,04
R. punctatum														0,04	0,2
Rhytidiadelphus triquetrus															0,2
Sarmentyphnum sarmentosum				0,02										0,57	
Scorpidium scorpidioides	11,43			3,76										0,49	
Straminergon stramineum		1,55	8,14	3,21	5,88	2,45	0,87			0,23	1,57	0,45	2,6	1,54	0,96
Tomentyphnum nitens				0,17									0,1	0,94	
Lichenes									0,06					0,02	
Cenococcum craniforme				0,01				0,06					3	0,04	0,07
Coal						0,08								0,04	
Unknown					0,11	0,02							0,02		0,53
Mineral material	0,71			0,01	0,2	0,01				0,34			0,4	0,54	0,37
Species n	20	21	41	79	50	50	38	31	40	38	34	31	66	74	48

Seeds / spores (n)	**L**	**S**	**SF**	**RF**	**MePF**	**OmOlN**	**ErPiB**	**DsPiB**	**SphfB**	**SprPiM**	**OlMC**	**TSprM**	**MeMC**	**EuMC**	**HSprM**
Lignin	**11**	**45**	**68**	**248**	**64**	**20**	**17**	**21**	**14**	**9**	**22**	**354**	**209**	**492**	**726**
Alnus spp.				2	1		1							26	9
A. glutinosa		12	4												40
A. incana		1	6											10	28
Betula spp.	7	3	8	147	2	13	1		11		5	349	142	247	244
B. pendula			2								3	1			34
B. pubescens	1	28	41	61	56	1	1	21	3	6	10		63	191	346
Picea abies	1		1	12						1	2	3	3	8	18
Pinus sylvestris	2	1	6	26	5	6	14			2	2	1		9	7
Rubus idaeus													1	1	
Nanolignin	**0**	**50**	**270**	**264**	**112**	**93**	**109**	**23**	**81**	**93**	**498**	**3**	**426**	**28**	**2**
Andromeda polifolia			264	181	104	61	75	18	20	90	482	3	424	2	
Betula nana			2	11	6	1		1		3	9			13	2
Chamaedaphne calyculata								2	42						
Empetrun nigrum				20	2		1	1	19		3		2	1	
Ledum palustre				10											
Vaccinium spp.								1							
V. myrtillus		50		1										9	
V. oxycoccos			4	41		30	27							3	
V. uliginosum							6				4				
V. vitis-idaea						1									

***Carex* spp. (tot.)**	**524**	**907**	**1767**	**1088**	**655**	**306**	**24**	**2**	**1**	**105**	**73**	**13**	**2084**	**459**	**1042**
C. aquatilis		41	38	34	1							1	10	5	25
C. buxbaumii			7												
C. canescens	5	90	36	7	1		14					4	58	61	788
C. cespitosa				1										24	
C. chordorrhiza			1014	199	143	4			1		2	2	190	70	26
C. diandra	5	33	4	51	14								86	41	2
C. dioica														10	
C. echinata				26										24	
C. elongata				1											
C. flava				30										23	
C. globularis							6	2		103		3	19		
C. lasiocarpa	65		65	189	151	28				2	12	2	971	33	43
C. laxa							1								
C. limosa			20	188	88	8					1		64	45	20
C. livida				2											
C. loliacea														1	
C. magellanica				5	34	1							5	1	
C. nigra		5		5	21							1	6	21	
C. pauciflora						3					1				
C. rhynchophysa													42		
C. rostrata	402	738	532	228	98	46	1				56		291	84	29
C. vaginata				11		1								4	11
C. vesicaria	44		34	104	107	190					1		339	4	92
Eleocharis palustris	3	6	50	1											
***Eriophorum* spp.**			**1**	**13**	**9**	**57**	**13**	**2**		**2**	**137**		**52**	**3**	
E. angustifolium				1		1					10		1	1	
E. latifolium				1										2	
E. vaginatum			1	8	9	16	11	2		2	127		51		
Schoenoplectus spp.		1													
S. lacustris	24			4											4
***Trichophorum* spp.**						**2,0**									
T. alpinum				4										2	
T. cespitosum				1		4									
Poaceae spp.									1		2				2
Juncus spp.		1													
Angelica sylvestris														1	
Bidens radiatus															1
Calla palustris		2	10	1	4								3		21
Caltha palustris				1											
Cicuta virosa		2	11	1	2								6		2
Filipendula ulmaria				2										4	
Hippuris vulgaris	6	1	1	1											
Lysimachia spp.			1											1	
L. thyrsiflora			9										1		4
L. vulgaris													10		
Menyanthes trifoliata	**3**	**51**	**155**	**350**	**68**	**23**					**4**	**2**	**277**	**148**	**60**
Myosotis	1														4
Myriophyllun verticillatum	15														
Nuphar	1														
Pedicularis palustris				2											
Potamogeton alpinus		1											1		
P. berchtoldii	2														
P. gramineus	102			3										1	
P. natans				8											
P. pusillus	9												4		
Potentilla erecta														14	
P. palustris	9	116	490	38	40	2					3		200	77	166
Ranunculus spp.				1											
Rubus chamaemorus								2							
R. saxatilis				1											
Rumex spp.															1
Scheuchzeria palustris			**1**	**66**	**6**	**1**							**8**	**2**	
Selaginella selaginoides					9									524	
Sparganium minimum				2											
S. simplex	9														
Cenococcum craniforme			2		1	3			2	46	9	2		173	154
Cristatella mucedo	1												* spores		
Unknown	2				1								34*	2	6
Species n	26	22	34	50	28	25	17	13	11	13	24	15	31	43	

Leaves n	**L**	**S**	**SF**	**RF**	**MePF**	**OmOlN**	**ErPiB**	**DsPiB**	**SphfB**	**SprPiM**	**OlMC**	**TSprM**	**MeMC**	**EuMC**	**HSprM**
Alnus spp.													17		
A. glutinosa													5		
Betula spp.	1			1			1					11		5	13
B. pendula															1
B. pubescens				2						2				4	5
Juniperus communis														5	
Picea abies		21	11	7	12		2	1	2	1		114	97	191	394
Pinus sylvestris			2	69	37	16	16	73	4	65	21	20	2	51	199
Salix spp.											1	2			
Andromeda polifolia				21	63	106	18		24	20	57		11	1	
Betula nana				1	2	11	1	3	6	21	12			9	1
Calluna vulgaris									60	50					
Chamaedaphne calyculata				2		1	4			12					
Empetrum nigrum			2	10	8	5	77	10	260	122	56		8	73	10
Ledum palustre				5			18	46	55	3	42	1			
Vaccinium microcarpum				6	1	5	54	89	80		8				
V. myrtillus									2	1		31			2
V. oxycoccos				52	109	223	23	56	62	95	31	3	73	63	
V. uliginosum								8	10	43	1	1			
V. vitis-idaea							2		6			15		9	3
Lycopodium inundatum														50	
Rubus chamaemorus									1	3					
Selaginella selaginoides				1											
Species n	1	1	3	12	7	7	11	8	13	13	9	9	7	11	9

Appendix 9

Indicative values of certain mire plants with respect to mean pH, redox potential (mV) and element concentrations in the peat ash (ppm). Cation concentrations in peat are based on k-values of 1-10 when the concentrations are within the following limits: 1= < 8 000, 2= < 11 500, 3= < 16 500, 4= < 18 500, 5= < 25 000, 6= < 35 000, 7= < 51 000, 8= < 75 000, 9= < 100 000, 10= > 100 000.
O = minimum concentration of an element, X = maximum concentration; also shown are the rations Ca/Mg and Fe/Mn.

Plant species	**n**	**pH**	**mV**	**k**	**Al** O < 700 --- X > 3 500	**Ca** O < 2 000 --- X >8 000	**Mg** O < 550 --- X > 1 600	**Na** O < 100 --- X > 300	**K** O < 180 --- X > 1800	**Cu** O < 7---X > 40	**Fe** O < 3 000 --- X > 18 000	**Mn** O < 100 --- X >800	**Pb** O < 6 --- X > 30	**Zn** O < 22 --- X > 90	**P** O < 450 --- X > 1 000	**Ca / Mg**	**Fe / Mn**
Lignin (total)	**716**	**4.98**	**115**	**4**												5.9	138
Alnus glutinosa	**27**	5.40	9	6					X				X	X		4.4	263
A. incana	**14**	5.40	100	5					X					X		4.4	87
Alnus spp.	**29**	5.40	-5	7							X					3.5	109
Betula pendula	**13**	4.60	245	5												3.9	74
B. pubescens	**146**	5.10	80	5										X		4.7	119
Betula spp.	**188**	5.40	83	5												6.0	126
Juniperus communis	**7**	5.79	87	8												3.6	94
Picea abies	**110**	5.22	86	5										X		4.8	108
Pinus sylvestris	**171**	4.66	144	4												6.0	132
Rubus idaeus	2	5.35	155	5												3.6	17
Salix aurita	1	4.80	180	7									O			2.6	167
S. caprea	1	3.60	305	3						O						2.6	27
S. glauca	1	4.70	170	4	X			X								1.3	28
S. myrsinites	1	4.10		4	O			O	X	O						3.2	7
Salix spp.	3	4.47	130	6	X			O				O			X	4.7	225
Nanolignin (total)	**592**	**4.60**	**148**	**3**												5.5	174
Andromeda polifolia	**228**	4.38	178	2								O				4.9	152
Betula nana	**87**	4.68	132	4										X	O	5.7	155
Calluna vulgaris	7	3.49	259	5						O						3.6	264
Chamaedaphne calyculata	**15**	3.69	287	1		O				O		O				3.8	88
Empetrum spp.	**112**	4.27	203	3												3.9	122
Ledum palustre	**20**	3.97	200	2	O			O			O	O			O	3.7	98
Vaccinium microcarpum	**29**	3.81	271	2											O	3.9	103
V. myrtillus	**13**	4.37	211	4												3.0	93
V. oxycoccos	**214**	4.63	130	3						O				O		5.0	147
Vaccinium spp.	1	3.60	150	1	O			O		O	O	O				4.1	13
V. uliginosum	**28**	3.67	245	3						O						3.4	87
V. vitis-idaea	**13**	4.28	214	3	O					O						3.5	29
Carex (total)	**897**	**4.99**	**112**	**4**												6.1	160
Carex aquatilis	**30**	5.55	31	6	X											5.3	130
C. buxbaumii	3	4.93		3					O			O				5.7	181
C. canescens	**62**	5.10	97	6												4.4	150
C. cespitosa	6	5.80	160	8		X	X					X				5.7	28
C. chordorrhiza	**175**	5.29	91	5												7.0	121
C. diandra	**41**	5.78	35	5			X						O	O		6.7	88
C. dioica	2	5.20	44	10		X					X	X				6.4	11

C. echinata	6	5.58	43	7	X	X										5.9	84
C. elongata	1	5.10		2							O	O				5.1	14
C. flava	19	5.72	79	7	X	X	X				X	X				8.2	184
C. globularis	49	3.99	168	3								O			X	4.6	176
C. heleonastes	1	5.30	- 110	4	X					X	O	O	O	O		3.0	8
C. lasiocarpa	172	5.00	149	3	X							O	O			6.7	149
C. laxa	1	3.60	220	1		O	O	O			O	O		O		3.0	51
C. limosa	134	5.32	103	4												6.7	135
C. livida	2	5.75	130	8							X	X	X			6.5	52
C. loliacea	1	5.50	225	6		X	X	O				O		O	X	6.5	95
C. magellanica	14	4.60	167	2			O	O	O			O				6.2	201
C. nigra	25	5.31	95	6								X				8.4	108
C. pauciflora	5	3.78		1	O	O	O			O	O	O			O	4.6	137
C. pseudocyperus	2	5.40	50	3				O						O		9.1	2685
C. rariflora	1	4.10		1		O	O					O				4.0	112
C. rhynchophysa	2	5.05		4				O	O			O	O	O		9.0	60
C. rostrata	2	5.15	89	5					O			O	O			6.2	198
Carex spp.	873	5.02	109	5												6.2	162
C. vaginata	12	5.41	88	5												5.9	68
C. vesicaria	82	5.14	103	5									O			5.7	149
Eleocharis palustris	3	5.75	0	5					X				X	X		3.2	26
Eleocharis spp.	1	5.10	107	10	X			X			X	O		X	X	0.0	899
***Eriophorum* spp. (total)**	**453**	**4.33**	**166**	**3**								O				5.2	208
Eriophorum angustifolium	21	4.71	126	6							X			X		4.3	185
E. latifolium	4	5.43	118	7	X											5.3	102
E. vaginatum	206	3.94	197	2								O		O	O	4.7	199
Rhynchospora alba	2	5.45	178	6	X							X			O	3.7	35
Scirpus lacustris	5	5.88	125	7									O			9.4	168
Scirpus spp.	1	6.00	-70	6	X		X	X	X		O		X	X		1.8	0,5
Trichophorum alpinum	29	5.58	114	5												7.9	62
T. cespitosum	21	3.97	216	2											O	4.1	167
Trichophorum spp.	86	4.85	141	3												6.9	122
Poaceae (total)	**101**	**5.43**	**62**	**6**	X											7.5	93
Poaceae spp.	37	5.35	30	5	X			X					O			9.0	51
Calamagrostis phragmitoides	1	4.80	180	7									O		X	6.5	167
Calamagrostis spp.	1	6.30	-90	6		X	X	O	O	X				O		2.6	32
Juncus spp.	1	6.00	-70	6	X		X	X	X		O		X	X		1.8	0,5
Molinia caerulea	12	5.13	98	7		X	X	X		X	X	X				4.7	84
Phragmites australis	61	5.59	55	6	X					X			O			7.5	105
Herbae (total)	**831**	**5.07**	**105**	**5**												6.3	164
Angelica sylvestris	1	5.40	76	10		X					X	X	X	X		5.5	11
Bidens radiatus	1	5.20	125	5	X							O	O	O		3.6	156
Calla palustris	26	5.17	34	5											X	4.1	211
Caltha palustris	1	5.20	100	3		O	O	O	O			O	O	O		3.7	130
Cicuta virosa	11	5.14	53	3								O		O		5.2	127
Cirsium heterophyllum	1	4.10		4	O			O	X	O						3.2	7
Dactylorchis maculata	1	3.70	250	2						O					O	2.8	14
Drosera anglica	1	5.10		2							O	O				5.1	14
Drosera spp.	2	4.55	183	2						O					O	3.5	34
***Equisetum* spp. (total)**	**522**	**5.30**	**98**	**5**												6.7	151
Equisetum fluviatile	134	5.30	41	5					O			O		O		6.9	255
Equisetum spp.	1	6.30	10	7	O				O	O				O		3.8	100
E. sylvaticum	20	4.33	140	3								O			X	5.2	126
Filipendula ulmaria	2	6.55	88	6		X	X			X				O		5.6	17
Hippuris vulgaris	7	5.77	-63	7												8.1	163
Lycopodium inundatum	1	4.10		4	O		X	O	X	O			O			3.2	7
Lysimachia spp.	2	4.40		4	O			O	X	O						3.2	7
L. thyrsiflora	9	5.66	-16	6												4.7	144
L. vulgaris	184	5.15		3	X		O	O	O			O	O			11.0	349

Menyanthes trifoliata	**538**	5.25	65	**5**					**O**							6.6	160
Myosotis spp.	2	5.90	-40	**4**	X								O			4.5	86
Myriophyllum verticillatum	3	6.10		**8**		X					X		O			10.9	217
Nuphar luteum	1	6.10		**9**		X					X		O			14.3	241
Pedicularis palustris	3	6.47	166	**6**		X	X						O			7.7	11
Potamogeton alpinus	2	5.20	90		X												
P. berchtoldii	1			**1**		O	O					O		O		2.4	41
P. gramineus	7	5.97		**7**									O			11.3	105
P. natans	4	6.45		**4**		X		X					O			6.9	2
P. pusillus	2	5.50	100	**9**		X					X		O			11.3	275
Potentilla erecta	2	4.85		**10**	O			O			X	X				4.8	12
P. palustris	**177**	5.32	40	**5**										**X**		5.0	165
Ranunculus sceleratus	1	6.70		**4**				X					O			6.1	2
Ranunculus spp.	2	6.50		**4**		X		X			O		O			7.2	2
Rubus chamaemorus	7	3.50	245	**2**	O			O								2.9	27
R. saxatilis	1	6.30	-90	**6**		X	X	O	O	X				O		6.5	32
Rumex spp.	1	5.20	125	**5**	X							O	O	O		3.6	156
Scheuchzeria palustris	**303**	4.85	128	**3**					**O**			**O**	**O**	**O**	**O**	6.5	193
Selaginella selaginoides	**34**	5.69	93	**8**	**X**	**X**	**X**				**X**	**X**				7.5	234
Solidago virgaurea	1	4.10		**4**	O			O	X	O						3.2	7
Sparganium minimum	2	6.25		**4**									O			8.6	7
S. simplex	2	6.10		**9**		X					X					11.3	275
Utricularia spp.	1	5.40	115	**2**						O		O				4.1	55
Sphagnales (total)	**903**	**4.75**	**138**	**3**												6.1	154
S. acutifolia-type	9	4.57	121	**3**								O		O		5.9	120
S. angustifolium	**214**	4.25	174	**3**												4.2	136
S. aongstroemii	1	4.10		**3**	X		O				O	O	O			8.0	38
S. balticum	**70**	3.71	222	**1**	**O**					**O**	**O**	**O**		**O**	O	3.8	180
S. capillifolium	9	3.80		**1**		O	O	O		O		O				3.8	174
S. centrale	**15**	4.35	178	**4**											**X**	3.0	72
S. compactum	4	3.90		**1**		O	O			O		O				4.9	47
S. contortum	4	6.55		**5**		X							O	O		9.0	20
S. cuspidata-type	**16**	5.50	1	**6**					**X**					**X**		4.2	90
S. cuspidatum	2	3.45	165	**1**	O	O	O			O		O		O	O	2.6	108
S. cuspidatum coll.	**86**	4.53	122	**3**						**O**		**O**	**O**		**O**	5.7	169
S. fallax	**118**	4.42	165	**3**			**O**	**O**				**O**				4.9	238
S. fimbriatum	1	4.80	180	**7**									O		X	2.6	167
S. fuscum	**130**	3.86	216	**2**	**O**					**O**	**O**				**O**	4.7	156
S. girgensohnii	**38**	5.23	115	**6**		**X**	**X**	**X**						**O**		5.2	218
S. jensenii	**19**	4.32	188	**2**			**O**		**O**					**O**		4.4	190
S. lindbergii	**23**	4.14	188	**1**			**O**			**O**	**O**	**O**	**O**		**O**	5.2	190
S. magellanicum	**155**	3.98	196	**1**			**O**	**O**		**O**	**O**	**O**			**O**	4.7	176
S. majus	**56**	4.19	161	**2**		**O**	**O**	**O**	**O**	**O**			**O**		**O**	6.1	235
S. obtusum	7	4.89	4	**3**						O		O				4.4	562
S. papillosum	**149**	4.19	197	**2**			**O**					**O**				5.0	215
S. platyphyllum	6	5.50	-41	**6**	X					X						3.6	12
S. recurvum coll.	**87**	4.65	126	**2**	**O**							**O**		**X**	**O**	6.8	221
S. riparium	**89**	5.08	75	**5**										**X**		5.3	117
S. rubellum	**43**	4.17	174	**2**							**O**	**O**			**O**	4.5	161
S. russowii	**49**	4.39	178	**3**				**O**								4.6	167
Sphagnum spp.	**29**	4.61	61	**4**									**O**			4.7	123
S. squarrosum	**58**	5.31	44	**6**												4.5	125
S. subfulvum	**20**	5.52	176	**6**		**X**						**X**				9.4	47
S. subsecundum	**110**	5.16	173	**3**					**O**			**O**	**O**			7.3	158
S. tenellum	7	3.56	253	**1**		O		O		O		O		O	O	2.5	248
S. teres	**180**	5.51	87	**5**										**X**		6.3	96
S. warnstorfii	**77**	5.70	117	**6**		**X**	**X**									6.7	75
S. palustria-type	2	5.20	38	**5**				O	O				O	O	O	3.8	128
Bryidae (total)	**628**	**5.05**	**111**	**4**												9.7	162
Aulacomnium palustre	**35**	4.73	150	**4**						**O**						6.2	217

Bryidae spp.	17	5.11	128	5								O				8.5	155
Bryum pseudotriquetrum	3	4.83	295	5		X										6.9	21
Bryum spp.	1	4.00	225	2		O	O					O		O	X	4.5	332
B. weigelii	1	5.10	140	2				O	O			O	O			5.5	61
Calliergon cordifolium	109	5.33	75	5									O			5.0	148
C. giganteum	5	6.10		9	X	X					X		O			8.4	310
C. megalophyllum	9	6.52		4		X		X			O		O			6.6	2
C. richardsonii	9	5.23	157	4		X						O		O		12.7	146
Calliergon spp.	13	4.79	46	3								O				4.9	244
Campylium stellatum	12	5.48	177	7		X	X					X	X			4.9	47
Cinclidium stygium	6	5.60	91	7		X						X				6.2	41
Dicranum majus	1	6.80	230	5	O	X	X	O			O		O	O		4.3	2
D. polysetum	16	3.34	309	1	O	O				O	O	O			O	2.3	148
Dicranum spp.	1	4.40	145	3		O		O		O		O	O	O	O	3.2	124
Hamatocaulis lapponicus	9	5.61	41	5			O	O	O					O		4.9	149
H. vernicosus	11	5.16	176	3					O							10.1	63
Helodium blandowii	13	4.99	44	5								O		X		5.2	188
Hylocomium splendens	6	5.10	178	6	X		X								X	3.6	39
Loeskypnum badium	8	5.54	127	6	X		X									4.4	60
Meesia triquetra	18	5.54	37	5					O					O		5.4	139
Mnium spp.	1	5.60	310	7		X	X						X			5.7	50
Paludella squarrosa	58	5.85	20	5	O				O				O		O	5.5	102
Pleurozium schreberi	19	4.04	205	2				O		O	O	O				4.4	151
Pohlia nutans	23	4.25	187	3				O		O	O					3.9	199
Polytrichum commune	15	4.04	172	3											X	3.4	79
Polytrichum spp.	23	4.53	113	3	X			O				O		O		4.9	211
P. strictum	33	3.94	183	3								O				6.9	189
P. swartzii	1	5.30	80	6									O	O		5.2	20
Pseudobryum cinclidioides	41	5.34	52	5					X					X		4.7	135
Pseudo-calliergon trifarium	86	5.88	80	3		X			O				O		O	9.1	25
Rhizomnium magnifolium	2	5.05	308	3				X							X	4.3	19
R. pseudopunctatum	3	5.73	273	5		X	X									4.1	10
R. punctatum	4	5.55	113	7	X		X					X				1.5	50
Rhizomnium spp.	1	5.60	310	7		X	X						X			5.7	50
Rhytidiadelphus triquetrus	1	4.80	240	7	X		X	X				X				0.0	4
Sanionia uncinata	1	4.90	30	5								O		O		5.1	179
Scorpidium cossonii	8	5.56	149	5		X	X									4.8	73
S. revolvens coll.	33	5.87	63	6		X				O						8.1	68
S. revolvens	33	5.84	95	6		X	X		O			X		O		8.1	67
S. scorpioides	44	5.72	102	6		X			O							8.4	65
Straminergon stramineum	239	5.05	88	4										O		5.0	167
Tomentypnum nitens	26	6.04	49	6		X	X							O		4.5	91
Warnstorfia exannulata	94	5.16	132	3		O						O				7.5	122
W. fluitans	46	4.25	167	2		O	O	O				O	O			4.4	194
W. sarmentosa	14	5.25	38	7	X	X	X					X				5.1	59
Warnstorfia spp.	21	5.16	91	3			O	O		O		O				5.7	188
W. trichophylla	7	6.56		5		X		X					O			7.3	7
Hepaticae	7	3.97	255	3						O						4.2	93
Marchantia	2	4.85	260	3		X	X	O		O	O			O		3.9	10
Lichenes	5	4.03	290	2	O					O	O	O				4.0	43
Cladonia spp.	1			1	O						O	O				3.0	13
Cenococcum graniforme	143	4.93	121	5	X										X	5.7	156
Cristatella mucedo	1	3.80	200	1		O	O					O		O		2.4	41
Unknown	26	5.20	90	5												6.0	134

Appendix 10

Physical and chemical properties of the various plant species and their decomposed remains recovered from the peat horizons of the mires studied here: water content (%), dry density (kg/m^3), degree of peat humification $H_{1\text{–}10}$, amorphous and organic material (%), ash content (%) and element concentrations (ppm). Mean values (x) are shown in bold, followed by standard deviations, maximum and minimum values and frequencies (n).

Plant species		W %	kg/ m^3	H_{1-10}	Amorfic %	Org. %	Ash %	pH	mV	Al	Ca	Mn	Cu	Mg	Na	Pb	K	Zn	Fe	P	Fe/Mn	Ca/ Mg	Ca/ K	Cu/Zn	Na/K	Fe/P	Sites
Lignin (total)	**x**	**88,8**	**101,5**	**3,9**	**45,7**	**9,8**	**8,9**	**4,98**	**115**	**2866**	**5061**	**218**	**16**	**945**	**158**	**6**	**309**	**31**	**9508**	**693**	**138**	**5,9**	**44**	**1,1**	**1,0**	**20**	
	sd	5,2	60,4	1,3	19,7	3,1	12,0	0,92	113	3303	5038	1119	22	809	292	9	547	48	20819	590	200	4	51	2	0,8	38	
	max	96,5	717,0	9,0	91,2	26,2	88,7	6,8	375	35505	40226	18666	257	6145	5217	74	4733	436	228961	8540	2533	63	331	26	8	485	
	min	45,7	26,0	1,0	0,1	3,5	0,8	2,9	-195	84	89	1	1	11	4	0	7	1	104	63	0,3	0,2	0,4	0,0	0,0	0,2	
	n	707	705	713	340	704	706	716	469	681	678	675	680	681	670	664	682	681	681	451	675	678	678	679	670	450	70
Alnus spp.	**x**	**89,5**	**98,1**	**4,3**	**31,9**	**9,3**	**11,1**	**5,40**	**-5**	**2360**	**5378**	**248**	**19**	**1573**	**136**	**6**	**634**	**83**	**25783**	**515**	**109**	**4**	**41**	**1,1**	**0,8**	**63**	
	sd	2,4	25,6	1,2	16,2	1,9	7,4	0,36	77	1864	2695	116	18	612	70	11	1875	140	21648	265	57	1	42	3	0,6	64	
	max	94,1	179,0	6,0	85,2	15,6	35,8	6,0	260	6182	15286	591	96	3763	403	48	9962	672	117506	1319	261	7	235	16	2	323	
	min	81,6	38,4	1,0	9,1	5,7	1,6	4,3	-160	141	1023	33	3	336	53	0	59	5	64	5	0,4	0,9	0,4	0,0	0,0	0,3	
	n	29	29	29	22	29	29	27	29	29	29	29	28	29	26	29	29	29	29	29	29	29	29	29	29	29	9
A. glutinosa	**x**	**89,5**	**94,7**	**4,3**	**43,2**	**9,2**	**11,2**	**5,40**	**9**	**3008**	**3573**	**131**	**19**	**895**	**198**	**30**	**4251**	**243**	**17700**	**493**	**263**	**4**	**18**	**0,5**	**0,7**	**35**	
	sd	1,9	22,3	0,9	9,6	1,2	10,2	0,36	76	2149	1393	70	11	520	154	54	5830	308	20124	482	490	1	22	0,5	0,8	26	
	max	92,1	166,8	6,0	64,7	12,1	36,2	6,0	180	10711	6557	315	50	2375	736	280	16841	821	76020	1607	2510	7	70	2	3	106	
	min	83,4	64,2	3,0	27,7	7,2	4,1	4,3	-85	1047	1018	28	9	396	50	0	38	8	63	2	0,3	2	0,2	0,0	0,0	12	
	n	27	27	27	20	27	27	27	20	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	27	7
A. incana	**x**	**86,7**	**135,5**	**3,9**	**42,6**	**8,8**	**20,2**	**5,40**	**100**	**3436**	**5025**	**249**	**21**	**1270**	**291**	**33**	**3456**	**158**	**8455**	**531**	**87**	**4**	**24**	**0,7**	**0,7**	**57**	
	sd	8,5	114,8	1,4	18,1	1,5	24,5	0,54	171	3232	3374	487	12	874	300	72	6046	253	10211	489	99	1	37	0,7	0,7	126	
	max	93,1	489,4	6,0	70,3	12,1	78,6	6,8	315	12577	15263	1923	46	3577	915	280	16841	676	30580	1764	265	7	142	3	2	485	
	min	61,1	60,4	1,0	13,4	6,5	1,9	4,6	-170	293	2485	23	4	365	38	0	20	8	66	2	0,3	2	0,2	0,0	0,0	1	
	n	14	14	14	10	14	14	14	13	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	8
***Betula* spp.**	**x**	**89,1**	**98,1**	**3,7**	**41,7**	**9,7**	**11,1**	**5,40**	**83**	**2265**	**6601**	**319**	**19**	**1230**	**218**	**7**	**383**	**32**	**11647**	**703**	**126**	**6**	**55**	**1,2**	**1,1**	**33**	
	sd	5,4	56,5	1,1	19,3	6,8	12,9	0,87	105	3206	4663	1222	23	827	427	10	601	47	15731	586	406	4	65	2	0,9	59	
	max	96,0	489,4	7,0	89,8	89,7	78,6	6,8	330	35505	21245	14983	211	6145	5217	59	3850	347	117506	5162	5304	24	328	16	4	485	
	min	61,1	29,0	1,0	0,1	3,6	0,9	3,2	-160	94	357	3	2	59	4	0	19	1	377	63	0,6	0,0	0,0	0,0		0,7	
	n	188	187	187	99	186	189	189	127	181	181	181	180	181	178	181	181	181	181	120	182	182	182	182	181	120	42
B. pendula	**x**	**89,8**	**69,2**	**3,5**	**30,3**	**9,4**	**7,5**	**4,60**	**167**	**3398**	**4524**	**374**	**24**	**1045**	**151**	**10**	**1077**	**35**	**12083**	**786**	**74**	**4**	**21**	**0,9**	**0,7**	**68**	
	sd	3,4	37,1	1,6	13,6	3,1	7,3	0,76	102	4264	3034	568	30	344	79	10	1109	19	10229	489	66	3	31	0,9	1,1	157	
	max	94,5	171,5	5,0	46,4	15,3	25,2	5,5	305	12577	11922	1923	99	1660	295	34	2917	57	30580	1421	166	9	81	3	4	485	
	min	82,0	36,0	1,0	13,4	5,3	1,3	3,2	45	345	1334	69	5	557	54	0	69	8	218	63	0,4			0,1	0,1	0,3	
	n	13	13	13	4	13	13	13	9	10	9	10	10	10	10	10	10	10	10	9	10	10	10	10	10	9	10
B. pubescens	**x**	**90,3**	**82,4**	**3,8**	**39,7**	**8,8**	**7,9**	**5,10**	**80**	**2332**	**4910**	**328**	**14**	**1016**	**151**	**15**	**1749**	**113**	**12153**	**551**	**119**	**5**	**30**	**0,7**	**0,8**		
	sd	2,7	29,9	1,4	17,9	2,2	7,9	0,80	116	2573	4423	1617	18	859	111	29	3551	232	26688	389	221	3	35	0,8	0,7		
	max	95,1	190,2	9,0	87,6	17,7	47,7	6,8	330	13074	30069	18666	184	5116	736	280	16841	821	217411	1817	2447	18	174	5	4		
	min	81,1	26,0	1,0	1,8	1,5	0,9	0,5	-180	10	179	2	2	10		0	10	1	10	2	0,4			0,0	-0,3		
	n	146	147	148	84	147	146	148	112	140	137	139	139	139	138	137	140	139	140	116	139	139	138	139	140		45
Juniperus communis	**x**	**88,7**	**89,5**	**2,6**	**25,7**	**9,3**	**17,5**	**5,79**	**87**	**4239**	**7024**	**616**	**20**	**2013**	**227**	**16**	**1148**	**72**	**42981**	**547**	**94**	**4**	**13**	**0,4**	**0,4**	**186**	
	sd	1,8	26,5	1,4	14,1	1,6	10,9	0,94	130	4835	4536	611	17	1207	140	16	1338	80	43963	467	87	0,9	11	0,3	0,3	184	
	max	90,8	124,0	4,0	51,1	11,9	32,2	6,8	240	12577	15263	1923	53	3763	403	39	3850	241	117506	1319	201	6	29	0,9	0,7	485	
	min	85,2	40,5	1,0	13,4	7,2	5,5	4,1	-40	94	3095	154	4	562	80	0	155	13	271	63	2	3	1	0,1	0,0	0,4	
	n	7	7	7	6	7	7	7	6	7	7	7	7	7	6	7	7	7	7	6	7	7	7	7	7	6	5
Picea abies	**x**	**88,2**	**107,5**	**3,7**	**39,7**	**9,7**	**12,0**	**5,22**	**86**	**2362**	**5893**	**277**	**16**	**1308**	**245**	**13**	**1525**	**110**	**10988**	**738**	**108**	**5**	**35**	**0,9**	**0,8**	**24**	
	sd	6,1	73,6	1,2	18,5	3,3	15,7	0,84	127	3659	5383	758	15	997	533	17	2917	221	16138	798	145	2	51	2	0,8	39	
	max	95,4	544,8	8,0	85,2	26,2	78,6	6,8	315	35505	40226	6843	115	5116	5217	109	12154	820	117506	5162	899	14	285	9	4	323	
	min	56,0	29,1	1,0	0,1	4,5	1,2	3,2	-195	115	746	2	3	206	26	0	18	1	64	4	0,3	0,0	0,0	0,0	0,0	0,3	
	n	110	110	110	73	110	110	110	85	109	108	110	110	110	108	107	110	110	110	85	110	110	110	110	110	85	42
Pinus sylvestris	**x**	**89,9**	**81,6**	**3,3**	**39,7**	**9,3**	**6,5**	**4,66**	**144**	**2238**	**4953**	**293**	**13**	**914**	**171**	**8**	**533**	**34**	**6924**	**662**	**132**	**6**	**43**	**0,9**	**1,0**	**19**	
	sd	4,2	38,9	1,4	19,3	3,5	7,4	0,98	93	3480	5471	1543	19	791	426	11	867	42	18996	604	251	4	63	1,3	1,1	57	
	max	96,5	269,0	8,0	77,8	26,2	43,8	6,7	320	35505	35839	18666	184	4282	5217	74	4733	347	208053	5162	2533	24	314	8	8	485	
	min	69,8	29,1	1,0	1,2	3,5	0,8	3,0	-180	94	123	1	1	25	20	0	7	1	122	63	0,3	0,0	0,0	0,0	0,0	0,3	
	n	171	170	170	54	171	171	170	102	166	165	166	166	166	166	163	166	166	166	92	166	166	166	166	166	92	55

Rubus idaeus	x	**72,1**	**338,8**	**4,5**	**60,1**	**10,0**	**44,5**	**5,35**	**155**	**3709**	**4829**	**813**	**30**	**1648**	**335**	**9**	**372**	**25**	**9020**	**451**	**19**	**4**	**37**	**1,3**	**1,2**	35	
	sd	20,8	288,7	0,7	5,1	3,3	53,2	0,21	92	1199	972		27	892	288	11	410	23	9476			3	43	0,1	0,6		
	max	86,8	542,9	5,0	63,7	12,3	82,1	5,5	220	4557	5516	813	49	2278	538	16	662	41	15720		19	5	67	1	2		
	min	57,4	134,6	4,0	56,5	7,6	6,8	5,2	90	2861	4142	813	11	1017	131	1	82	8	2319		19	2	6	1	0,8		
	n	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	1,0	2	2	2	2	1,0	2
***Salix* spp.**	x	**82,0**	**129,9**	**4,7**	**0,1**	**13,6**	**16,8**	**4,47**	**130**	**9025**	**2681**	**60**	**24**	**626**	**78**	**11**	**1078**	**39**	**13257**		**225**	**5**	**3**	**0,6**	**0,1**		
	sd	9,0	130,8	2,5		2,1	23,5	0,71		12292	506	4	19	223	37	15	460	6	4455		88	2	2	0,4	0,0		
	max	87,4	279,6	7,0		15,9	43,9	5,1		17717	3039	62	37	784	104	21	1403	43	16407		288	6	4	0,9	0,1		
	min	71,6	38,0	2,0		11,9	1,3	3,7		333	2323	57	10	468	51	0	752	34	10106		163	3	2	0,3	0,1		
	n	3	3	3	1	3	3	3	1	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		3
Salix aurita	n=1	**89,3**	**64,2**	**3,0**		**9,3**	**13,5**	**4,80**	**180**	**1588**	**3218**	**163**	**22**	**1254**	**142**	**0**	**1789**	**37**	**27254**	**1040**	**167**	**3**	**2**	**0,6**	**0,1**	**26**	1
S. caprea	n=1	**90,2**	**65,5**	**2,0**		**9,2**	**6,0**	**3,60**	**305**	**1204**	**2469**	**141**	**7**	**963**	**132**	**19**	**2529**	**57**	**3854**	**1338**	**27**	**3**	**1,0**	**0,1**	**0,1**	**3**	1
S. glauca	n=1	**56,0**	**544,8**	**6,0**		**12,0**	**72,8**	**4,70**	**170**	**5128**	**2198**	**109**	**36**	**1648**	**586**	**14**	**732**	**80**	**3004**	**4583**	**28**	**1**	**3**	**0,5**	**0,8**	**0,7**	1
S. myrsinites	n=1	**87,4**	**40,5**	**1,0**		**11,9**	**5,5**	**4,10**		**94**	**5656**	**711**	**4**	**1792**	**80**	**5**	**3850**	**49**	**4983**		**7**	**3**	**1,5**	**0,1**	**0,02**		1
Nanolignin (total)	**x**	**90,7**	**76,8**	**3,5**	**31,6**	**8,8**	**4,8**	**4,60**	**148**	**1307**	**4594**	**128**	**8**	**866**	**121**	**8**	**332**	**25**	**6488**	**496**	**174**	**5**	**42**	**0,7**	**1,1**	18	
	sd	3,1	32,0	1,2	17,7	2,7	5,6	0,96	105	1782	6035	817	9	811	93	10	621	28	14638	277	207	4	54	1,2	1,1	36	
	max	96,5	279,7	9,0	78,7	19,4	68,8	6,8	425	17717	40258	18666	96	5116	915	74	4733	309	217411	2503	2533	25	470	16	16	485	
	min	71,6	22,3	1,0	0,1	3,5	0,8	2,9	-180	29	123	1	1	39	4	0	5	1	32	28	0,3	0,0	0,0	0,0	0,0	0,0	
	n	592	590	592	249	592	593	588	427	565	563	559	563	564	562	552	565	566	564	427	558	563	563	566	563	426	53
Andromeda polifolia	x	**90,7**	**71,4**	**3,4**	**30,4**	**8,9**	**3,7**	**4,38**	**178**	**1351**	**3346**	**78**	**8**	**709**	**114**	**7**	**396**	**32**	**3990**	**485**	**152**	**5**	**37**	**0,5**	**1,1**	**12**	
	sd	3,2	30,9	1,3	17,9	2,9	3,2	0,89	90	1518	3989	124	9	634	84	11	727	33	5119	293	170	3	56	1,0	1,1	14	
	max	96,5	185,6	6,0	78,7	19,4	24,3	6,7	425	10105	23516	921	60	4039	495	59	4733	309	36516	2503	1076	23	470	7	8	82	
	min	74,8	22,3	1,0	0,3	3,5	0,8	2,9	-85	29	123	2	1	39	24	0	7	2	32	28	0,6	0,2	0,4	0,0	0,0	0,4	
	n	228	226	229	52	228	229	226	123	207	207	206	205	207	206	205	207	207	207	120	206	207	207	207	206	120	42
Betula nana	x	**90,2**	**75,3**	**3,1**	**31,3**	**9,3**	**5,1**	**4,68**	**132**	**1003**	**4841**	**111**	**8**	**978**	**125**	**15**	**1321**	**108**	**8092**	**448**	**155**	**6**	**39**	**0,6**	**0,7**	**23**	
	sd	2,7	25,9	1,3	16,7	2,5	3,9	0,96	112	1237	4158	126	8	713	73	19	2456	244	13099	293	181	5	62	1,0	0,9	44	
	max	95,4	144,3	6,0	78,7	17,3	28,3	6,5	330	8089	22216	711	42	4039	407	109	9198	875	90044	1485	791	25	331	7	4	323	
	min	82,3	31,0	1,0	0,3	4,4	1,2	3,1	-90	94	709	3	2	192	35	0	39	3	34	2	0,2	2	0,3	0,0	0,0	0,3	
	n	87	87	87	51	87	87	87	67	82	81	82	82	81	80	82	82	82	82	72	82	81	81	82	82	72	32
Calluna vulgaris	x	**89,4**	**74,4**	**2,4**	**32,5**	**9,9**	**5,9**	**3,49**	**259**	**1709**	**2142**	**162**	**5**	**663**	**111**	**15**	**785**	**41**	**14096**	**416**	**264**	**4**	**9**	**0,3**	**0,4**	**30**	
	sd	2,9	36,4	1,3	22,1	2,2	9,9	0,73	74	2947	678	217	5	279	110	13	962	33	33496	153	252	1	7	0,6	0,3	63	
	max	91,9	124,0	5,0	60,9	14,4	28,3	5,1	330	8089	3095	467	16	1029	351	39	2555	98	90044	621	668	6	19	2	0,8	159	
	min	85,2	39,0	1,0	13,4	8,0	1,5	3,0	130	152	832	2	1	174	43	2	56	5	253	277	1,4	2	0,9	0,0	0,0	0,6	
	n	7	7	7	5	7	7	7	6	7	7	7	7	7	7	7	7	7	7	6	7	7	7	7	7	6	3
Chamaedaphne calyculata	x	**89,4**	**73,9**	**3,3**	**13,4**	**10,1**	**3,9**	**3,69**	**287**	**1602**	**1998**	**48**	**6**	**566**	**196**	**10**	**565**	**35**	**2157**	**515**	**88**	**4**	**8**	**0,2**	**0,8**	**3**	
	sd	5,2	39,9	1,8	16,4	4,6	4,3	0,88	71	2882	1449	58	3	226	118	8	651	13	3551	309	79	2	11	0,3	0,8	4	
	max	95,2	174,9	7,0	47,8	19,1	15,7	5,5	350	11173	5464	189	12	968	398	31	2644	60	13901	1156	226	10	44	1	2	12	
	min	77,3	36,2	1,0	0,4	4,7	1,1	2,9	93	197	707	3	1	168	43	0	85	11	280	201	4	1	1	0,0	0,0	0,6	
	n	15	15	15	7	15	15	14	12	15	15	15	15	15	15	15	15	15	15	10	15	15	15	15	15	10	8
***Empetrum* spp.**	x	**89,5**	**70,7**	**3,2**	**25,3**	**9,9**	**4,8**	**4,27**	**203**	**935**	**5906**	**119**	**8**	**1214**	**116**	**9**	**618**	**26**	**4315**	**465**	**122**	**4**	**43**	**0,7**	**0,6**	**14**	
	sd	3,3	39,2	1,4	21,7	2,9	7,6	1,13	107	1347	9160	171	9	1111	118	11	836	20	10060	343	272	2	83	1	0,6	25	
	max	95,0	279,7	7,0	73,2	18,9	68,8	6,8	400	8089	40226	921	54	4517	915	74	3850	98	90044	2503	2533	17	470	7	4	159	
	min	75,7	24,0	1,0	0,1	4,4	0,4	2,9	-10	48	419	1	1	66	16	0	13	3	74	77	0	1	0,7	0,0	0,0	0,3	
	n	112	112	111	40	112	112	112	89	100	100	99	100	100	100	92	100	100	100	83	99	100	100	100	100	83	36
Ledum palustre	x	**89,9**	**58,3**	**2,5**	**21,6**	**13,8**	**2,9**	**3,97**	**200**	**449**	**5270**	**80**	**12**	**1264**	**90**	**10**	**946**	**35**	**950**	**406**	**98**	**4**	**62**	**1,4**	**0,3**	**3**	
	sd	2,7	20,4	1,2	12,8	18,1	2,1	1,05	99	330	6152	109	14	998	46	7	1010	26	835	219	113	2	114	3	0,3	3	
	max	93,6	96,6	5,0	36,0	89,7	7,1	6,2	390	1333	17505	388	51	3184	191	27	2973	105	3302	855	337	10	304	7	1,2	11	
	min	82,4	29,0	1,0	1,2	6,4	0,9	3,0	10	90	833	3	2	140	35	0	51	5	122	142	0,3	1,3	0,7	0,0	0,0	0,3	
	n	20	20	20	9	20	20	20	17	18	18	18	18	18	18	18	18	18	18	17	18	18	18	18	18	17	11
***Vaccinium* spp.**	n=1	**89,5**	**51,2**	**3,0**		**10,2**	**2,8**	**3,60**	**150**	**248**	**2750**	**35**	**6**	**672**	**64**	**16**	**994**	**38**	**438**	**454**	**13**	**4**	**3**	**0,2**	**0,1**	**1,0**	1
V. microcarpum	x	**90,1**	**59,9**	**2,7**	**15,4**	**9,5**	**3,4**	**3,81**	**271**	**1116**	**3870**	**161**	**8**	**939**	**107**	**10**	**588**	**29**	**2920**	**336**	**103**	**4**	**25**	**0,6**	**0,5**	**23**	
	sd	3,1	25,3	1,4	13,6	3,0	5,1	1,01	73	3011	6607	381	12	912	62	9	620	20	6637	219	136	4	66	1,4	0,6	95	
	max	94,3	122,9	6,0	49,5	17,3	25,2	6,8	400	12577	30069	1923	46	4426	295	34	2168	78	30580	1211	422	17	331	7	3	485	
	min	82,3	28,5	1,0	1,2	5,6	0,4	3,0	80	48	419	3	1	66	31	0	19	4	52	63	0,3	1,0	1,2	0,0	0,0	0,2	
	n	29	29	29	18	29	29	29	25	26	26	26	26	26	26	24	26	26	26	26	26	26	26	26	26	26	11

V. myrtillus	**x**	**88,2**	**92,8**	**2,6**	**35,3**	**10,2**	**9,4**	**4,37**	**211**	**2111**	**4759**	**516**	**11**	**1542**	**164**	**13**	**1387**	**33**	**6860**	**857**	**93**	**3**	**12**	**0,5**	**0,4**	**7**	
	sd	3,4	49,4	1,1	23,3	2,7	12,2	1,22	72	3485	5179	1024	8	1414	121	12	1003	23	7823	379	152	2	27	0,3	0,6	9	
	max	95,4	190,2	4,0	64,6	15,0	47,7	6,8	305	13074	15263	3820	31	5116	500	34	2924	81	27254	1338	550	9	98	1,0	2	26	
	min	81,1	39,0	1,0	0,1	4,5	1,4	3,2	110	293	498	14	3	336	63	0	56	3	271	320	1	0,0	0,0	0,1	0,04	0,4	
	n	13	13	13	7	13	13	13	9	13	12	13	13	13	13	13	13	13	13	6	13	13	13	13	13	6	11
V. oxycoccos	**x**	**91,3**	**66,6**	**3,1**	**31,0**	**8,3**	**4,3**	**4,63**	**130**	**809**	**3639**	**116**	**7**	**783**	**138**	**7**	**454**	**22**	**7342**	**477**	**147**	**5**	**35**	**0,6**	**1,2**	**19**	
	sd	2,9	23,3	1,1	16,1	2,6	3,8	0,90	104	1156	2636	219	7	484	91	7	845	22	16660	252	142	3	35	0,8	1,0	42	
	max	95,6	155,7	6,0	67,5	17,3	33,4	6,7	425	12577	14995	1923	56	3631	658	40	4733	162	217411	1485	777	19	237	9	7	485	
	min	74,8	23,3	1,0	0,3	4,4	1,0	3	-85	29	386	2	1	61	4	0	8	2	32	28	0,3	1	0,37	0,0	0,0	0,3	
	n	214	214	215	107	214	215	211	153	201	201	201	200	201	201	200	201	202	201	162	200	200	200	202	201	161	44
V. uliginosum	**x**	**89,1**	**62,0**	**2,3**	**16,0**	**10,4**	**3,9**	**3,67**	**245**	**865**	**2971**	**182**	**7**	**902**	**127**	**15**	**1277**	**38**	**4931**	**584**	**87**	**3**	**6**	**0,3**	**0,3**	**12**	
	sd	3,3	31,2	1,4	16,3	3,1	5,3	0,60	70	1559	4054	220	4	699	85	12	1224	20	17452	322	123	2	11	0,4	0,3	39	
	max	94,5	141,3	5,0	51,1	17,1	28,3	5,6	390	8089	22410	921	22	3941	351	53	4733	98	90044	1338	437	10	49	2	1,2	159	
	min	82,4	29,9	1,0	1,0	5,5	0,9	2,9	130	133	828	3	2	140	31	1	43	4	122	208	0,3	1,3	0,4	0,1	0,0	0,3	
	n	28	28	28	10	28	28	28	21	26	26	26	26	26	26	26	26	26	26	16	26	26	26	26	26	16	17
V. vitis-idaea	**x**	**89,2**	**52,3**	**2,1**	**13,0**	**10,4**	**4,2**	**4,28**	**214**	**400**	**6709**	**289**	**6**	**1624**	**107**	**9**	**1700**	**47**	**2612**	**503**	**29**	**3**	**20**	**0,2**	**0,2**	**7**	
	sd	3,7	11,4	1,3	13,6	3,6	2,4	1,26	81	421	8473	290	2	1285	68	7	1325	27	5478	245	48	1,4	30	0,1	0,4	15	
	max	94,4	77,5	5,0	33,2	17,1	8,7	6,8	280	1720	30069	921	9	4426	281	19	3850	105	20338	855	170	7	84	0,5	1,1	46	
	min	82,4	38,4	1,0	1,2	5,5	1,3	3,0	10	84	1334	3	3	348	36	0	52	11	122	229	0,3	2	0,7	0,1	0,02	0,3	
	n	13	13	13	5	13	13	13	9	13	13	13	13	13	13	10	13	13	13	9	13	13	13	13	13	9	11
***Carex* (total)**	**x**	**89,5**	**96,4**	**3,8**	**44,0**	**9,3**	**7,8**	**4,99**	**112**	**2461**	**5043**	**170**	**14**	**891**	**140**	**6**	**256**	**27**	**8630**	**630**	**160**	**6**	**46**	**1,0**	**1,1**	**18**	
	sd	4,8	55,5	1,2	18,4	2,9	10,4	0,83	104	3088	5543	973	19	813	183	9	484	43	18401	422	209	4	51	2	0,8	27	
	max	96	717	9	91,2	20,59	88,7	7,6	425	35505	40258	18666	257	6145	4360	74	4733	436	228961	5162	2533	63	470	26	8	323	
	min	45,7	22	1	0,1	3,61	0,8	2,9	-195	70	89	1	1	11	4	0	7	1	104	89	0,3	0,2	0,4	0,0	0,0	0,2	
	n	897	894	908	437	895	898	905	620	872	863	859	870	871	862	859	872	871	871	618	858	862	862	868	862	616	71
***Carex* spp.**	**x**	**89,4**	**97,2**	**3,9**	**44,4**	**9,4**	**7,8**	**5,02**	**109**	**2558**	**5050**	**171**	**14**	**887**	**141**	**6**	**233**	**28**	**8914**	**642**	**162**	**6**	**47**	**1,0**	**1,1**	**18**	
	sd	4,7	53,6	1,1	18,3	2,9	10,2	0,81	104	3326	5537	985	19	811	186	9	438	46	18685	464	210	4	51	2	0,8	27	
	max	96,0	717,0	9,0	91,2	20,6	88,7	7,6	425	35505	40258	18666	257	6145	4360	74	4733	436	228961	5162	2533	63	470	26	8	323	
	min	45,7	22,0	1,0	0,1	3,6	0,8	2,9	-195	70	89	1	1	11	4	0	7	1	104	89	0,6	0,2	0,4	0,0	0,0	0,2	
	n	873	872	884	431	871	874	882	599	848	838	836	846	847	838	836	848	846	848	605	835	837	837	843	838	604	69
C. aquatilis	**x**	**89,9**	**95,9**	**3,8**	**45,3**	**9,0**	**10,1**	**5,55**	**31**	**4192**	**5797**	**139**	**27**	**1121**	**186**	**7**	**222**	**48**	**13120**	**784**	**130**	**5**	**67**	**2**	**1,2**	**22**	
	sd	2,5	28,3	0,9	10,5	2,0	8,8	0,56	81	6330	4270	85	39	667	177	8	269	95	12124	857	157	2	87	4	0,6	24	
	max	94,6	174,3	6,0	69,6	12,6	43,8	6,6	160	35505	17083	333	211	2491	736	35	1192	347	63861	5162	899	10	314	16	2	106	
	min	84,6	50,1	3,0	25,3	5,2	4,1	3,6	-160	224	1811	24	3	444	50	0	38	5	1944	240	20,6	2	4	0,06	0,26	3	
	n	30	30	30	23	30	30	30	27	30	27	30	30	30	30	30	30	30	30	30	30	27	27	30	30	30	14
C. buxbaumii	**x**	**86,7**	**129,6**	**4,3**		**13,0**	**4,2**	**4,93**		**3882**	**3580**	**22**	**13**	**633**	**91**		**85**	**24**	**3729**		**181**	**6**	**46**	**1,1**	**1,1**		
	sd	0,7	13,2	0,6		0,7	0,2	0,15		49	557	8	7	141	15		23	25	1048		41	0,4	22	0,8	0,3		
	max	87,5	142,9	5,0		13,7	4,3	5,1		3929	4222	27	21	796	108		102	53	4791		225	6	72	2	1,4		
	min	86,1	116,6	4,0		12,3	4,0	4,8		3831	3230	12	9	550	82		59	5	2696		142	5	32	0,2	0,9		
	n	3	3	3		3	3	3		3	3	3	3	3	3		3	3	3		3	3	3	3	3		1
C. canescens	**x**	**86,9**	**129,0**	**4,0**	**42,9**	**10,4**	**15,3**	**5,10**	**97**	**2926**	**5758**	**463**	**18**	**1298**	**206**	**12**	**651**	**42**	**14911**	**909**	**150**	**4**	**39**	**1,2**	**0,7**	**19**	
	sd	5,2	67,2	1,2	17,7	2,5	16,1	0,66	113	2661	4683	2366	16	871	192	12	1594	80	29263	567	244	2	69	2	0,5	32	
	max	94,5	489,4	9,0	76,3	15,6	78,6	6,4	315	12022	18561	18666	99	3631	915	59	12154	593	208053	2485	1789	10	331	7	2	227	
	min	61,1	48,7	2,0	8,7	5,3	1,4	3,5	-195	158	498	6	2	254	35	0	49	3	67	4	0,4	1	0,3	0,03	0,01	1,4	
	n	62	63	66	48	62	62	65	61	62	61	62	62	62	62	62	62	62	62	58	62	61	61	62	62	58	30
C. cespitosa	**x**	**88,8**	**106,7**	**3,5**	**37,8**	**9,4**	**14,7**	**5,80**	**160**	**1940**	**12775**	**3343**	**18**	**2480**	**177**	**17**	**777**	**47**	**38492**	**892**	**28**	**6**	**36**	**1,0**	**0,7**	**48**	
	sd	3,2	32,3	1,2	17,3	2,6	13,5	0,97	60	1824	5698	7511	7	1414	108	15	730	62	83200	198	35	2	37	0,8	0,9	100	
	max	94,9	145,3	5,0	55,1	11,8	41,6	6,8	230	4723	19424	18666	29	3856	335	41	1981	167	208053	1225	94	10	108	2	2	227	
	min	86,4	54,7	2,0	17,8	4,9	6,1	4,1	76	293	2606	52	11	495	88	0	93	8	271	742	1,1	4	8	0,1	0,04	0	
	n	6	6	6	5	6	6	6	5	6	6	6	6	6	6	6	6	6	6	5	6	6	6	6	6	5	4
C. chordorrhiza	**x**	**90,7**	**83,7**	**3,8**	**45,5**	**8,6**	**6,8**	**5,29**	**91**	**2462**	**5181**	**279**	**13**	**771**	**150**	**6**	**202**	**23**	**9859**	**711**	**121**	**7**	**50**	**1,0**	**1,3**	**18**	
	sd	3,1	31,5	1,1	17,5	2,7	5,9	0,74	90	2235	4955	1580	10	643	94	10	276	25	20614	302	107	5	49	1	0,9	24	
	max	95,6	201,9	9,0	84,2	17,7	51,4	6,8	260	15428	39737	14983	60	4426	450	56	1793	208	228961	1846	541	63	304	12	7	164	
	min	80,3	22,3	2,0	2,5	4,1	1,7	3,1	-195	84	179	2	3	26	14	0	27	2	253	228	4,6	2	0,7	0,1	0,0	0,5	
	n	175	175	178	70	175	175	179	86	169	168	169	169	169	167	167	169	169	169	98	169	168	168	169	169	98	35
C. diandra	**x**	**91,4**	**81,1**	**3,6**	**35,3**	**7,9**	**7,6**	**5,78**	**35**	**1888**	**7116**	**171**	**18**	**1109**	**193**	**3**	**199**	**19**	**9522**	**625**	**88**	**7**	**68**	**2**	**1,5**	**22**	
	sd	3,1	37,0	1,0	13,2	2,6	4,6	0,77	91	2254	4553	118	35	633	115	5	397	14	8629	181	76	3	61	4	0,8	16	
	max	95,6	229,9	7,0	63,2	15,0	24,3	6,8	280	9924	17083	394	211	2491	658	25	2632	58	30422	1009	250	12	237	16	3	56	
	min	82,2	39,7	2,0	9,1	4,1	3,4	3,6	-90	124	498	5	4	183	76	0	54	5	724	316	5	1	1	0,1	0,3	2	
	n	41	41	41	20	41	41	40	22	41	41	41	41	41	41	41	41	41	41	24	41	41	41	41	41	24	13
C. dioica	**x**	**87,4**	**126,6**	**3,5**	**45,5**	**9,3**	**25,1**	**5,20**	**44**	**919**	**11810**	**9799**	**18**	**1854**	**223**	**29**	**697**	**100**	**109536**	**845**	**11**	**6**	**29**	**0,2**	**0,4**	**121**	
	sd	1,3	26,5	0,7	5,2	2,0	23,3	0,28	46	558	1278	12540	11	195	159	17	615	95	139324	99	0,48	1	28	0,1	0,1	151	
	max	88,3	145,3	4,0	49,1	10,7	41,6	5,4	76	1313	12714	18666	25	1992	335	41	1132	167	208053	915	12	7	49	0,3	0,4	227	
	min	86,4	107,8	3,0	41,8	8,0	8,6	5,0	11	524	10906	932	10	1716	110	17	262	33	11019	775	11	5	10	0,1	0,3	14	
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1

C. echinata	x	**86,2**	**126,3**	**3,5**	**60,1**	**11,7**	**14,7**	**5,58**	**43**	**6310**	**10310**	**254**	**67**	**1814**	**181**	**16**	**263**	**35**	**22963**	**817**	**84**	**6**	**95**	**6**	**1,0**	**37**	
	sd	1,5	18,8	1,0	10,9	1,3	7,2	0,56	92	3603	6110	152	76	1054	89	13	206	33	33778	312	87	1,1	108	8	0,5	61	
	max	88,9	141,1	5,0	71,1	13,0	28,3	6,3	130	11754	17083	464	211	2716	351	39	534	98	90044	1158	198	7	235	16	2	159	
	min	84,8	93,8	2,0	43,2	10,2	8,1	5,1	-90	2301	2652	73	16	368	98	5	65	6	2692	488	14	4	6	0,2	0,3	2	
	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	3
C. elongata	n=1	**91,9**	**65,2**	**2,0**		**7,3**	**20,9**	**5,10**		**519**	**5112**	**55**	**44**	**995**	**364**	**8**	**1636**	**55**	**787**		**14**	**5**	**3**	**0,8**	**0,2**		1
C. flava	x	**88,6**	**110,4**	**4,1**	**47,5**	**9,7**	**13,1**	**5,72**	**79**	**3889**	**11230**	**1256**	**36**	**1681**	**128**	**8**	**627**	**66**	**25549**	**743**	**184**	**8**	**77**	**2**	**0,7**	**32**	
	sd	3,3	41,3	1,3	21,6	2,1	11,9	0,51	72	3385	6694	4236	39	1154	67	11	1132	96	67935	406	581	3	84	2	0,4	79	
	max	93,5	225,4	7,0	72,8	14,5	50,1	6,4	166	11512	35081	18666	184	3988	335	41	3850	436	228045	1207	2533	12	331	7	2	227	
	min	79,6	40,5	1,0	17,4	6,0	5,5	4,1	-55	94	5656	1	4	610	35	0	56	4	580	215	2	3	1,5	0,1	0,0	2	
	n	19	19	19	7	19	19	19	8	19	19	19	19	19	18	18	19	19	19	8	19	19	19	19	19	8	6
C. globularis	x	**87,7**	**105,0**	**3,5**	**41,8**	**10,4**	**8,9**	**3,99**	**168**	**2690**	**2933**	**87**	**10**	**697**	**116**	**11**	**871**	**29**	**5161**	**1096**	**176**	**5**	**12**	**0,6**	**0,4**	**5**	
	sd	6,5	87,6	1,7	19,0	2,6	13,8	0,47	77	2826	2324	103	10	317	97	7	974	23	7623	961	275	3	14	0,8	0,3	5	
	max	93,6	544,8	7,0	65,9	17,1	72,8	4,9	305	12913	11262	467	49	1648	586	33	4733	105	35639	4583	1649	17	56	4	1,2	26	
	min	56,0	29,1	1,0	1,2	6,0	1,5	2,9	0	155	535	2	2	42	33	0	45	4	122	229	0,3	1,3	0,4	0,1	0,03	0,3	
	n	49	47	49	12	49	49	49	42	49	49	48	49	49	49	48	49	49	48	28	48	49	49	49	49	27	15
C. heleonastes	n=1	**85,9**	**150,9**	**5,0**	**69,5**	**10,6**	**24,7**	**5,30**	**-110**	**12684**	**2195**	**24**	**97**	**731**	**256**	**4**	**243**	**14**	**195**	**716**	**8**	**3**	**9**	**7**	**1,1**	**0,3**	1
C. lasiocarpa	x	**89,2**	**99,3**	**4,1**	**56,4**	**10,1**	**6,4**	**5,00**	**149**	**3862**	**4657**	**92**	**19**	**771**	**110**	**4**	**202**	**26**	**5714**	**653**	**149**	**7**	**51**	**2**	**1,1**	**11**	
	sd	3,2	32,3	1,2	17,2	2,9	5,2	0,79	95	2673	4378	116	20	724	92	8	464	34	9544	272	146	5	58	2	0,9	20	
	max	95,8	190,4	7,0	89,8	18,5	30,1	6,8	375	15428	23516	711	184	4282	552	55	3850	335	90044	1494	797	63	470	12	7	159	
	min	80,4	35,0	1,0	7,6	3,6	0,9	3,5	-160	94	179	2	1	26	14	0	7	1	229	171	2	2	0,6	0,1	0,0	1,3	
	n	172	171	179	64	171	173	180	96	165	165	165	165	165	162	164	165	165	165	87	166	166	166	166	165	88	31
C. laxa	n=1	**87,2**	**125,4**	**4,0**	**69,1**	**12,4**	**2,8**	**3,60**	**220**	**4063**	**1224**	**11**	**10**	**403**	**58**	**7**	**139**	**6**	**556**	**774**	**51**	**3**	**9**	**2**	**0,4**	**1**	1
C. limosa	x	**91,0**	**84,8**	**3,6**	**47,0**	**8,5**	**6,2**	**5,32**	**103**	**2302**	**5618**	**218**	**12**	**841**	**137**	**7**	**507**	**58**	**6860**	**537**	**135**	**7**	**51**	**1,0**	**1,3**	**17**	
	sd	3,3	32,5	0,9	17,0	2,8	5,4	0,80	83	2281	6199	1298	11	835	89	15	1635	160	9739	261	245	3	50	1,4	1,0	21	
	max	95,6	229,6	6,0	84,2	15,2	39,0	6,8	390	9924	39737	14983	50	6145	401	109	9198	875	92579	1211	2533	17	291	12	4	164	
	min	77,4	22,0	1,0	10,1	4,1	0,8	3,7	-85	124	352	1	1	25	13	0	27	2	75	3	0,8	2	0,3	0,0	0,0	0,4	
	n	134	134	136	55	134	134	137	76	132	132	132	132	132	132	130	132	132	132	83	132	132	132	132	132	83	31
C. livida	x	**88,5**	**112,7**	**2,5**	**56,0**	**9,4**	**19,2**	**5,75**	**130**	**1534**	**6503**	**7540**	**17**	**949**	**162**	**40**	**584**	**119**	**51034**	**776**	**52**	**6**	**10**	**0,3**	**0,3**	**87**	
	sd	1,7	30,4	0,7	7,0	2,6	11,0	0,07	7	1225	4993	10526	1	171	35	7	309	127	58754	299	65	4	3	0,3	0,1	109	
	max	89,7	134,2	3,0	60,9	11,3	26,9	5,8	135	2400	10033	14983	18	1070	187	45	802	208	92579	987	98	9	13	0,6	0,4	164	
	min	87,3	91,2	2,0	51,0	7,6	11,4	5,7	125	668	2972	97	16	828	137	35	365	29	9488	564	6	4	8	0,1	0,2	10	
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C. loliacea	n=1	**86,5**	**127,2**	**3,0**	**53,5**	**12,3**	**8,4**	**5,50**	**225**	**1496**	**19368**	**41**	**22**	**2992**	**95**	**19**	**307**	**9**	**3906**	**1034**	**95**	**6**	**63**	**2**	**0,3**	**4**	1
C. magellanica	x	**90,9**	**88,8**	**3,3**	**39,5**	**8,6**	**5,4**	**4,60**	**245**	**1642**	**3369**	**32**	**9**	**539**	**90**	**7**	**154**	**25**	**3001**	**640**	**201**	**6**	**44**	**1,0**	**0,9**	**5**	
	sd	2,4	22,5	0,7	20,0	2,2	2,5	0,67	145	1313	2595	45	6	200	52	6	187	41	3463	180	129	4	38	1	0,5	4	
	max	94,5	128,5	5,0	76,3	13,0	10,1	5,9	425	4594	8660	124	19	966	232	20	733	162	12423	1029	409	14	120	3	2	14	
	min	85,8	52,0	2,0	0,3	5,4	2,1	3,4	60	267	1170	4	3	236	48	0	24	4	878	481	16	3	4	0,02	0,3	2	
	n	14	14	16	11	14	14	17	13	14	14	14	14	14	14	14	14	14	14	10	14	14	14	14	14	10	6
C. nigra	x	**86,9**	**131,7**	**3,6**	**44,4**	**10,4**	**12,9**	**5,31**	**95**	**2875**	**7117**	**896**	**21**	**1365**	**151**	**10**	**274**	**29**	**15429**	**675**	**108**	**8**	**76**	**2**	**0,8**	**20**	
	sd	6,5	91,7	0,7	19,1	1,8	17,9	0,68	72	2254	6067	3875	16	1108	175	12	360	63	42195	399	102	12	94	3	0,5	46	
	max	92,1	542,9	5,0	83,1	14,9	82,1	6,7	225	8589	19368	18666	56	3248	736	41	1192	280	208053	1652	358	63	271	9	2	227	
	min	57,4	66,2	3,0	10,1	7,6	1,0	4,1	-70	323	748	7	2	48	31	0	27	4	310	187	11	2	3,0	0,1	0,1	0,7	
	n	25	24	26	22	24	25	25	26	24	24	23	24	24	24	24	24	24	24	23	23	24	24	24	24	23	17
C. pauciflora	x	**94,3**	**48,4**	**2,0**		**5,5**	**2,4**	**3,78**		**443**	**1795**	**25**	**5**	**483**	**157**	**10**	**338**	**37**	**1409**	**201**	**137**	**5**	**12**	**0,3**	**0,8**	**5**	
	sd	1,0	10,0	0,7		0,9	0,8	0,29		248	477	26	2	278	105	6	328	35	845		144	3	11	0,3	0,6		
	max	95,2	60,0	3,0		6,9	3,7	4,1		805	2592	68	8	877	330	21	864	96	2836	201	379	9	29	0,7	2		
	min	93,0	36,2	1,0		4,7	1,6	3,4		193	1399	4	3	205	56	5	49	7	780	201	13	3	3	0,0	0,2		
	n	5	5	5		5	5	4		5	5	5	5	5	5	5	5	5	5	1	5	5	5	5	5	1,0	4
C. pseudocyperus	x	**93,7**	**64,8**	**5,0**		**6,1**	**3,7**	**5,40**	**50**	**3044**	**5236**	**104**	**10**	**578**	**49**	**10**	**104**	**17**	**6125**	**618**	**2685**	**9**	**51**	**0,7**	**0,5**	**10**	
	sd	1,2	13,2	0,0		1,2	0,2	0,14	0	313	903	18	7	29	13	1	18	4	125	148	3704	1,1	0,0	0,6	0,2	2	
	max	94,5	74,1	5,0		7,0	3,8	5,5	50	3265	5874	116	15	598	58	11	116	19	6213	723	66	10	51	1,1	0,6	12	
	min	92,8	55,5	5,0		5,3	3,5	5,3	50	2823	4597	91	5	557	39	9	91	14	6036	513	54	8	51	0,3	0,3	9	
	n	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C. rariflora	n=1	**90,6**	**90,6**	**3,0**	**32,2**	**8,4**	**10,1**	**4,10**		**1011**	**1685**	**11**	**8**	**421**	**174**	**11**	**314**	**42**	**1235**	**596**	**112**	**4**	**5**	**0,2**	**0,6**	**2**	1
C. rhynchophysa	x	**87,4**	**120,2**	**5,0**		**12,4**	**4,3**	**5,05**		**1693**	**5978**	**50**	**21**	**1173**	**83**	**3**	**68**	**14**	**8610**		**60**	**9**	**51**	**0,7**	**0,5**		
	sd	0,1	3,9	0,0		0,1	0,4	0,07		333	865	8	4	155	13	1	0	1	1276		9	1,1	0,1	0,6	0,2		
	max	87,4	122,9	5,0			4,6	5,1		1928	6589	55	24	1282	92	3	68	14	9512		175	5	97	2	1,4		
	min	87,3	117,4	5,0			4,0	5,0		1457	5366	44	18	1063	74	2	68	13	7707		173	5	79	1,4	1,1		
	n	2	2	2		2	2	2		2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		1
C. rostrata	x	**90,6**	**84,8**	**4,0**	**43,1**	**8,7**	**7,0**	**5,15**	**89**	**2391**	**4707**	**94**	**15**	**801**	**142**	**5**	**170**	**28**	**10566**	**573**	**198**	**6**	**45**	**1,0**	**1,2**	**25**	
	sd	2,9	30,1	1,0	16,3	2,5	7,0	0,67	113	3372	3956	96	19	522	121	8	232	48	14830	465	273	4	36	1	0,8	39	
	max	95,8	229,9	7,0	89,8	18,5	43,8	6,8	390	35505	34929	464	184	3993	736	56	1636	347	98418	5162	2510	22	237	12	6	323	
	min	80,4	22,0	1,0	0,3	3,6	1,3	3,5	-170	88	498	1	1	48	-36	0	7	2	540	89	2,4	0,0	0,0	0,0	-0,3	1	
	n	184	185	191	102	184	184	191	143	174	168	173	172	173	169	173	174	174	174	142	173	173	173	174	172	142	33
C. vaginata	x	**86,7**	**121,9**	**3,3**	**54,5**	**11,2**	**11,3**	**5,41**	**88**	**3866**	**7442**	**284**	**24**	**1309**	**459**	**7**	**211**	**26**	**8066**	**847**	**68**	**6**	**59**	**2**	**1,4**	**7**	
	sd	5,3	31,2	0,6	10,4	2,4	11,1	0,92	108	2398	6064	573	23	931	1230	10	176	44	8510	258	65	2	69	4	2	5	
	max	94,5	181,8	5,0	70,8	15,0	45,5	6,6	225	9624	19368	2085	96	2992	4360	35	667	163	28438	1056	209	10	233	15	7	15	
	min	72,0	53,7	3,0	39,8	5,4	3,1	4,1	-90	1119	1185	13	8	171	21	0	65	6	1768	436	11	2	7	0,1	0,1	2	
	n	12	12	12	8	12	12	12	8	12	12	12	12	12	12	12	12	12	12	8	12	12	12	12	12	8	8

C. vesicaria	x	**89,2**	**99,4**	**4,2**	**46,2**	**9,9**	**7,5**	**5,14**	**103**	**3267**	**4599**	**138**	**20**	**831**	**197**	**3**	**228**	**24**	**8936**	**628**	**149**	**6**	**40**	**1,1**	**1,1**	**26**	
	sd	3,8	34,0	1,2	24,3	2,9	7,1	0,80	93	3319	3415	245	22	513	497	6	439	23	8045	387	119	3	31	1,3	0,9	28	
	max	95,8	210,8	8,0	91,2	17,5	45,5	6,8	355	16061	14854	2085	103	2119	4360	40	3517	163	29188	1794	541	12	176	7	7	106	
	min	72,0	35,0	1,0	0,3	3,6	1,2	3,7	-90	124	746	3	1	206	20	0	12	2	716	150	2	2	0,5	0,1	0,0	2	
	n	82	82	81	21	82	82	82	44	80	80	80	80	80	77	80	80	80	80	44	80	80	80	80	79	44	25
***Eleocharis* spp.**	n=1	**84,6**	**174,3**	**3,0**	**69,6**	**8,7**	**43,8**	**5,10**	**107**	**35505**		**71**	**40**	**1787**	**691**	**14**	**714**	**347**	**63861**	**5162**	**899**	**0,0**	**0,0**	**0,1**	**1,0**	**12**	1
E. palustris	x	**86,8**	**139,5**	**4,0**	**38,9**	**10,1**	**21,9**	**5,75**	**0**	**3409**	**5686**	**125**	**21**	**1610**	**377**	**99**	**5687**	**231**	**2489**	**306**	**26**	**3**	**106**	**1,2**	**1,3**	**15**	
	sd	4,6	79,7	1,0	11,8	3,1	14,6	0,35	99	2404	5954	82	12	1177	329	157	9660	385	3222	293	22	2	180	1,0	1,2	12	
	max	91,3	229,9	5,0	46,1	13,6	35,6	6,0	70	5789	12240	175	35	2368	736	280	16841	676	6153	587	41	6	314	2	2	25	
	min	82,2	79,5	3,0	25,3	8,2	6,6	5,5	-70	981	609	30	13	254	91	6	39	7	96	2	0,5	2	0,2	0,1	0,0	2	
	n	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
***Eriophorum* spp. (total)**	x	**89,4**	**92,1**	**3,8**	**39,9**	**9,8**	**5,0**	**4,33**	**166**	**2314**	**2690**	**71**	**10**	**597**	**115**	**6**	**242**	**23**	**5434**	**527**	**208**	**5**	**29**	**0,9**	**1,1**	**15**	33
	sd	4,2	45,9	1,3	23,7	3,2	7,7	0,73	83	2982	2419	192	16	447	235	9	517	28	13024	343	193	4	27	1,7	1,2	35	
	max	95,8	542,9	8,0	88,7	26,2	82,1	6,7	390	27007	23354	2085	257	3631	4360	63	4733	309	217411	2503	1649	25	220	26	16	485	
	min	57,4	22,0	1,0	0,3	3,6	0,9	2,9	-110	29	89	1	1	11	9	0	5	1	32	28	0,3	0,2	0,4	0,01	0,0	0,2	
	n	453	453	452	168	453	454	448	299	429	429	428	428	430	425	429	430	430	430	289	428	429	429	428	425	289	
E. angustifolium	x	**90,4**	**71,8**	**3,4**	**28,3**	**9,0**	**6,8**	**4,71**	**126**	**806**	**3292**	**173**	**8**	**888**	**199**	**17**	**1208**	**109**	**22486**	**558**	**185**	**4**	**23**	**0,4**	**0,9**	**32**	13
	sd	3,4	36,5	1,4	14,4	3,3	7,5	0,81	89	857	1858	217	7	549	140	18	1987	248	49724	365	182	3	25	0,3	0,9	44	
	max	95,4	185,6	6,0	52,1	19,4	33,4	6,3	260	3542	7114	736	31	1811	488	56	6602	802	217411	1170	777	14	82	0,8	4	186	
	min	80,0	32,0	1,0	8,3	4,4	1,0	3,2	-20	94	810	2	2	221	29	0	40	5	34	2	0,2	2	0,4	0,01	0,02	4	
	n	21	21	21	13	21	21	21	16	18	18	18	18	18	18	18	18	18	18	16	18	18	18	18	18	16	13
E. latifolium	x	**87,7**	**107,8**	**2,8**	**50,4**	**10,1**	**16,5**	**5,43**	**118**	**6167**	**8032**	**709**	**17**	**1819**	**225**	**21**	**1213**	**52**	**30779**	**820**	**102**	**5**	**11**	**0,4**	**0,5**	**48**	
	sd	4,0	40,6	1,0	23,4	3,0	8,6	0,40	42	4913	6138	776	8	1610	85	14	1606	31	40698	288	109	1	8	0,3	0,4	74	
	max	93,5	140,7	4,0	71,1	13,0	28,3	6,0	166	11754	14995	1852	26	3631	351	39	3611	98	90044	1119	198	7	23	0,7	0,9	159	
	min	84,8	48,7	2,0	17,4	6,0	7,8	5,1	65	255	2652	125	6	368	163	7	206	32	2963	566	2	4	4	0,2	0,1	5	
	n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
E. vaginatum	x	**90,2**	**75,8**	**3,4**	**32,4**	**9,4**	**3,1**	**3,94**	**197**	**1325**	**2482**	**47**	**8**	**593**	**103**	**7**	**267**	**19**	**3077**	**439**	**199**	**5**	**30**	**0,8**	**1,3**	**9**	
	sd	3,4	33,9	1,2	22,0	3,1	3,2	0,60	75	2754	2261	100	21	305	68	8	583	21	7067	300	168	4	29	2	2	15	
	max	95,8	190,4	7,0	79,7	18,5	28,3	6,6	390	27007	12580	813	257	2243	495	56	4733	113	90044	2503	791	25	193	26	16	159	
	min	74,8	22,0	1,0	0,3	4,2	0,9	2,9	-110	29	305	2	1	39	9	0	5	2	32	28	0,3	1	0,4	0,0	0,04	0,2	
	n	206	206	206	102	206	207	201	159	183	183	182	181	183	183	182	183	183	183	164	182	183	183	181	183	164	33
Rhynchospora alba	x	**88,9**	**113,8**	**1,5**	**30,9**	**8,7**	**21,9**	**5,45**	**178**	**7121**	**3229**	**1000**	**21**	**918**	**243**	**30**	**562**	**44**	**17383**	**244**	**35**	**4**	**6**	**0,5**	**0,4**	**248**	
	sd	0,8	10,5	0,7	24,7	1,1	4,7	0,07	88	7717	665	1306	19	358	74	6	42	4	18664	256	28	0,7	0,8	0,4	0,1	336	
	max	89,4	121,2	2,0	48,4	9,5	25,2	5,5	240	12577	3699	1923	34	1171	295	34	591	46	30580	425	55	4	6	0,7	0,5	485	
	min	88,3	106,4	1,0	13,4	7,9	18,5	5,4	115	1664	2758	76	7	665	190	26	532	41	4185	63	16	3	5	0,2	0,4	10	
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
***Scirpus* spp.**	n=1	**87,0**	**109,2**	**4,0**	**45,4**	**8,4**	**35,6**	**6,00**	**-70**	**5789**	**4210**	**175**	**35**	**2368**	**736**	**280**	**16841**	**676**	**96**	**2**	**0,5**	**2**	**0,2**	**0,1**	**0,04**	**25**	1
S. lacustris	x	**88,1**	**119,6**	**4,8**		**9,1**	**21,5**	**5,88**	**125**	**4855**	**9439**	**193**	**61**	**1030**	**226**	**1**	**238**	**67**	**33810**	**686**	**168**	**9**	**44**	**1,3**	**1,0**	13	
	sd	2,1	18,4	0,8		0,2	13,6	0,39		1804	4866	77	27	405	127	1	116	39	29475		110	4	21	0,9	0,3		
	max	90,1	148,9	6,0		9,5	41,0	6,1		7566	14718	252	102	1699	427	2	412	109	69732		310	14	67	3	1,4		
	min	85,0	101,5	4,0		8,9	8,4	5,2		3358	3560	59	29	696	102	0	110	11	6645		33	4	13	0,5	0,6		
	n	5	5	5		5	5	5	1	5	5	5	5	5	5	5	5	5	5	1	5	5	5	5	5	1	2
***Trichophorum* spp.**	x	**89,4**	**98,1**	**3,1**	**44,4**	**9,4**	**8,3**	**4,85**	**141**	**2406**	**4729**	**147**	**15**	**815**	**141**	**12**	**419**	**31**	**6834**	**604**	**122**	**7**	**37**	**1,0**	**0,8**	**19**	
	sd	4,1	48,7	1,0	18,1	2,6	9,7	0,93	75	2732	4319	270	13	709	86	14	671	26	12565	310	138	7	47	1,4	0,6	63	
	max	95,7	389,4	6,0	78,7	16,0	68,0	6,7	320	12577	22216	1923	54	4039	374	59	3850	103	90044	1348	541	63	271	7	3	485	
	min	66,7	22,3	1,0	7,7	4,2	0,9	3,1	25	94	123	3	1	119	41	0	40	2	218	63	0,4	0,2	0,6	0,0	0,0	0	
	n	86	86	87	49	86	87	82	59	87	87	86	87	87	87	87	87	87	87	64	86	87	87	87	87	64	13
T. alpinum	x	**88,8**	**105,1**	**2,9**	**48,5**	**10,1**	**9,6**	**5,58**	**114**	**2652**	**7425**	**190**	**21**	**1131**	**126**	**12**	**428**	**31**	**8798**	**723**	**62**	**8**	**56**	**1,4**	**0,7**	**16**	
	sd	2,2	26,4	0,7	15,3	1,7	5,5	0,55	68	3100	5738	226	14	1076	77	16	743	27	16952	298	62	4	66	2	0,4	33	
	max	93,8	160,0	5,0	78,7	13,0	28,3	6,7	320	11754	22216	862	54	4039	364	59	3850	103	90044	1179	234	16	271	7	1,4	159	
	min	84,8	40,5	1,0	26,8	5,8	3,5	4,1	45	94	2389	6	2	304	42	0	57	5	502	215	7	3	1	0,1	0,02	1,4	
	n	29	29	29	22	29	29	29	22	29	29	29	29	29	29	29	29	29	29	22	29	29	29	29	29	22	7
T. cespitosum	x	**91,3**	**68,8**	**2,5**	**32,0**	**8,1**	**5,6**	**3,97**	**216**	**1266**	**2571**	**164**	**8**	**675**	**168**	**17**	**585**	**32**	**4987**	**403**	**167**	**4**	**12**	**0,3**	**0,7**	**28**	
	sd	3,3	37,5	0,9	14,8	3,0	6,2	0,88	62	2619	1270	434	7	307	96	13	729	21	7408	248	152	2	12	0,2	0,7	113	
	max	95,4	140,3	4,0	48,4	14,3	25,2	5,9	280	12577	5011	1923	34	1305	330	59	2719	93	30580	1034	449	8	46	0,7	3	485	
	min	85,2	22,3	1,0	7,7	4,5	1,4	3,1	115	183	1116	3	1	221	41	2	69	6	308	63	2	2	0,6	0,04	0,04	0	
	n	21	21	22	12	21	22	18	14	22	22	21	22	22	22	22	22	22	22	18	21	22	22	22	22	18	11
Poaceae (total)	**x**	**87,9**	**111,7**	**3,8**	**47,5**	**10,4**	**11,6**	**5,43**	**62**	**4525**	**7644**	**413**	**34**	**1277**	**211**	**10**	**467**	**42**	**12165**	**761**	**93**	**8**	**78**	**2**	**1,0**	**18**	
	sd	4,5	50,4	1,2	16,8	2,8	10,7	0,72	104	5798	5156	1997	44	953	529	29	1779	80	26605	626	209	7	86	4	0,6	34	
	max	94,0	444,4	8,0	79,7	22,1	57,8	6,7	310	35505	23516	18666	257	4164	5217	280	16841	676	208053	5162	1789	63	470	26	3	227	
	min	59,6	24,0	1,0	12,9	5,7	0,9	3,5	-170	94	352	3	1	61	24	0	33	3	96	2	0,5	1	0,2	0,1	0,0	0,2	
	n	101	102	102	66	101	101	101	71	97	95	97	97	97	97	97	97	97	97	71	97	95	95	97	97	71	26
Poaceae spp.	x	**86,6**	**118,2**	**4,5**	**47,9**	**11,3**	**11,3**	**5,35**	**30**	**4700**	**7331**	**331**	**37**	**1250**	**302**	**4**	**228**	**32**	**6636**	**822**	**51**	**9**	**61**	**2**	**1,0**	**18**	**12**
	sd	6,5	71,5	1,2	22,5	3,4	11,9	0,73	111	6914	4561	1173	55	1014	888	7	298	28	9383	295	60	11	46	5	0,5	23	
	max	93,8	444,4	7,0	79,7	22,1	57,8	6,6	260	28862	23354	6843	257	4164	5217	37	1583	127	32774	1397	317	63	174	26	3	70	
	min	59,6	24,0	2,0	14,3	5,8	1,0	3,8	-150	131	352	3	2	101	55	0	50	5	260	445	2	1	1,1	0,1	0,2	0	
	n	37	37	37	16	37	37	37	17	33	33	33	33	33	33	33	33	33	33	17	33	33	33	33	33	17	12

Hippuris vulgaris	x	**87,9**	**128,6**	**4,1**	**44,7**	**9,2**	**22**	**5,77**	**-63**	**3929**	**7113**	**145**	**47**	**784**	**261**	**6**	**241**	**59**	**25443**	**649**	**163**	**8**	**34**	**1,0**	**1,1**	**9**	
	sd	3,7	52,3	0,9	11,5	2,2	14	0,45	32	1407	5615	102	32	470	148	8	125	39	28058	159	106	4	25	0,5	0,4	6	
	max	93,6	229,9	5,0	55,4	13,6	41,04	6,1	-40	5776	14718	252	102	1699	463	22	415	109	69732	829	309,9	14,3	66,7	1,6	2	14	
	min	82,2	60,5	3,0	32,6	6,2	4,4	5,2	-85	1741	609	30	10	254	102	0	110	7	1219	530	33,2	2,4	3,3	0,4	0,6	2	
	n	7	7	7	3	7	7	6	2	7	7	7	7	7	7	7	7	7	7	3	7	7	7	7	7	3	3
Lycopodium inundatum	n=1	**87,4**	**40,5**	**1,0**		**11,9**	**5,5**	**4,10**		**94**	**5656**	**711**	**4**	**1792**	**80**	**5**	**3850**	**49**	**4983**		**7**	**3**	**1,5**	**0,1**	**0,02**		1
***Lysimachia* spp.**	x	**87,2**	**38,8**	**3,5**		**12,1**	**5,5**	**4,40**		**94**	**5656**	**711**	**4**	**1792**	**80**	**5**	**3850**	**49**	**4983**		**7**	**3**	**1,5**	**0,1**	**0,02**		
	sd	0,3	2,5	3,5		0,3	0,1	0,42																			
	max	87,4	40,5	6,0		12,3	5,5	4,7																			
	min	87,0	37,0	1,0		11,9	5,4	4,1																			
	n	2	2	2		2	2	2		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		2
L. thyrsiflora	x	**88,6**	**106,5**	**4,9**	**40,4**	**10,4**	**8,8**	**5,66**	**-16**	**3023**	**5328**	**137**	**20**	**1168**	**159**	**7**	**171**	**51**	**17091**	**533**	**144**	**5**	**44**	**1,0**	**1,0**	**43**	
	sd	2,1	18,6	0,6	10,5	1,4	6,3	0,48	40	767	1930	90	11	405	107	11	187	74	8356	200	37	1,5	17	0,6	0,6	18	
	max	90,7	142,2	6,0	54,6	12,3	24,3	6,5	30	3831	8871	274	46	1658	352	29	656	219	30945	849	183	7	72	2	2	60	
	min	84,0	85,0	4,0	30,1	8,9	4,0	5,1	-70	1896	2751	27	9	729	69	0	59	11	4791	283	95	3	14	0,1	0,0	13	
	n	9	9	9	4	9	9	9	7	9	9	9	9	9	8	9	9	9	9	7	9	9	9	9	9	7	6
L. vulgaris	x	**90,4**	**93,6**	**5,5**		**9,3**	**4,4**	**5,15**		**5073**	**3513**	**14**	**17**	**321**	**74**	**0**	**87**	**33**	**4887**		**349**	**11**	**41**	**0,5**	**0,5**		
	sd	0,5	8,1	0,7		0,5	0,3	0,07		16	33	0	1	5		0	18	6	91		6	0,1	8	0,1	0,7		
	max	90,7	99,3	6,0		9,6	4,6	5,2		5084	3536	14	17	324		0	99	37	4951		354	11	47	0,6	1,0		
	min	90,0	87,8	5,0		8,9	4,1	5,1		5061	3490	14	16	317		0	74	28	4823		345	11	36	0,4	0,0		
	n	2	2	2		2	2	2		2	2	2	2	2	1	2	2	2	2		2	2	2	2	2		1
Menyanthes trifoliata	x	**90,6**	**86,8**	**3,8**	**42,1**	**8,7**	**6,7**	**5,25**	**65**	**2171**	**5155**	**183**	**14**	**844**	**142**	**6**	**177**	**24**	**10713**	**607**	**160**	**7**	**51**	**1,1**	**1,2**	**22**	
	sd	3,1	30,9	0,9	16,5	2,5	5,8	0,67	92	2167	4293	1042	17	617	92	8	406	39	19403	292	228	4	52	2	0,8	30	
	max	96,0	294,7	9,0	91,2	18,2	51,2	6,8	390	16061	35081	18666	211	3993	628	63	7925	679	217411	1846	2533	63	470	16	7	323	
	min	67,7	22,0	1,0	8,3	3,9	0,8	3,5	-195	88	305	1	1	47	4	0	27	1	98	4	1,2	1,5	0,3	0,0	0,0	1	
	n	538	536	540	339	536	538	542	378	530	523	529	529	530	525	529	530	530	530	420	528	522	522	530	528	419	46
***Myosotis* spp.**	x	**87,6**	**117,7**	**5,5**	**45,3**	**10,4**	**17,2**	**5,90**	**-40**	**6099**	**4948**	**167**	**26**	**1264**	**234**	**1**	**235**	**57**	**3697**	**642**	**86**	**4**	**21**	**0,5**	**1,0**	**2**	
	sd	2,6	29,5	0,7		2,7	4,1	0,99		2770	917	187	5	733	175	1	13	35	3040		114	2	5	0,2	0,7		
	max	89,4	138,5	6,0		12,3	20,1	6,6		8057	5596	299	29	1782	358	1	244	82	5846		167	6	25	0,7	1,5		
	min	85,7	96,8	5,0		8,4	14,3	5,2		4140	4299	35	22	745	110	0	225	32	1547		5	3	18	0,4	0,5		
	n	2	2	2	1	2	2	2	1	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	2
Myriophyllum verticillatum	x	**87,1**	**128,1**	**4,7**		**9,1**	**28,1**	**6,10**		**4451**	**12107**	**235**	**69**	**1151**	**283**	**1**	**256**	**90**	**51069**		**217**	**11**	**54**	**0,9**	**1,2**		
	sd	2,2	19,4	0,6		0,2	14,0	0,00		1211	4139	15	28	499	136	1	151	24	24877		107	3	17	0,6	0,2		
	max	89,4	148,9	5,0		9,2	41,0	6,1		5776	14718	252	102	1699	427	2	412	109	69732		310	14	67	2	1,4		
	min	85,0	110,4	4,0		8,9	13,2	6,1		3403	7334	225	52	722	157	0	110	63	22826		100	8	35	0,5	1,0		
	n	3	3	3		3	3	3		3	3	3	3	3	3	3	3	3	3		3	3	3	3	3		1
Nuphar luteum	n=1	**87,0**	**124,9**	**5,0**		**9,1**	**30,1**	**6,10**		**4173**	**14718**	**252**	**52**	**1032**	**266**	**0**	**246**	**98**	**60649**		**241**	**14**	**60**	**0,5**	**1,1**		1
Pedicularis palustris	x	**94,6**	**48,5**	**2,7**	**17,4**	**5,1**	**6,9**	**6,47**	**166**	**1012**	**14152**	**871**	**18**	**2173**	**297**	**4**	**1296**	**27**	**4856**	**580**	**11**	**8**	**74**	**0,7**	**2**	**5**	
	sd	1,0	1,7	0,6		0,8	0,8	0,42		663	1339	850	17	1264	103	8	2005	12	1640		8	3	70	0,6	1,5		
	max	95,2	50,1	3,0		6,0	7,8	6,8		1488	14995	1852	38	3631	401	13	3611	39	5842		16	10	144	1,4	3		
	min	93,5	46,8	2,0		4,6	6,2	6,0		255	12608	372	6	1378	196	0	103	15	2963		2	4	4	0,2	0,1		
	n	3	3	3	1	3	3	3	1	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	1	2
Potamogeton alpinus	x		**112,6**	**4,0**	**66,0**			**5,20**	**90**																		
	sd			0,0	14,6			0,28	0																		
	max			4,0	76,3			5,4	90																		
	min			4,0	66,0			5,2	90																		
	n		1	2	2			2	2																		2
P. berchtoldii	n=1	**82,2**	**229,9**	**5,0**	**46,1**	**13,6**	**23,5**			**3456**	**609**	**30**	**16**	**254**	**304**	**10**	**182**	**10**	**1219**	**587**	**41**	**2**	**3**	**2**	**2**	**2**	1
P. gramineus	x	**89,5**	**106,7**	**4,7**		**8,5**	**16,7**	**5,97**		**3561**	**9592**	**191**	**45**	**875**	**187**	**2**	**179**	**71**	**23869**		**105**	**11**	**62**	**0,7**	**1,1**		
	sd	2,6	23,5	1,3		0,7	13,4	0,14		1641	3381	47	34	389	122	3	116	23	29257		122	2	20	0,6	0,2		
	max	91,7	148,9	7,0		9,2	41,0	6,1		5776	14718	252	102	1699	427	8	412	109	69732		310	14	97	2	1,4		
	min	85,0	86,8	3,0		7,6	6,3	5,8		321	7086	131	7	585	78	0	73	54	2122		15	8	35	0,1	0,6		
	n	7	7	7		7	7	7		7	7	7	7	7	7	7	7	7	7		7	7	7	7	7		1
P. natans	x	**94,3**	**50,3**	**2,7**		**4,3**	**29,6**	**6,45**		**2562**	**11019**	**440**	**34**	**1598**	**643**	**4**	**482**	**58**	**1024**		**2**	**7**	**30**	**0,6**	**2**		
	sd	2,2	15,5	0,6		0,7	21,3	0,30		662	1168	49	9	78	228	8	322	28	69		0,19	0,56	15	0,2	0,4		
	max	95,8	73,3	3,0		5,2	61,5	6,7		3520	11834	507	45	1675	984	15	955	100	1103		2	7	43	0,9	2		
	min	91,1	40,1	2,0		3,6	18,3	6,1		2052	9293	396	24	1526	514	0	277	39	940		2	6	10	0,5	1,0		
	n	4	4	3		4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4	4	4		1
P. pusillus	x	**86,0**	**136,9**	**4,6**	**59,6**	**9,0**	**35,6**	**5,50**	**100**	**4975**	**14493**	**239**	**53**	**1366**	**347**	**0**	**329**	**104**	**65191**		**275**	**11**	**47**	**0,5**	**1,1**		
	sd	1,4	17,0	0,5	12,5	0,2	7,7	0,50	15	1133	318	19	1	472	114	0	117	8	6423		49	4	18	0,0	0,03		
	max	87,0	148,9	5,0	76,3	9,1	41,0	6,1	115	5776	14718	252	54	1699	427	0	412	109	69732		310	14	60	0,5	1,1		
	min	85,0	124,9	4,0	46,5	8,9	30,1	4,9	85	4173	14268	225	52	1032	266	0	246	98	60649		241	8	35	0,5	1,0		
	n	2	2	5	4	2	2	6	4	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		2
Potentilla erecta	x	**83,9**	**119,7**	**2,0**		**10,7**	**28,5**	**4,85**		**669**	**6776**	**7510**	**10**	**1510**	**80**	**7**	**2319**	**104**	**116972**		**12**	**5**	**6**	**0,1**	**0,01**		
	sd	5,0	111,9	1,4		1,6	32,4	1,06		812	1583	9615	8	400		3	2165	77	158376		6	2	6	0,01	0,01		
	max	87,4	198,8	3,0		11,9	51,4	5,6		1243	7895	14308	16	1792		9	3850	158	228961		16	6	10	0,1	0,02		
	min	80,3	40,5	1,0		9,6	5,5	4,1		94	5656	711	4	1227		5	788	49	4983		7	3	1,5	0,1	0,0		
	n	2	2	2		2	2	2		2	2	2	2	2	1	2	2	2	2		2	2	2	2	2		1

P. palustris	x	90,5	85,4	4,0	42,1	8,5	8,4	5,32	40	2662	4144	129	14	891	175	12	1406	96	14023	598	165	5	31	0,82	1,0	28	
	sd	2,9	32,0	1,0	15,3	2,2	8,4	0,63	99	3320	2374	123	12	540	140	25	3570	205	22785	539	260	2	28	1,0	0,8	38	
	max	95,5	279,7	9,0	85,2	15,6	68,8	6,6	350	35505	14245	804	102	3763	915	280	16841	821	217411	5162	2510	16	149	12	3,8	323	
	min	75,7	36,0	1,0	8,7	3,9	1,2	3,5	-195	124	357	4	2	133	39	0	27	3	63	2	0,3	0,0	0,0	0,0	0,0	2	
	n	177	177	185	126	176	177	184	142	170	163	169	169	169	166	170	170	169	170	149	169	169	169	169	170	149	29
***Ranunculus* spp.**	x	95,4	43,8	3,0		4,0	19,3	6,50		2337	11474	405	33	1595	538	0,0	348	45	973		2	7	34	0,76	2		
	sd	0,6	2,0	0,0		0,6	0,6	0,28		187	192	12	1	85	21		93	8	47		0,04	0,3	10	0,2	0,4		
	max	95,8	45,2	3,0		4,4	19,7	6,7		2469	11609	413	34	1655	552		413	50	1006		2	7	41	0,9	2		
	min	95,0	42,4	3,0		3,6	18,8	6,3		2205	11338	396	32	1535	523		282	39	940		2	7	27	0,6	1,3		
	n	2	2	2		2	2	2		2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		1
R. sceleratus	n=1	91,1	73,3			5,2	61,5	6,70		3520	9293	507	45	1526	984	0	955	100	1048		2	6	10	0,5	1,0		1
Rubus chamaemorus	x	89,2	48,3	1,6	9,7	10,3	4,1	3,50	245	472	2582	252	8	931	85	12	1578	34	4418	576	27	3	2	0,4	0,1	6	
	sd	2,4	13,0	0,8		2,4	4,2	0,62	51	504	342	184	6	201	27	11	804	14	10090	276	62	0,6	1,2	0,5	0,04	11	
	max	91,2	64,2	3,0		15,5	13,5	4,8	320	1588	3218	467	22	1254	142	31	2555	49	27254	1040	167	4	4	2	0,1	26	
	min	84,2	34,6	1,0		8,4	1,9	3,0	180	164	2212	35	3	672	64	0	620	4	259	326	0,6	2	0,9	0,1	0,03	1	
	n	7	7	7	1	7	7	7	5	7	7	7	7	7	7	7	7	7	7	5	7	7	7	7	7	5	6
R. saxatilis	n=1	88,9	93,8	3,0	43,2	10,2	8,1	6,30	-90	2301	15286	221	96	2362	98	5	65	6	7150	488	32	6	235	16	2	15	1
***Rumex* spp.**	n=1	88,9	112,1	6,0		9,5	14,9	5,20	125	7566	3560	59	29	1001	178	2	267	11	9198	686	156	4	13	3	0,7	13	1
Scheuchzeria palustris	x	91,1	83,5	3,8	34,8	8,5	4,0	4,85	128	1597	4488	81	8	667	116	3	95	22	4872	444	193	6	50	0,7	1,5	15	
	sd	3,7	33,3	1,1	17,1	3,4	3,7	0,94	72	1808	6186	109	8	689	91	6	83	33	8423	210	232	3	44	0,7	1,0	17	
	max	96,5	230,4	9,0	84,1	20,6	32,2	6,8	260	13563	40258	583	60	4174	552	74	855	309	117506	1319	2533	24	291	5	8	94	
	min	74,8	36,6	2,0	6,9	3,5	0,8	3,1	-30	29	89	1	1	11	4	0	7	0	32,0	28	2,4	1,71	1,31	0,0	0,0	0,4	
	n	303	303	304	80	303	304	303	170	303	302	298	300	302	302	297	303	304	303	171	297	301	301	303	302	170	27
Selaginella selaginoides	x	86,9	120,1	4,0	52,2	10,4	16,4	5,69	93	4241	17462	962	18	2235	132	14	445	60	26551	814	234	7	85	1,3	0,5	12	
	sd	3,5	42,1	1,4	16,3	2,2	13,9	0,79	82	4816	15767	2791	10	1712	146	17	683	112	59426	193	488	3	89	1,2	0,4	32	
	max	95,8	225,4	7,0	71,1	13,9	51,4	6,7	240	18849	40258	14308	40	5116	552	74	3850	436	228961	1179	2533	14	291	4	1,4	159	
	min	79,6	40,5	1,0	19,2	3,6	5,5	3,9	-90	94	1353	1	4	368	29	0	64	4	361	463	2	0,0	0,0	0,05	0,0	0,4	
	n	34	34	34	16	34	34	34	26	34	32	28	34	34	31	24	34	34	34	24	28	34	34	34	34	24	10
Solidago virgaurea	n=1	87,4	40,5	1,0		11,9	5,5	4,10		94	5656	711	4	1792	80	5	3850	49	4983		7	3	1,5	0,1	0,0		1
Sparganium minimum	x	92,6	77,2	3,5		6,7	14,1	6,25		3324	9594	296	32	1166	349	1	264	41	1658		7	9	48	0,8	1,3		
	sd	4,6	49,2	0,7		4,3	7,9	0,64		1583	2466	141	3	522	287	1	211	3	1015		7	2	29	0,1	0,04		
	max	95,8	112,0	4,0		9,8	19,7	6,7		4443	11338	396	34	1535	552	1	413	43	2375		12	10	69	0,9	1,3		
	min	89,3	42,4	3,0		3,6	8,5	5,8		2205	7850	196	30	797	146	0	114	39	940		2	7	27	0,7	1,3		
	n	2	2	2		2	2	2		2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		1
S. simplex	x	86,0	136,9	5,0		9,0	35,6	6,10		4975	14493	239	53	1366	347	0	329	104	65191		275	11	47	0,5	1,1		
	sd	1,4	17,0	0,0		0,2	7,7	0,00		1133	318	19	1	472	114	0	117	8	6423		49	4	18	0,0	0,0		
	max																										
	min																										
	n	2	2	2		2	2	2		2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		1
***Utricularia* spp.**	n=1	88,3	121,2	2,0	48,4	9,5	18,5	5,40	115	1664	2758	76	7	665	190	26	532	41	4185	425	55	4	5	0,2	0,4	10	1
Sphagnales (total)	x	89,9	88,8	3,6	37,5	9,1	6,5	4,75	138	1906	4618	177	12	878	146	7	295	25	7196	611	154	6	43	0,9	1,4	17	
	sd	4,7	53,6	1,2	19,8	3,0	9,5	0,95	111	2550	5409	993	19	784	255	11	550	29	15967	692	185	10	52	1,6	6	33	
	max	96,5	717,0	9,0	89,8	26,2	88,7	6,8	425	28862	40258	18666	257	6145	5217	125	4733	309	228961	8632	2533	191	470	26	140	485	
	min	45,7	22,0	1,0	0,1	3,5	0,7	2,9	-195	29	1	1	1	6	4	0	4	1	21	28	0,3	0,0	0,0	0,0	0,0	0,0	
	n	903	901	911	439	902	904	907	638	875	875	866	874	875	867	862	876	875	875	640	865	875	875	874	867	639	69
***Sphagnum* spp.**	x	87,0	71,1	4,8	51,6	15,1	4,4	4,61	61	3430	2976	115	14	683	109	5	350	23	9848	604	123	5	33	1,3	1,1	24,8	
	sd	2,7	50,1	1,1	23,6	14,6	4,3	0,62	70	2728	2254	111	12	606	72	6	830	30	11026	298	90	2	31	2	0,7	29	
	max	92,3	229,9	6,0	87,7	89,7	23,5	6,3	190	9243	6638	297	42	1822	304	18	2973	105	31269	1265	326	8	111	5	3	83	
	min	82,2	29,0	1,0	22,8	7,2	1,0	3,2	-30	276	352	2	3	101	28	0	48	4	461	346	2	2	1,1	0,1	0,0	0,7	
	n	29	29	29	7	29	29	28	8	12	12	12	12	12	12	12	12	12	12	9	12	12	12	12	12	9	11
S. angustifolium	x	89,1	96,7	3,7	37,3	10,1	5,4	4,25	174	1872	2790	161	8	707	103	8	414	25	6295	584	136	4	24	0,6	0,8	15	
	sd	4,3	51,8	1,4	23,7	2,9	8,2	0,92	96	2142	2813	984	8	536	86	9	700	27	17070	512	122	2	29	0,8	1,3	25	
	max	94,9	544,8	9,0	90,7	19,1	72,8	6,6	380	12913	22216	14308	49	4282	658	59	4733	219	228961	4583	668	17	193	5	16	203	
	min	56,0	29,1	1,0	0,1	4,9	0,4	2,9	-50	48	89	2	1	11	9	0	5	2	76	77	0,3	0,8	0,4	0,04	0,0	0,0	
	n	214	214	214	89	214	214	214	176	213	213	213	214	212	209	212	213	214	212	153	212	212	212	214	209	152	34
S. aongstroemii	n=1	86,9	112,1	4,0		10,8	17,3	4,10		9924	2334	21	23	290	283	0	258	48	792		38	8	9	0,5	1,1		1
S. balticum	x	91,9	65,5	2,8	25,3	7,7	2,7	3,71	222	503	2158	47	4	635	117	10	300	21	2217	367	180	4	24	0,3	1,2	7	
	sd	3,0	25,3	0,9	17,7	2,2	1,7	0,60	47	512	1572	90	3	272	71	10	527	18	1387	202	155	3	23	0,3	1,0	4	
	max	95,8	127,6	5,0	71,6	13,8	7,9	6,6	320	2834	12580	476	13	1232	330	56	2719	83	7981	1060	669	25	127	2	4	16	
	min	74,8	22,0	1,0	3,1	4,2	1,0	3,0	105	29	386	2	1	201	28	0	8	3	32	28	0,6	2	0,6	0,0	0,04	0,4	
	n	70	70	71	32	70	71	66	57	70	70	69	69	70	70	69	70	70	70	62	69	70	70	69	70	62	20
S. capillifolium	x	88,2	104,4	3,6		11,5	2,8	3,80		2017	1344	23	5	431	97	8	444	28	1779		174	4	15	0,2	0,9		
	sd	3,6	43,3	1,4		3,5	0,6	0,21		1467	485	29	3	313	81	7	994	15	646		112	1,1	11	0,1	1,1		
	max	93,0	170,3	5,0		16,3	3,8	4,3		4302	2334	86	12	1079	250	21	3076	51	2836		361	5	40	0,4	4		
	min	83,4	38,7	1,0		6,9	2,0	3,6		300	867	2	3	190	34	0	44	10	721		27	2	0,6	0,1	0,1		
	n	9	9	9		9	9	9		9	9	9	9	9	9	9	9	9	9		9	9	9	9	9		3

S. centrale	x	**86,4**	**135,3**	**3,3**	**43,6**	**10,5**	**12,7**	**4,35**	**178**	**2163**	**2906**	**225**	**12**	**1079**	**162**	**14**	**1149**	**44**	**7811**	**1240**	**72**	**3**	**10**	**0,4**	**0,4**	**9**	
	sd	9,0	120,8	1,7	16,9	3,2	17,7	0,89	63	1516	1215	239	9	543	132	15	1064	29	10629	1065	104	0,9	13	0,3	0,3	12	
	max	94,1	544,8	6,0	69,5	19,4	72,8	6,1	260	5128	4506	753	36	1866	586	59	2973	105	31877	4583	353	5	41	1,0	1,0	36	
	min	56,0	38,4	1,0	22,5	5,7	1,5	2,9	20	345	810	2	3	221	29	0	38	3	218	425	0,4	1,3	1,3	0,1	0,0	0,3	
	n	15	15	15	10	15	15	15	14	15	15	14	15	15	15	15	15	14	15	14	14	15	15	14	15	14	10
S. compactum	x	**93,4**	**66,8**	**4,0**		**6,5**	**2,3**	**3,90**		**1562**	**1792**	**24**	**7**	**375**	**102**	**9**	**136**	**69**	**1130**		**47**	**5**	**16**	**0,1**	**0,8**		
	sd	1,6	19,0	0,8		1,5	1,3	0,47		335	406	4	2	127	69	13	98	38	94		7	0,5	6	0,04	0,1		
	max	94,7	92,3	5,0		8,4	4,1	4,2		1812	2362	28	9	560	205	29	282	122	1237		57	5	23	0,2	0,9		
	min	91,3	50,8	3,0		5,2	1,4	3,2		1086	1415	20	5	277	63	1	76	36	1007		41	4	8	0,1	0,7		
	n	4	4	4		4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4	4	4		1
S. contortum	x	**94,5**	**55,4**	**3,0**		**5,3**	**5,9**	**6,55**		**1495**	**10813**	**312**	**11**	**1202**	**286**	**0**	**124**	**16**	**6254**		**20**	**9**	**89**	**0,7**	**2**		
	sd	0,6	8,1	0,0		0,6	0,6	0,21		238	2172	42	2	207	45	1	21	3	738		2	1,0	20	0,2	0,3		
	max	95,1	64,9	3,0		6,1	6,4	6,8		1763	13580	356	13	1458	333	1	144	19	6964		22	10	110	0,9	3		
	min	93,8	45,4	3,0		4,7	5,0	6,3		1292	8981	256	9	953	230	0	95	13	5290		17	8	62	0,5	2		
	n	4	4	4		4	4	4		4	4	4	4	4	4	4	4	4	4		4	4	4	4	4		1
S. cuspidatum	x	**91,6**	**77,5**	**3,5**		**8,2**	**2,1**	**3,45**	**165**	**182**	**1176**	**27**	**3**	**441**	**109**	**10**	**175**	**13**	**3085**	**373**	**108**	**3**	**7**	**0,4**	**1,1**	**8**	
	sd	2,5	31,5	0,7		2,4	0,8	0,07	78	10	361	5	1	21	13	1	54	11	2505	6	72	0,7	4	0,5	0,9	7	
	max	93,4	99,8	4,0		10,0	2,6	3,5	220	189	1431	30	4	456	118	10	213	21	4856	377	158	3	11	0,8	2	13	
	min	89,8	55,2	3,0		6,5	1,5	3,4	110	175	921	23	2	426	99	9	136	5	1314	369	57	2	4	0,1	0,5	3	
	n	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	**2**	**2**	**2**	2	2	2	2
***S. cuspidatum* coll.**	x	**91,9**	**72,6**	**3,5**	**23,3**	**7,8**	**3,4**	**4,53**	**122**	**861**	**2948**	**65**	**7**	**666**	**100**	**4**	**365**	**28**	**6382**	**343**	**169**	**6**	**36**	**0,7**	**1,3**	**21**	
	sd	2,3	19,8	1,0	11,5	2,2	2,3	0,76	103	1517	1798	76	8	326	48	8	1758	106	6604	174	110	7	22	0,8	0,8	22	
	max	95,4	141,0	6,0	47,2	17,3	14,8	5,9	390	9910	11922	365	46	1635	219	58	11873	705	24027	1211	511	63	128	5	4	86	
	min	82,3	38,0	2,0	3,4	4,5	0,8	3,3	-90	85	429	2	2	25	-36	0	16	2	68	5	0,4	1,3	0,3	0,02	0,01	0,4	
	n	86	86	85	46	86	86	86	82	84	84	84	84	84	84	84	84	84	84	83	84	84	84	84	83	83	12
S. fallax	x	**91,0**	**85,6**	**3,8**	**38,1**	**8,4**	**4,7**	**4,42**	**165**	**1984**	**2148**	**55**	**9**	**544**	**93**	**6**	**227**	**37**	**7443**	**732**	**238**	**5**	**28**	**0,6**	**1,0**	**21**	
	sd	3,3	34,3	1,2	21,7	2,8	7,2	0,62	100	1925	1345	99	12	439	74	11	484	45	20642	1076	252	3	30	0,7	0,6	30	
	max	96,5	279,0	8,0	80,3	20,4	64,8	5,7	425	10152	8332	736	115	2317	448	63	3166	309	217411	8540	1649	17	220	3	4	186	
	min	75,3	34,6	1,0	0,3	3,5	0,9	3,2	0	133	123	1	1	48	24	0	12	2	706	174	4,4	0,2	0,7	0,0	0,0	2	
	n	118	118	118	22	118	118	119	62	118	118	119	119	119	116	119	119	119	119	62	119	118	118	119	116	62	14
S. fimbriatum	n=1	**89,3**	**64,2**	**3,0**		**9,3**	**13,5**	**4,80**	**180**	**1588**	**3218**	**163**	**22**	**1254**	**142**	**0**	**1789**	**37**	**27254**	**1040**	**167**	**3**	**2**	**0,6**	**0,1**	**26**	1
S. fuscum	x	**90,1**	**68,0**	**3,0**	**19,9**	**9,6**	**3,2**	**3,86**	**216**	**627**	**5297**	**62**	**5**	**965**	**110**	**9**	**526**	**23**	**2628**	**415**	**156**	**5**	**28**	**0,4**	**0,7**	**9**	
	sd	2,6	29,7	1,2	17,4	2,5	2,6	0,96	92	785	9315	120	3	963	68	6	768	17	4744	226	158	4	47	0,5	1,5	16	
	max	94,8	146,4	6,0	69,1	17,3	12,3	6,8	400	4063	40258	921	27	4517	398	31	4733	80	26588	984	791	24	235	3	16	82	
	min	82,3	24,0	1,0	0,3	5,2	0,4	2,9	-30	48	419	2	1	140	31	0	5	3	52	77	0,6	1,0	0,4	0,04	0,03	0,2	
	n	130	128	129	58	130	130	129	109	123	123	118	123	123	123	112	123	123	123	103	118	123	123	123	123	103	19
S. girgensohnii	x	**85,4**	**123,4**	**3,9**	**35,1**	**11,7**	**15,0**	**5,23**	**115**	**1884**	**13975**	**398**	**18**	**2162**	**411**	**11**	**684**	**22**	**8016**	**839**	**218**	**5**	**97**	**2**	**0,7**	**13**	
	sd	6,9	75,8	1,5	16,4	3,8	14,8	1,00	98	1788	14888	1241	10	1363	1093	15	824	22	11270	444	449	3	123	2	1,1	23	
	max	94,1	489,4	7,0	71,0	26,2	78,6	6,5	315	7910	40258	6843	46	4283	5217	74	2973	105	46128	2112	2533	10	470	8	7	91	
	min	61,1	38,4	1,0	10,1	5,7	3,2	3,6	-40	345	692	1	7	106	29	0	50	1	218	204	0,4	2	1,0	0,1	0,0	0,3	
	n	38	38	38	19	38	38	38	34	38	38	32	38	38	38	30	38	38	37	33	32	38	38	38	38	32	14
S. jensenii	x	**91,8**	**79,5**	**2,8**	**27,7**	**7,8**	**5,1**	**4,32**	**188**	**1844**	**2124**	**125**	**9**	**522**	**122**	**6**	**149**	**13**	**4865**	**861**	**190**	**4**	**33**	**0,8**	**1,4**	**33**	
	sd	2,1	23,4	1,2	17,4	1,8	5,4	0,58	78	3102	720	436	9	212	63	8	213	12	7136	1927	136	2	28	0,6	0,7	113	
	max	94,8	130,3	6,0	69,9	12,0	25,2	5,5	350	12577	3699	1923	34	1171	295	34	855	46	30580	8540	444	10	120	2	2	485	
	min	87,3	48,4	1,0	3,4	5,1	1,0	3,6	20	85	1228	5	2	212	50	0	24	3	735	63	16	3	2	0,2	0,3	2	
	n	19	19	19	16	19	19	19	18	19	19	19	19	19	19	19	19	19	19	18	19	19	19	19	19	18	77
S. lindbergii	x	**91,7**	**76,5**	**3,4**	**45,6**	**8,1**	**3,0**	**4,14**	**188**	**1830**	**2264**	**21**	**6**	**441**	**116**	**5**	**227**	**36**	**2012**	**442**	**190**	**5**	**28**	**0,6**	**1,3**	**6**	
	sd	3,2	29,1	1,0	26,0	3,1	1,8	0,41	38	2294	1164	37	6	188	82	6	702	45	1255	196	125	2	13	0,9	0,7	3	
	max	95,4	127,2	5,0	73,2	14,0	8,9	5,0	250	9712	4847	183	21	931	348	24	3517	162	6056	758	510	8	58	4	3	13	
	min	85,5	35,0	1,0	10,7	4,5	1,2	3,6	126	108	1170	3	1	227	39	0	39	3	870	200	12	2	0,5	0,02	0,1	2	
	n	23	23	24	6	23	24	21	10	24	24	23	24	24	24	24	24	24	24	13	23	24	24	24	24	13	7
S. magellanicum	x	**91,2**	**79,3**	**3,5**	**27,4**	**8,6**	**2,6**	**3,98**	**196**	**1225**	**2142**	**37**	**6**	**534**	**91**	**6**	**210**	**27**	**2519**	**429**	**176**	**5**	**26**	**0,4**	**1,1**	**7**	
	sd	3,1	31,5	1,3	18,9	3,0	1,8	0,62	75	1306	2108	69	6	400	62	9	406	27	3454	306	162	3	26	0,6	1,5	7	
	max	96,5	174,4	9,0	78,7	18,9	11,7	6,5	390	7188	22216	586	42	4039	495	56	3076	162	30422	2503	744	23	166	5	16	39	
	min	80,1	29,1	1,0	1,8	3,5	0,7	3,0	-80	29	123	2	1	25	9	0	5	2	32	28	2,0	0,19	0,56	0,0	0,04	0,4	
	n	155	155	155	62	155	155	155	106	154	154	155	154	154	154	154	154	155	154	97	154	153	153	155	154	96	24
S. majus	x	**92,1**	**75,6**	**3,7**	**59,8**	**7,7**	**3,0**	**4,19**	**161**	**1801**	**1763**	**287**	**7**	**321**	**85**	**3**	**118**	**60**	**3663**	**409**	**235**	**6**	**24**	**0,3**	**1,1**	**26**	
	sd	3,0	27,3	1,0	2,4	2,8	4,2	0,48	39	1968	1662	2000	6	202	73	7	228	59	12199	197	234	3	16	0,5	0,6	46	
	max	96,5	164,8	5,0	61,4	17,5	26,9	6,0	230	9924	10033	14983	31	1070	495	45	1592	309	92579	762	971	17	73	3	3	164	
	min	82,2	30,0	1,0	57,0	3,5	0,9	3,3	90	133	123	1	1	48	24	0	12	4	673	174	6	0,19	0,85	0,01	0,2	2	
	n	56	56	56	3	56	56	56	12	56	55	56	56	56	56	56	56	56	56	12	56	55	55	56	56	12	9
S. obtusum	x	**91,4**	**66,4**	**2,6**	**31,5**	**8,1**	**5,6**	**4,89**	**4**	**993**	**2927**	**83**	**6**	**713**	**135**	**11**	**301**	**41**	**7262**	**702**	**562**	**4**	**26**	**0,4**	**1,1**	**11**	
	sd	2,1	12,6	0,8	9,2	2,0	0,8	0,53	79	494	858	26	2	292	43	8	523	33	1204	81	290	1,5	15	0,6	0,5	3	
	max	92,9	80,7	3,0	42,1	12,3	6,6	5,4	110	1631	4567	104	9	1305	228	25	1484	109	8632	784	784	6	43	2	2	13	
	min	86,8	42,4	1,0	18,5	6,7	4,5	3,9	-80	359	2009	31	3	479	103	4	71	5	5157	570	67	2	3,1	0,1	0,2	6,6	
	n	7	7	7	7	7	7	7	4	7	7	7	7	7	7	7	7	7	7	6	7	7	7	7	7	6	3

S. papillosum	x	**91,1**	**79,8**	**3,3**	**36,1**	**8,2**	**4,7**	**4,19**	**197**	**1601**	**2247**	**32**	**9**	**532**	**110**	**7**	**208**	**31**	**3019**	**580**	**215**	**5**	**28**	**0,7**	**1,1**	**8**	
	sd	3,9	42,3	1,1	21,5	2,7	7,9	0,54	86	1739	1507	51	12	353	76	9	425	41	2754	863	192	3	25	1,0	0,7	7	
	max	96,5	389,4	8,0	76,3	17,5	68,0	5,4	425	9910	11922	365	115	2317	495	56	3517	309	15398	8540	971	17	157	6	4	58	
	min	66,7	22,0	1,0	0,3	3,5	0,8	3,2	20	85	123	1	1	47	24	0	16	2	297	139	12	0,2	0,5	0,0	0,1	0,7	
	n	149	149	152	54	149	150	149	95	144	144	144	145	145	144	145	145	145	145	96	144	144	144	145	144	96	20
S. platyphyllum	x	**86,6**	**136,8**	**3,7**	**61,1**	**10,0**	**24,5**	**5,50**	**-41**	**15447**	**4335**	**411**	**114**	**1156**	**306**	**9**	**367**	**30**	**5599**	**756**	**12**	**4**	**14**	**7**	**0,9**	**98**	
	sd	5,3	58,9	1,6	27,4	3,4	7,4	0,40	159	10377	3609	756	95	501	124	12	172	16	12245	426	8	2	14	9	0,5	217	
	max	95,0	224,0	5,0	79,7	14,0	34,0	6,3	240	28862	11609	1923	257	1867	523	34	591	50	30580	1198	24	7	41	26	2	485	
	min	78,8	45,2	1,0	13,4	4,4	13,8	5,2	-150	2469	2195	24	32	731	150	0	205	10	195	63	2	2	6	0,6	0,5	0	
	n	6	6	6	5	6	6	6	5	6	6	6	6	6	6	6	6	6	6	5	6	6	6	6	6	5	2
S. recurvum **coll.**	x	**92,0**	**68,8**	**3,2**	**30,3**	**7,7**	**3,4**	**4,65**	**126**	**552**	**3785**	**39**	**5**	**667**	**126**	**12**	**1244**	**118**	**4198**	**342**	**221**	**7**	**42**	**0,5**	**2**	**11**	
	sd	1,5	13,3	0,7	13,4	1,4	1,8	0,70	90	541	2578	43	3	422	43	20	2852	266	4972	249	190	5	28	0,4	1,1	6	
	max	94,4	94,9	5,0	61,3	10,8	9,1	6,8	350	2575	15263	154	16	3577	319	109	9432	958	20872	1265	791	25	118	2	4	37	
	min	88,8	37,4	2,0	2,8	5,4	1,0	2,9	-90	29	386	2	1	201	28	1	8	3	32	3	0,6	1,3	0,3	0,0	0,0	0	
	n	87	87	86	77	87	87	86	77	87	87	87	85	87	87	86	87	87	87	87	87	87	87	87	87	86	9
S. riparium	x	**90,3**	**89,0**	**3,6**	**41,4**	**8,7**	**8,1**	**5,08**	**75**	**1635**	**3447**	**125**	**11**	**785**	**171**	**17**	**1662**	**146**	**11629**	**599**	**117**	**5**	**28**	**0,9**	**1,0**	**17**	
	sd	3,4	40,2	1,0	16,6	2,5	9,5	0,60	113	1461	2320	108	9	500	139	21	2965	287	24214	436	134	6	41	2	0,9	23	
	max	95,4	279,7	6,0	85,2	16,4	68,8	6,4	315	6518	18561	736	46	3117	915	109	9962	958	217411	1846	697	63	331	12	4	186	
	min	75,7	31,4	1,0	8,3	4,4	1,4	3,4	-195	100	609	3	2	119	35	0	38	3	34	2	0,2	2	0,3	0,0	0,0	2	
	n	89	90	91	83	89	89	90	78	89	89	88	89	89	89	89	89	88	89	89	88	89	89	88	89	89	21
S. rubellum	x	**91,4**	**78,7**	**3,3**	**22,7**	**8,2**	**3,9**	**4,17**	**174**	**1469**	**3285**	**41**	**9**	**793**	**139**	**6**	**192**	**21**	**2510**	**353**	**161**	**4**	**36**	**0,8**	**2**	**7**	
	sd	2,9	30,2	1,1	10,2	2,7	3,0	0,68	69	1908	3047	55	9	617	65	7	421	21	2170	188	133	2	30	1,4	0,91	4	
	max	95,4	164,8	6,0	42,7	17,5	14,9	6,2	280	7566	19672	240	36	4282	330	38	2719	97	10991	753	511	10	139	6	4	22	
	min	82,2	36,2	1,0	7,6	4,5	1,2	3,1	45	29	123	2	1	201	26	0	8	2	32	28	2	0,2	1,1	0,0	0,0	0,4	
	n	43	43	43	19	43	44	38	31	44	44	43	43	44	44	42	44	44	44	37	43	44	44	44	44	37	9
S. russowii	x	**87,9**	**102,9**	**3,6**	**43,8**	**10,9**	**6,8**	**4,39**	**178**	**2165**	**5682**	**144**	**9**	**1025**	**83**	**9**	**539**	**26**	**5054**	**674**	**167**	**5**	**31**	**0,6**	**0,5**	**11**	
	sd	5,0	58,6	1,5	26,9	3,0	10,2	0,93	75	2885	10120	217	10	1175	68	9	834	20	7166	499	284	3	46	0,6	0,5	20	
	max	93,6	311,4	7,0	89,7	19,4	58,8	6,8	280	17717	40226	813	49	4517	438	33	4733	85	35639	2503	1649	17	208	2	2	94	
	min	67,9	29,1	1,0	1,2	6,0	1,3	3,3	0	84	305	2	2	42	29	0	32	2	122	150	0,3	2	0,4	0,1	0,0	0,3	
	n	49	49	49	18	49	49	49	35	49	49	47	49	49	49	43	49	49	49	23	47	49	49	49	49	23	15
S. squarrosum	x	**89,4**	**99,5**	**3,9**	**42**	**8,8**	**11,4**	**5,31**	**40**	**2607**	**4028**	**154**	**15**	**1015**	**195**	**7**	**362**	**39**	**15953**	**731**	**125**	**4**	**30**	**0,6**	**1,1**	**33**	
	sd	4,8	62,7	1,0	15	1,7	13,6	0,63	117	2089	1864	114	10	624	168	7	617	48	16871	389	88	2	21	0,5	0,7	51	
	max	94,2	489,4	7,0	88	15,0	78,6	6,5	315	9924	11366	583	53	3763	915	26	3736	280	117506	1846	528	8	78	3	2,8	323	
	min	61,1	31,4	1,0	9	5,6	3,4	3,6	-195	145	457	6	2	209	58	0	49	6	792	89	13	1	0,8	0,12	0	1,4	
	n	58	59	58	54	58	58	59	47	58	58	58	58	58	56	58	58	58	58	56	58	58	58	58	58	56	16
S. subfulvum	x	**88,7**	**111,6**	**3,5**	**51,2**	**10,0**	**9,9**	**5,52**	**176**	**2829**	**9142**	**873**	**27**	**1142**	**102**	**8**	**192**	**34**	**14477**	**559**	**47**	**9**	**88**	**2**	**1,0**	**72**	
	sd	3,4	34,4	1,0	28,6	2,6	10,9	0,76	139	6399	5715	3190	56	1066	59	14	234	36	50905	369	51	4	58	5	0,6	182	
	max	93,8	198,8	5,0	79,7	16,3	51,4	6,7	320	27007	22216	14308	257	4039	295	55	788	158	228961	1198	173	14	194	24	3	485	
	min	80,3	57,2	1,0	13,4	5,8	1,4	3,4	-110	226	1084	8	4	350	40	0	22	4	260	63	7	3	6	0,1	0,0	0,2	
	n	20	20	20	6	20	20	20	7	20	20	20	20	20	19	20	20	20	20	7	20	20	20	20	20	7	6
S. subsecundum	x	**92,2**	**73,5**	**3,3**	**41,5**	**7,4**	**5,5**	**5,16**	**173**	**1743**	**4180**	**97**	**10**	**591**	**149**	**5**	**157**	**30**	**5297**	**665**	**158**	**7**	**46**	**0,7**	**1,5**	**13**	
	sd	2,2	21,1	0,7	15,9	2,0	4,2	0,76	136	1491	3297	108	9	335	88	9	223	41	9914	196	214	4	39	0,8	0,9	22	
	max	95,4	134,2	6,0	89,8	13,1	28,3	6,7	425	9910	19211	753	60	1724	450	59	1636	309	90044	1211	1076	24	227	5	7	159	
	min	85,2	44,5	2,0	0,3	4,1	0,8	3,8	-85	197	421	1	1	47	24	0	24	3	297	189	4,6	2	1,3	0,01	0,21	0,9	
	n	110	110	114	56	110	110	115	54	110	110	110	110	110	110	110	110	110	110	56	110	110	110	110	110	56	16
S. tenellum	x	**88,9**	**88,0**	**3,0**		**10,8**	**2,7**	**3,56**	**253**	**896**	**1756**	**23**	**4**	**662**	**99**	**5**	**345**	**18**	**2700**	**214**	**248**	**3**	**11**	**0,3**	**0,6**	**7**	
	sd	2,9	40,8	1,2		2,8	2,0	0,65	5	1498	1488	36	3	324	61	6	532	12	2093	50	168	1	10	0,2	0,4	2	
	max	92,4	144,3	4,0		15,0	6,6	4,9	260	4288	4567	102	11	1305	228	14	1484	34	6864	272	477	5	29	0,5	1,1	8	
	min	84,8	42,4	1,0		7,4	0,9	3,1	250	169	685	3	1	375	50	0	13	5	1083	174	67	2	3	0,1	0,2	4	
	n	7	7	7		7	7	7	4	7	7	7	7	7	7	7	7	7	7	5	6	6	6	6	6	4	2
S. teres	x	**92,0**	**73,8**	**3,6**	**40,5**	**7,5**	**6,4**	**5,51**	**87**	**1710**	**5512**	**149**	**11**	**909**	**163**	**10**	**1239**	**101**	**10079**	**492**	**96**	**6**	**51**	**0,7**	**1,3**	**23**	
	sd	2,6	23,2	0,9	15,9	2,1	5,3	0,66	124	1642	3756	122	10	490	112	17	3110	230	19658	280	89	3	40	0,7	0,9	24	
	max	96,0	227,2	9,0	89,8	20,6	47,1	6,8	375	13563	19211	736	60	3763	658	109	15306	958	217411	1319	527	24	207	5	4	186	
	min	77,0	38,3	2,0	9,1	3,6	2,2	3,8	-90	114	357	0	3	90	4	0	24	0	63	2	0,3	2	0,3	0,0	0,0	0,6	
	n	180	180	185	113	180	180	186	119	180	179	180	179	179	178	180	180	180	180	138	179	179	179	179	180	138	17
S. warnstorfii	x	**86,3**	**136,6**	**3,5**	**41,5**	**10,1**	**16,1**	**5,70**	**117**	**2881**	**12805**	**670**	**29**	**2202**	**165**	**11**	**444**	**30**	**12297**	**728**	**75**	**7**	**109**	**2**	**0,8**	**15**	
	sd	8,2	110,0	1,1	16,1	2,4	18,7	0,54	102	3382	8323	2752	30	1320	160	14	741	30	36494	371	112	3	106	3	0,6	36	
	max	94,1	717,0	7,0	72,8	17,1	88,7	6,8	315	17421	40226	18666	211	6145	812	74	3850	167	228961	1764	618	13	470	16	2	227	
	min	45,7	38,4	1,0	10,1	5,7	4,0	3,7	-90	94	1949	6	4	368	35	0	39	5	218	215	0,4	1	1,4	0,1	0,0	0,3	
	n	77	75	76	59	75	76	75	61	75	75	71	75	75	74	72	75	75	75	56	71	75	75	75	75	57	15
S. acutifolia-t **ype**	x	**88,2**	**114,7**	**4,7**	**43,3**	**10,4**	**10,5**	**4,57**	**121**	**4472**	**3449**	**55**	**41**	**551**	**145**	**6**	**190**	**16**	**2595**	**611**	**120**	**6**	**35**	**2**	**1,0**	**5**	
	sd	9,0	9,0	9,0	5,0	9,0	9,0	9,00	8	9	9	8	9	9	9	9	9	9	8	7	8	9	9	9	9	6	
	max	91,9	174,4	7,0	69,5	18,9	35,3	6,0	250	12684	9039	224	184	1122	365	14	417	40	6194	917	269	12	128	7	3	16	
	min	80,1	78,7	3,0	20,6	7,9	2,8	3,8	-110	569	481	7	4	82	16	0	28	6	195	378	8	2	3	0,3	0,4	0,3	
	n	9	9	9	5	9	9	9	8	9	9	8	9	9	9	9	9	9	8	7	8	9	9	9	9	6	7
S. cuspidata- **type**	x	**90,0**	**91,3**	**4,1**	**41,5**	**8,8**	**10,4**	**5,50**	**0,7**	**2541**	**4196**	**183**	**15**	**1156**	**167**	**33**	**4593**	**261**	**17054**	**365**	**90**	**4**	**24**	**0,4**	**0,6**	**34**	
	sd	2,3	23,7	0,8	18,4	1,3	12,2	0,59	57	2765	2490	137	16	906	173	69	6044	305	30092	413	88	2	29	0,3	0,7	24	
	max	92,4	166,8	6,0	85,2	11,7	36,2	6,3	128	10711	11366	583	53	3763	736	280	16841	785	117506	1319	295	7	97	0,9	2	89	
	min	83,4	65,5	3,0	19,7	7,2	2,2	4,1	-70	210	0	2	2	317	40	0	39	5	64	2	0,4	0,0	0,0	0,0	0,0	9	
	n	16	16	16	11	16	16	16	11	16	16	16	16	16	16	16	16	16	16	15	16	16	16	16	16	15	7

Bryidae (total)	**x**	**90,4**	**88,0**	**3,6**	**38,8**	**8,7**	**7,3**	**5,05**	**111**	**1951**	**5053**	**256**	**16**	**930**	**161**	**10**	**284**	**33**	**8467**	**867**	**162**	**10**	**59**	**0,9**	**6**	**21**	
	sd	4,0	45,2	1,1	18,1	2,6	9,4	0,90	113	2848	4581	1083	26	790	161	27	539	131	13849	1582	214	24	151	1	57	36	
	max	96,0	544,8	9,0	91,7	19,4	78,6	6,8	425	35505	35839	18666	216	6145	1811	407	4733	3166	208053	15306	2533	205	2368	16	888	485	
	min	56,0	24,0	1,0	0,1	3,6	0,8	2,9	-180	84	322	1	1	4	0	0	0	2	13	63	0,3	0,5	0,1	0,01	0,0	0,0	
	n	628	628	627	332	627	628	630	446	624	620	624	624	624	621	621	625	625	624	453	623	619	618	623	618	451	70
Bryidae spp.	**x**	**90,4**	**80,2**	**3,6**	**36,1**	**8,9**	**6,9**	**5,11**	**128**	**1608**	**9113**	**79**	**10**	**1202**	**119**	**12**	**405**	**24**	**7390**	**638**	**155**	**9**	**65**	**0,9**	**0,9**	**11**	
	sd	1,8	22,6	1,1	16,6	1,6	4,1	1,00	150	1257	6574	77	5	1034	61	14	634	32	10569	297	206	6	56	0,6	0,6	14	
	max	93,8	119,1	6,0	56,6	11,3	17,9	6,8	355	4231	22410	270	22	3941	324	53	1981	127	35639	1325	849	18	161	2	2	48	
	min	87,7	32,0	2,0	12,9	5,8	1,0	3,2	-50	237	1226	5	4	527	55	0	41	3	271	135	2	1,8	0,7	0,1	0,0	0,4	
	n	17	17	17	7	17	17	17	12	16	15	16	16	16	16	16	16	16	16	13	16	15	15	16	16	13	12
Aulacomnium palustre	**x**	**89,6**	**79,1**	**3,2**	**37,3**	**9,7**	**6,2**	**4,73**	**150**	**1401**	**5500**	**135**	**7**	**1100**	**127**	**10**	**841**	**25**	**7306**	**550**	**217**	**6**	**37**	**0,6**	**0,9**	**16**	
	sd	2,9	32,9	1,3	20,5	2,4	5,5	0,93	98	1613	4442	183	4	815	80	9	1157	19	9228	231	339	6	43	0,8	1,1	15	
	max	95,3	187,4	6,0	70,3	14,7	25,5	6,8	280	7411	19368	792	22	3577	362	33	4733	70	35639	1034	1649	24	149	4	4	46	
	min	80,6	29,9	1,0	1,2	4,1	2,5	3,3	-80	94	1248	3	2	235	40	0	35	3	122	298	0,3	2	0,4	0,1	0,0	0,3	
	n	35	35	35	15	35	35	35	26	35	35	35	35	35	35	35	35	35	35	18	35	35	35	35	35	18	20
***Bryum* spp.**	n=1	**90,0**	**103,7**	**3,0**	**40,0**	**9,6**	**3,9**	**4,00**	**225**	**3945**	**1302**	**11**	**8**	**291**	**106**	**12**	**171**	**6**	**3653**	**1013**	**332**	**4**	**8**	**1**	**0,6**	**4**	1
B. pseudotriquetrum	**x**	**89,7**	**85,5**	**3,0**	**7,5**	**9,5**	**7,8**	**4,83**	**295**	**2295**	**11317**	**284**	**17**	**1855**	**161**	**27**	**1383**	**36**	**3513**	**782**	**21**	**7**	**35**	**0,5**	**0,4**	**4**	
	sd	1,5	45,0	1,0	7,6	0,9	4,9	1,42	21,2	2480	10014	193	10	1809	37	37	1869	16	4060	351	26	4	30	0,2	0,5	5	
	max	90,8	119,1	4,0	12,9	10,6	12,3	5,7	310	5106	22410	507	24	3941	202	53	3534	53	8070	1030	50	12	55	0,7	1,0	8	
	min	88,0	34,4	2,0	2,1	8,9	2,5	3,2	280	414	2945	161	5	728	130	0	156	22	282	533	0,6	3	0,8	0,2	0,1	0,5	
	n	3	3	3	2	3	3	3	2	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3	3	2	3
B. weigelii	n=1	**94,3**	**51,2**	**4,0**		**5,6**	**2,5**	**5,10**	**140**	**1740**	**2947**	**67**	**10**	**532**	**76**	**0**	**67**	**28**	**4089**	**524**	**61**	**6**	**44**	**0,4**	**1,1**	**8**	1
***Calliergon* spp.**	**x**	**90,1**	**92,5**	**4,0**	**32,5**	**9,4**	**4,6**	**4,79**	**46**	**1975**	**2743**	**72**	**9**	**595**	**104**	**7**	**107**	**25**	**8361**	**780**	**244**	**5**	**30**	**0,8**	**1,1**	**14**	
	sd	2,6	28,8	0,6	13,0	2,5	2,5	0,71	84	1324	1864	81	3	440	49	9	81	18	6776	178	241	1,1	18	0,9	0,5	10	
	max	93,6	140,3	5,0	46,7	14,3	9,1	6,0	180	5556	6994	277	13	1579	193	28	312	58	25100	1070	782	6	60	3	2	40	
	min	85,2	59,6	3,0	11,2	6,1	1,3	3,5	-50	141	323	4	3	71	37	0	39	4	494	570	22,4	3	4,7	0,1	0,27	1,2	
	n	13	13	13	9	13	13	13	9	13	13	13	12	13	13	13	13	13	13	10	13	13	12	12	12	10	10
C. cordifolium	**x**	**90,9**	**83,6**	**3,7**	**37,1**	**8,4**	**7,2**	**5,33**	**75**	**1783**	**4304**	**120**	**14**	**970**	**132**	**5**	**213**	**26**	**13454**	**587**	**148**	**5**	**44**	**1,1**	**1,1**	**29**	
	sd	2,5	24,6	1,0	14,4	2,0	5,1	0,70	138	1502	3008	103	15	662	79	6	424	34	15274	275	118	2	48	1,3	0,6	39	
	max	94,7	187,4	9,0	76,3	15,6	32,2	6,7	425	9924	17214	583	102	3763	403	25	3736	241	117506	1764	971	14	304	9	3	323	
	min	80,6	31,4	2,0	0,3	5,1	1,2	3,9	-180	124	692	1	1	48	27	0	12	3	584	89	5,1	2	1,5	0,0	0,1	1,4	
	n	109	108	110	79	108	109	110	92	108	108	108	108	108	107	108	108	108	108	100	108	108	107	108	106	100	27
C. giganteum	n=1	**85,0**	**148,9**	**5,0**		**8,9**	**41,0**	**6,10**		**5776**	**14268**	**225**	**54**	**1699**	**427**	**0**	**412**	**109**	**69732**		**310**	**8**	**35**	**0,5**	**1,0**		1
C. megalophyllum	**x**	**93,4**	**60,3**	**2,7**		**4,8**	**36,9**	**6,52**		**2742**	**10450**	**451**	**32**	**1578**	**702**	**3**	**501**	**62**	**987**		**2**	**7**	**27**	**0,6**	**2**		
	sd	2,8	26,1	0,6		1,3	24,7	0,30		701	1625	50	8	80	237	7	282	26	102		0,3	0,8	15	0,2	0,4		
	max	95,8	100,4	3,0		6,9	66,4	6,8		3520	11834	507	45	1675	984	15	955	100	1103		2	7	43	0,9	2		
	min	89,7	40,1	2,0		3,6	18,3	6,1		2052	8176	396	24	1501	514	0	277	39	838		2	5	10	0,4	1,0		
	n	5	5	3		5	5	5		5	5	5	5	5	5	5	5	5	5		5	5	5	5	5		1
C. richardsonii	**x**	**89,5**	**91,5**	**3,3**	**12,9**	**9,7**	**8,5**	**5,23**	**157**	**576**	**10940**	**35**	**12**	**1062**	**164**	**17**	**373**	**15**	**3195**	**623**	**146**	**13**	**52**	**0,8**	**0,6**	**5**	
	sd	1,0	14,3	0,5		1,1	5,3	0,24	96	367	5374	48	10	1083	97	14	347	11	2197	202	91	5	46	0,4	0,3	1,5	
	max	90,9	119,1	4,0	12,9	11,4	19,6	5,6	310	1365	22410	161	33	3941	388	53	1225	32	8070	1030	297	18	161	1,4	1,3	8	
	min	88,0	68,8	3,0	12,9	7,4	4,3	4,8	50	243	5398	10	4	623	102	9	97	5	1733	466	50	6	4	0,4	0,3	3	
	n	9	9	9	1	9	9	9	6	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2
Campylium stellatum	**x**	**86,5**	**127,5**	**3,0**	**52,3**	**9,9**	**21,2**	**5,48**	**177**	**4705**	**10544**	**2114**	**22**	**2497**	**223**	**38**	**657**	**74**	**25972**	**855**	**47**	**5**	**20**	**0,4**	**0,4**	**48**	
	sd	2,8	32,4	1,0	19,8	2,2	13,8	0,49	85	4706	6976	4278	10	1716	145	15	352	51	31770	265	54	3	20	0,4	0,2	66	
	max	89,7	190,2	5,0	78,7	12,9	47,7	6,5	320	13074	22410	14983	42	5116	500	59	1318	208	92579	1158	194	9	63	2	0,8	164	
	min	81,1	90,3	2,0	12,9	6,2	9,3	4,8	93	605	3095	73	8	562	95	17	195	20	2150	564	4	0,0	0,0	0,1	0,1	2	
	n	12	12	12	11	12	12	12	11	12	10	12	12	12	12	12	12	12	12	9	12	12	12	12	12	9	9
Cinclidium stygium	**x**	**87,5**	**116,7**	**3,5**	**58,1**	**10,9**	**13,0**	**5,60**	**91**	**3715**	**14203**	**2702**	**28**	**2458**	**121**	**26**	**381**	**60**	**18796**	**770**	**41**	**6**	**67**	**2**	**0,5**	**32**	
	sd	3,1	33,8	1,4	20,9	2,8	7,2	0,55	129	4689	4595	6026	12	1070	45	19	311	76	36325	364	47	2	64	2	0,3	65	
	max	91,9	169,9	5,0	78,7	14,5	26,9	6,5	320	11215	22216	14983	42	4039	187	55	802	208	92579	1207	133	9	193	6	0,8	164	
	min	83,3	77,4	2,0	24,6	7,6	6,7	5,0	-55	475	10033	6	10	1070	57	6	88	6	800	255	6	5	13	0,1	0,1	2	
	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4
***Dicranum* spp.**	n=1	**91,4**	**81,2**	**4,0**		**8,4**	**2,9**	**4,40**	**145**	**1266**	**1807**	**82**	**6**	**565**	**58**	**0**	**105**	**5**	**10149**	**174**	**124**	**3**	**17**	**1,2**	**0,6**	**58**	1
D. majus	n=1	**89,1**	**85,7**	**2,0**	**17,8**	**10,0**	**7,6**	**6,80**	**230**	**293**	**15263**	**154**	**11**	**3577**	**88**	**13**	**1981**	**13**	**271**	**761**	**2**	**4**	**8**	**0,8**	**0,04**	**0,4**	1
D. polysetum	**x**	**90,6**	**62,9**	**2,6**	**13,3**	**9,3**	**1,7**	**3,34**	**309**	**471**	**1439**	**39**	**3**	**676**	**186**	**9**	**584**	**29**	**986**	**349**	**148**	**2**	**12**	**0,1**	**1,3**	3	
	sd	2,3	14,6	0,6	9,5	2,3	0,5	0,40	37	401	594	67	1	179	109	4	1163	16	409	165	185	1	11	0,1	1,0	2	
	max	94,8	99,2	3,0	30,4	12,1	3,0	3,9	350	1582	2918	244	6	979	398	19	4733	53	2083	747	676	5	30	0,4	3	6	
	min	87,6	29,9	1,0	0,4	5,2	1,1	2,9	250	197	837	2	1	376	48	3	48	8	280	185	4	1	0,4	0,05	0,04	0,6	
	n	16	16	15	10	16	16	15	10	16	16	16	16	16	16	16	16	16	16	11	16	16	16	16	16	11	2

Hamatocaulis lapponicus	x	**92,0**	**70,1**	**3,0**	**43,3**	**7,6**	**5,2**	**5,61**	**41**	**1132**	**2372**	**119**	**8**	**490**	**99**	**9**	**64**	**14**	**17292**	**730**	**149**	**5**	**39**	**0,6**	**2**	**24**	
	sd	1,3	7,2	0,0	3,6	1,1	1,1	0,17	12	101	255	15	2	71	16	6	18	7	1525	137	34	0,26	11	0,1	0,3	4	
	max	93,5	86,7	3,0	49,6	10,2	8,1	5,7	50	1239	2628	129	13	603	138	25	106	31	18883	1009	231	5	59	0,8	2	29	
	min	88,9	61,3	3,0	39,7	6,2	4,6	5,2	20	968	1972	81	5	399	85	5	44	8	14552	573	116	4	19	0,4	1,3	19	
	n	9	9	9	9	9	9	9	5	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	1
H. vernicosus	x	**90,8**	**87,1**	**3,7**	**40,5**	**8,6**	**6,3**	**5,16**	**176**	**1837**	**5025**	**127**	**11**	**540**	**102**	**5**	**91**	**29**	**7431**	**775**	**63**	**10**	**53**	**0,5**	**1,1**	**13**	
	sd	2,5	19,4	1,6	9,4	2,6	3,8	0,86	103	2876	3731	94	13	343	55	5	52	21	8122	428	70	4	32	0,7	0,4	11	
	max	93,5	125,1	8,0	51,0	14,4	14,8	6,0	250	9910	11922	365	46	1303	196	16	193	66	20779	1265	195	17	106	3	2	29	
	min	85,5	61,3	3,0	28,1	6,2	0,8	3,9	30	267	429	3	1	25	20	0	32	4	124	295	10	4	13	0,1	0,6	0,4	
	n	11	11	11	6	11	11	11	4	11	11	11	11	11	11	11	11	11	11	6	11	11	11	11	11	6	3
Helodium blandowii	x	**89,8**	**88,1**	**3,8**	**35,4**	**9,5**	**6,3**	**4,99**	**44**	**1537**	**4474**	**77**	**9**	**791**	**115**	**17**	**2528**	**159**	**11573**	**624**	**188**	**5**	**28**	**0,7**	**0,7**	**19**	
	sd	1,6	17,6	0,8	15,2	1,3	2,4	0,56	77	838	3372	53	3	458	28	16	4630	269	9390	485	119	1,2	29	0,6	0,5	6	
	max	92,3	124,0	6,0	57,4	11,6	13,5	6,1	140	3114	9876	186	15	1515	173	48	12603	749	31877	1285	304	8	71	2	2	36	
	min	87,5	69,1	3,0	8,7	7,2	4,1	4,2	-85	428	1476	24	5	294	79	0	57	5	66	4	0,4	4	0,3	0,01	0,01	10	
	n	13	13	13	13	13	13	13	11	13	13	12	13	13	13	13	13	12	13	13	12	13	13	12	13	13	5
Hylocomium splendens	x	**83,3**	**172,5**	**4,5**	**49,1**	**11,2**	**24,6**	**5,10**	**178**	**5317**	**8260**	**953**	**22**	**2301**	**312**	**18**	**542**	**32**	**10765**	**1150**	**39**	**4**	**28**	**0,9**	**0,8**	**15**	
	sd	4,8	58,7	0,8	21,7	2,9	23,3	0,43	100	4131	8116	1448	12	1807	266	20	452	26	6031	744	29	2	28	0,5	0,6	15	
	max	88,0	281,3	5,0	65,3	14,4	60,5	5,6	310	13074	22410	3820	41	5116	772	53	1318	81	16826	2327	80	6	67	1,4	2	35	
	min	74,8	119,1	3,0	12,9	6,2	6,8	4,4	80	1365	1699	59	10	822	130	1	82	8	3446	451	4	0,0	0,0	0,4	0,3	2	
	n	6	6	6	5	6	6	6	6	6	5	6	6	6	6	6	6	6	6	5	6	6	6	6	6	5	5
Loeskypnum badium	x	**86,1**	**127,0**	**3,0**	**50,8**	**11,7**	**15,1**	**5,54**	**127**	**7546**	**9933**	**285**	**59**	**2035**	**178**	**18**	**519**	**38**	**5794**	**587**	**60**	**4**	**43**	**2**	**0,5**	**82**	
	sd	3,1	50,5	1,6	28,3	1,8	11,1	0,91	202	10093	9041	664	65	1334	113	19	457	21	10248	322	55	2	64	3	0,3	198	
	max	89,4	224,0	5,0	78,7	14,0	34,0	6,7	320	28862	22216	1923	203	4039	339	55	1484	75	30580	951	142	6	194	7	1,1	485	
	min	78,8	42,4	1,0	13,4	7,9	4,3	3,9	-150	395	2195	8	3	553	64	0	95	12	195	63	8	2	3	0,1	0,1	0,3	
	n	8	8	8	6	8	8	8	6	8	8	8	8	8	8	8	8	8	8	6	8	8	8	8	8	6	3
Meesia triquetra	x	**91,8**	**72,2**	**3,1**	**46,4**	**7,8**	**5,2**	**5,54**	**37**	**1134**	**2777**	**116**	**8**	**500**	**102**	**9**	**74**	**14**	**15655**	**756**	**139**	**5**	**39**	**0,6**	**2**	**21**	
	sd	1,4	9,0	0,3	5,8	1,3	1,1	0,22	11	286	1781	30	2	79	17	5	41	7	6049	202	48	2	11	0,2	0,4	8	
	max	93,6	97,4	4,0	61,3	11,4	8,1	5,7	50	1611	9819	151	13	664	151	25	222	31	20872	1265	231	15	59	1,0	2	33	
	min	88,1	61,3	3,0	39,7	6,1	4,1	5,1	20	332	1916	12	5	397	82	5	44	6	1800	499	28	4	17	0,3	0,5	4	
	n	18	18	18	17	18	18	18	9	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	2
Mnium **spp.**	n=1	**88,0**	**119,1**	**3,0**	**12,9**	**10,6**	**12,3**	**5,60**	**310**	**1365**	**22410**	**161**	**22**	**3941**	**130**	**53**	**459**	**32**	**8070**	**1030**	**50**	**6**	**49**	**0,7**	**0,3**	**8**	1
Paludella squarrosa	x	**90,7**	**84,2**	**3,9**	**28,4**	**8,7**	**6,9**	**5,85**	**20**	**660**	**6868**	**170**	**9**	**1423**	**124**	**4**	**133**	**20**	**15121**	**420**	**102**	**5**	**77**	**0,9**	**1,1**	49	
	sd	1,7	17,0	1,0	12,4	1,5	2,4	0,42	57	879	3570	92	8	672	83	6	124	21	10698	175	68,8	3,2	74,0	1,5	0,6	47	
	max	93,8	172,1	8,0	62,4	16,3	14,9	6,6	170	3999	17505	305	34	3291	628	29	897	131	32774	923	346	13	314	7	4	323	
	min	82,7	52,6	3,0	10,1	5,8	3,2	4,7	-80	124	2475	6	2	483	42	0	39	5	501	89	7	3	6	0,0	0,0	3	
	n	58	57	57	33	57	58	57	48	57	57	57	55	57	56	57	57	57	57	47	57	57	57	57	57	47	9
Phleurozium schreberi	x	**88,9**	**70,7**	**2,7**	**18,7**	**10,5**	**4,4**	**4,04**	**205**	**1204**	**4968**	**58**	**7**	**1045**	**81**	**16**	**848**	**33**	**1755**	**512**	**151**	**4**	**29**	**0,4**	**0,3**	**2**	
	sd	2,8	28,4	1,4	13,9	2,6	5,9	0,86	84	1265	8545	72	8	1145	55	16	1209	21	1870	205	210	4	66	1,0	0,3	2	
	max	93,4	144,4	6,0	40,7	17,1	28,1	6,4	290	5186	35839	244	40	4282	263	74	4733	80	6774	855	676	17	291	4	0,9	6	
	min	82,4	29,9	1,0	7,6	6,3	1,0	3,1	0	164	726	2	2	66	31	0	41	6	259	216	2	2	0,4	0,1	0,03	0,6	
	n	19	19	19	5	19	19	19	13	19	19	19	19	19	19	18	19	19	19	9	19	19	19	19	19	9	8
Pohlia nutans	x	**89,2**	**64,7**	**2,3**	**8,1**	**10,4**	**3,8**	**4,25**	**187**	**747**	**6605**	**102**	**5**	**1348**	**78**	**10**	**1132**	**35**	**1238**	**507**	**199**	**4**	**24**	**0,3**	**0,2**	**2**	
	sd	2,7	33,6	1,1	6,8	2,6	2,6	1,10	72	594	9382	125	3	1302	34	6	1195	18	1089	215	532	2	50	0,7	0,2	2	
	max	93,6	170,3	5,0	17,8	17,1	11,6	6,8	290	2077	35081	448	13	4426	175	19	4733	80	4638	855	2533	9	226	3	0,8	5	
	min	82,4	29,9	1,0	1,2	6,0	1,7	3,3	10	84	934	1	2	236	34	1	44	4	122	278	0,3	2	0,4	0,1	0,03	0,3	
	n	23	23	23	5	23	23	23	13	23	23	23	23	23	23	20	23	23	23	7	23	23	23	23	23	7	8
Polytrichum **spp.**	x	**88,5**	**104,4**	**4,5**	**57,6**	**10,9**	**5,0**	**4,53**	**113**	**4317**	**2996**	**94**	**10**	**637**	**83**	**6**	**132**	**17**	**7443**	**525**	**211**	**5**	**30**	**1,0**	**0,8**	**26**	
	sd	2,4	27,3	0,9	9,6	2,2	3,2	0,70	88	4102	1667	171	8	344	40	7	92	13	7666	232	337	2	24	1,2	0,5	23	
	max	91,6	143,4	7,0	70,1	15,7	16,3	5,6	260	15428	6426	813	26	1260	209	24	414	61	26381	1034	1649	8	111	4	3	56	
	min	83,6	24,0	3,0	46,7	8,0	1,8	3,6	-10	240	869	2	2	197	40	0	51	4	683	324	19	3	6	0,05	0,3	1,2	
	n	23	23	23	4	23	23	23	11	22	22	22	22	22	22	22	22	22	22	9	22	22	22	22	22	9	12
P. commune	x	**86,8**	**127,2**	**3,7**	**31,5**	**9,9**	**13,8**	**4,04**	**172**	**3250**	**2920**	**148**	**12**	**1018**	**195**	**14**	**1172**	**41**	**3865**	**1522**	**79**	**3**	**5**	**0,5**	**0,3**	**2**	
	sd	9,1	122,8	1,8	15,6	2,5	18,5	0,44	85	2621	1813	194	9	515	132	6	962	27	3831	1156	77	3	7	0,4	0,3	2	
	max	94,1	544,8	6,0	49,7	14,4	72,8	4,7	305	7955	8050	591	36	1866	586	23	2917	105	13990	4583	222	12	27	2	0,9	8	
	min	56,0	38,4	1,0	0,1	5,7	2,3	3,2	0	333	726	6	3	302	64	5	117	6	218	501	0,4	1,3	0,7	0,1	0,1	0,3	
	n	15	15	15	8	15	15	15	14	15	15	14	15	15	15	15	15	15	14	13	14	15	15	15	15	12	7
P. strictum	x	**88,9**	**91,5**	**3,0**	**37,1**	**10,3**	**5,7**	**3,94**	**183**	**2000**	**4029**	**85**	**8**	**687**	**105**	**10**	**722**	**21**	**3687**	**747**	**189**	**7**	**24**	**0,8**	**0,5**	**5**	
	sd	3,7	47,9	1,4	21,4	2,7	6,4	0,54	64	2735	3363	140	8	393	67	8	1021	21	4384	444	195	6	26	0,9	0,3	3	
	max	94,4	250,7	7,0	72,0	17,1	32,4	5,3	320	12913	11460	711	44	1893	317	40	3850	80	22367	2180	791	24	82	4	1,2	10	
	min	74,7	31,4	1,0	0,3	5,0	1,9	3,0	40	94	535	3	3	177	33	0	45	4	259	266	0,6	1,6	0,6	0,1	0,02	0,8	
	n	33	33	33	17	33	33	33	29	33	33	33	33	33	33	33	33	33	33	24	33	33	33	33	33	24	13
P. swartzii	n=1	**85,2**	**145,0**	**5,0**	**65,3**	**13,4**	**9,4**	**5,30**	80	**3646**	**5142**	**804**	**17**	**981**	**177**	**1**	**130**	**12**	**15707**	**610**	**20**	**5**	**40**	**1,4**	**1,4**	**26**	1
Pseudobryum cinclidioides	x	**89,8**	**95,1**	**3,8**	**41,3**	**8,7**	**9,6**	**5,34**	**52**	**2252**	**4187**	**121**	**15**	**970**	**165**	**16**	**3168**	**203**	**12430**	**530**	**135**	**5**	**25**	**0,8**	**0,8**	**23**	
	sd	5,0	66,3	0,9	14,3	1,7	12,1	0,59	142	974	2022	109	16	618	127	18	5004	290	20048	439	114	1,4	24	0,8	0,7	21	
	max	93,9	489,4	6,0	85,2	15,3	78,6	6,5	355	6182	11366	583	99	3763	812	77	15306	811	117506	1764	528	8	78	3	3	89	
	min	61,1	59,5	2,0	9,1	5,9	3,0	4,3	-90	1047	1018	4	5	294	48	0	29	3	63	4	0,3	2	0,3	0,01	0,01	1,4	
	n	41	41	41	39	41	41	41	34	41	41	40	41	41	41	41	41	40	41	41	40	41	41	40	41	41	10

Pseudo-calliergon trifarium	x	**93,0**	**68,6**	**3,3**	**37,2**	**6,6**	**6,4**	**5,88**	**80**	**1820**	**8736**	**171**	**14**	**1102**	**205**	**3**	**126**	**25**	**3076**	**361**	**25**	**9**	**92**	**0,9**	**2**	**12**	
	sd	2,4	22,4	0,9	11,9	2,1	3,7	0,54	87	1468	3597	103	12	686	101	7	74	19	4178	138	33	3	67	1,3	1,0	13	
	max	96,0	113,2	8,0	57,1	11,9	24,3	6,8	250	9924	19211	442	60	3291	523	53	428	109	33319	674	158	24	314	6	7	57	
	min	86,9	38,3	2,0	20,2	3,9	0,9	4,1	-90	306	1127	6	2	61	24	0	29	5	437	189	2	3	9	0,1	0,3	2	
	n	86	86	86	17	86	86	86	18	86	86	86	86	86	86	86	86	86	86	18	86	86	86	86	86	18	7
Rhizomnium spp.	n=1	**88,0**	**119,1**	**3,0**	**12,9**	**10,6**	**12,3**	**5,60**	**310**	**1365**	**22410**	**161**	**22**	**3941**	**130**	**53**	**459**	**32**	**8070**	**1030**	**50**	**6**	**49**	**0,7**	**0,3**	**8**	1
R. magnifolium	x	**75,1**	**300,1**	**3,0**	**57,4**	**9,0**	**45,0**	**5,05**	**308**	**1805**	**7244**	**136**	**29**	**1657**	**552**	**11**	**741**	**53**	**2679**	**1354**	**19**	**4**	**10**	**0,7**	**1,0**	**2**	
	sd	19,7	267,8	0,0	6,9	1,0	47,6	0,07	11	732	2582	83	25	428	368	14	392	21	1928	581	3	0,4	2	0,7	1,0	0,6	
	max	89,0	489,4	3,0	62,3	9,7	79	5	315	2322	9070	195	46	1959	812	21	1018	68	4042	1764	21	5	12	1,2	2	2	
	min	61,1	110,7	3,0	52,5	8,3	11	5	300	1287	5418	77	11	1354	291	1	464	38	1315	943	17	4	9	0,2	0,3	1,4	
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
R. pseudopunctatum	x	**84,8**	**149,0**	**2,7**	**45,5**	**8,7**	**30,6**	**5,73**	**273**	**1416**	**12023**	**338**	**17**	**2827**	**404**	**18**	**1540**	**35**	**1270**	**862**	**10**	**4**	**8**	**0,6**	**0,6**	**1,1**	
	sd	7,9	113,2	1,2	26,4	1,2	33,3	0,95	43	1219	5715	396	9	1132	447	9	866	20	867	142	15	0,5	1,4	0,3	0,9	1,1	
	max	89,5	279,7	4,0	70,3	10,0	68,8	6,8	315	2712	15382	792	27	3577	915	29	2097	51	1830	962	27	5	10	0,8	2	2	
	min	75,7	81,5	2,0	17,8	7,6	7,6	5,0	230	293	5424	67	11	1525	88	13	542	13	271	761	2	4	7	0,3	0,04	0,4	
	n	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3
R. punctatum	x	**86,4**	**133,6**	**4,0**	**45,8**	**6,9**	**28,2**	**5,55**	**113**	**7062**	**5197**	**2047**	**21**	**3454**	**329**	**16**	**725**	**49**	**21404**	**534**	**50**	**1,5**	**20**	**0,5**	**0,8**	**49**	
	sd	6,1	65,5	0,0	21,8	0,8	22,5	0,87	147	6944	180	2048	12	1920	198	18	685	37	5340	52	53	2	23	0,1	0,5	2	
	max	92,0	190,2	4,0	64,6	7,8	47,7	6,3	240	13074	5324	3820	31	5116	500	31	1318	81	26916	570	102	3	42	0,6	1,3	50	
	min	81,1	72,6	4,0	25,0	6,2	8,4	4,8	-20	858	5069	264	10	1738	150	0	120	16	16826	497	4	0,0	0,0	0,4	0,4	47	
	n	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4	2	4	4	4	4	4	2	2
Rhytidiadelphus triquetrus	n=1	**81,1**	**190,2**	**4,0**	**64,6**	**6,2**	**47,7**	**4,80**	**240**	**13074**		**3820**	**31**	**5116**	**500**	**31**	**1318**	**81**	**16826**		**4**	**0,0**	**0,0**	**0,4**	**0,4**		1
Sanioinia uncinata	n=1	**90,0**	**95,0**	**4,0**	**34,3**	**9,2**	**7,6**	**4,90**	**30**	**2137**	**3129**	**91**	**14**	**610**	**129**	**13**	**137**	**9**	**16256**	**594**	**179**	**5**	**23**	**2**	**0,9**	**12**	1
Scorpidium cossoni	x	**86,6**	**128,1**	**3,8**	**58,0**	**12,2**	**9,0**	**5,56**	**149**	**3701**	**12520**	**103**	**30**	**2360**	**104**	**17**	**285**	**27**	**3930**	**806**	**73**	**5**	**58**	**2**	**0,5**	**5**	
	sd	2,4	25,2	1,0	20,7	2,1	4,7	0,80	113	3983	8046	126	15	1315	40	18	230	22	3141	317	56	1,1	59	1,3	0,3	6	
	max	91,2	169,9	5,0	78,7	15,3	15,1	6,7	320	11215	22216	396	54	4039	163	55	747	75	10150	1207	141	6	194	5	0,9	18	
	min	83,3	86,2	2,0	28,1	8,5	1,9	4,3	-55	605	1134	8	6	361	62	0	71	10	510	356	14	3	12	0,5	0,1	1,4	
	n	8	8	8	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	3
S. revolvens	x	**91,9**	**76,1**	**3,3**	**46,6**	**7,3**	**8,0**	**5,84**	**95**	**1334**	**9056**	**819**	**12**	**1126**	**217**	**7**	**280**	**21**	**13400**	**723**	**67**	**8**	**64**	**0,7**	**2**	**25**	
	sd	3,8	35,7	0,7	16,9	3,0	7,5	0,75	75	1453	4515	3211	8	624	112	9	413	27	35314	319	77	3	41	0,4	1,0	53	
	max	96,0	195,8	5,0	82,9	15,1	41,6	6,8	230	8776	15263	18666	42	3577	438	41	1981	167	208053	1504	290	16	144	2	3	227	
	min	80,8	38,3	2,0	17,8	3,9	1,7	4,5	0	88	2096	10	4	415	33	0	46	5	271	256	2	4	4	0,2	0,04	0,4	
	n	33	33	33	11	33	33	33	15	33	33	33	33	33	33	33	33	33	33	17	33	33	33	33	33	17	10
S. revolvens **coll.**	x	**90,9**	**87,3**	**3,0**	**37,0**	**8,1**	**9,3**	**5,87**	**63**	**1807**	**11012**	**170**	**17**	**1806**	**156**	**9**	**157**	**24**	**9526**	**475**	**68**	**8**	**64**	**0,7**	**2**	**20**	
	sd	3,3	32,4	0,7	13,1	2,3	7,2	0,39	81	1598	4529	154	12	902	98	15	184	27	17373	339	80	3	41	0,4	1,0	33	
	max	95,6	201,9	6,0	59,1	12,5	34,1	6,6	160	8089	19211	753	51	3291	389	59	724	109	90044	1541	297	16	144	2	3	159	
	min	81,0	45,8	2,0	10,1	4,1	4,1	4,8	-155	387	1949	6	5	562	35	0	39	5	580	215	2	4	4	0,1	0,04	2	
	n	33	33	33	23	33	33	33	23	33	33	33	33	33	33	33	33	33	33	23	33	33	33	33	33	23	7
Scorpidium scorpioides	x	**89,4**	**104,3**	**3,5**	**42,6**	**9,4**	**10,5**	**5,72**	**102**	**2586**	**10186**	**488**	**32**	**1495**	**123**	**8**	**174**	**43**	**11354**	**557**	**65**	**8**	**107**	**2**	**0,9**	**21**	
	sd	1,9	18,9	1,3	14,1	1,4	7,5	0,55	92	2462	5242	2241	33	1069	80	13	160	41	22703	368	71	3	104	3	0,4	42	
	max	92,3	162,0	8,0	78,6	13,8	41,0	6,7	240	12000	23516	14983	184	3569	427	53	802	208	92579	1494	310	17	470	16	2	164	
	min	84,3	71,6	2,0	24,4	7,2	1,0	4,3	-90	267	1136	6	2	66	31	0	41	5	437	215	6	3	6	0,1	0,2	1,4	
	n	44	44	44	27	44	44	44	27	44	44	44	44	44	44	44	44	44	44	27	44	44	44	44	44	27	8
Straminergon stramineum	x	**90,9**	**84,2**	**3,7**	**36,3**	**8,6**	**5,2**	**5,05**	**88**	**1188**	**3754**	**105**	**9**	**838**	**120**	**6**	**209**	**21**	**10083**	**536**	**167**	**5**	**40**	**0,8**	**1,2**	**25**	
	sd	3,2	38,5	0,9	15,6	2,1	5,3	0,78	97	1344	2537	95	16	527	84	8	470	32	8924	418	148	3	33	2	0,9	24	
	max	95,4	544,8	7,0	76,3	17,0	72,8	6,8	390	7955	17083	517	211	3577	628	63	3736	335	58005	4583	777	25	237	16	8	122	
	min	56,0	31,4	1,0	7,7	4,4	1,2	2,9	-160	88	421	2	1	63	4	0	7	3	271	150	1,8	1,3	0,5	0,0	0,0	0,4	
	n	239	240	241	143	239	239	242	213	238	237	239	238	237	235	239	238	239	238	221	238	236	236	239	237	220	32
Tomentypnum nitens	x	**89,6**	**94,8**	**3,5**	**30,2**	**9,3**	**9,0**	**6,04**	**49**	**1015**	**9101**	**202**	**21**	**2032**	**128**	**8**	**217**	**13**	**16972**	**559**	**91**	**5**	**92**	**2**	**1,2**	**33**	
	sd	3,0	33,5	0,6	12,6	1,7	6,4	0,31	92	1435	5589	92	42	1227	54	12	381	8	10355	205	48	0,9	93	3	0,6	23	
	max	92,4	229,6	4,0	63,2	13,8	39	6,8	310	7023	22410	305	211	6145	331	53	1981	42	32774	1030	234	7	314	16	2	83	
	min	77,4	66,9	2,0	12,9	7,2	4,9	5,5	-55	131	2377	7	2	465	42	0	39	5	271	228	2	3	8	0,0	0,0	0,4	
	n	26	26	26	26	26	26	26	24	26	26	26	24	26	26	26	26	26	26	26	26	26	26	26	26	26	7
Warnstorfia **spp.**	x	**92,0**	**73,1**	**3,2**	**45,9**	**7,7**	**4,0**	**5,16**	**91**	**1125**	**2574**	**73**	**7**	**550**	**99**	**6**	**398**	**59**	**9833**	**531**	**188**	**6**	**43**	**0,7**	**1,4**	**22**	
	sd	1,5	17,8	0,8	14,2	1,4	1,7	0,57	75	1182	989	59	5	356	40	7	1491	150	7835	280	118	3	32	0,6	0,6	17	
	max	94,6	123,4	6,0	75,7	11,4	8,1	6	230	4946	5667	153	22	1610	193	25	6903	680	20872	1009	436	17	157	2	2	71	
	min	88,2	37,4	3,0	16,0	5,2	1,7	4	-30	144	865	2	2	61	38	0	36	5	75	3	0,8	3	0,4	0,01	0,03	2	
	n	21	21	21	13	21	21	20	12	21	21	21	21	21	21	21	21	21	21	18	20	20	20	20	20	18	8
W. exannulata	x	**91,8**	**75,8**	**3,4**	**41,2**	**7,6**	**6,3**	**5,16**	**132**	**1858**	**4500**	**96**	**11**	**624**	**168**	**9**	**694**	**72**	**4637**	**561**	**122**	**7**	**39**	**0,7**	**1,3**	**14**	
	sd	3,1	28,9	0,9	16,0	2,5	6,0	0,79	139	1865	2973	75	11	330	99	18	1934	192	7173	328	194	3	37	1,2	1,0	13	
	max	95,6	187,4	7,0	76,3	15,6	47,5	6,6	425	9924	11922	365	60	1658	592	109	9198	875	29002	1235	1076	18	227	12	7	60	
	min	80,6	30,0	1,0	0,3	4,4	0,8	3,3	-90	158	1	2	1	47	24	0	29	4	84	3	1	0,01	0,01	0,01	0,01	1	
	n	94	94	96	34	94	94	98	42	94	94	94	94	94	94	94	94	94	94	45	95	95	95	95	95	45	20
W. fluitans	x	**89,5**	**103,5**	**3,9**	**49,4**	**9,7**	**5,3**	**4,25**	**167**	**2654**	**1661**	**27**	**10**	**477**	**95**	**4**	**114**	**31**	**4683**	**608**	**194**	**4**	**32**	**0,8**	**1,4**	**11**	
	sd	4,0	42,8	1,0	22,4	3,2	11,1	0,52	48	5517	738	26	18	370	105	8	169	59	9296	874	154	2	31	0,9	1,2	10	
	max	94,9	279,0	8,0	91,7	19,4	64,8	5,3	280	35505	3174	130	115	2317	691	48	855	347	63861	5162	899	14	193	4	8	58	
	min	75,3	48,4	2,0	15,1	5,0	1,1	3,2	70	112	498	2	1	72	0	0	7	2	706	152	14	0,5	2,3	0,02	0,3	2	
	n	46	47	47	17	46	46	47	35	45	45	46	46	46	46	46	46	46	46	34	46	45	45	46	45	34	15

W. sarmentosa	x	85,0	149,9	3,8	48,9	11,4	18,6	5,25	38	5962	10635	1838	32	2180	186	17	371	37	23346	769	59	5	82	2	0,7	62	
	sd	7,7	92,3	1,3	19,1	2,8	15,2	0,35	91	5422	4435	5087	27	882	122	14	335	44	56103	416	94	2	100	2	0,3	141	
	max	90,4	444,4	6,0	72,8	17,1	57,8	6,1	240	17421	17214	18666	108	4051	459	41	1132	167	208053	1387	346	8	304	6	2	485	
	min	59,6	94,0	1,0	10,1	7,9	5,9	4,7	-85	524	2574	6	9	757	35	1	51	5	333	63	11	1,3	6	0,1	0,3	0,4	
	n	14	13	14	14	13	14	13	14	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	5
W. trichophylla	x	93,9	56,6	2,8		4,7	28,7	6,56		2446	11214	425	37	1537	623	3	418	53	2515	11	7	7	38	0,9	2		
	sd	2,5	22,3	0,4		1,1	24,6	0,26		773	1885	62	12	102	236	6	271	26	2627	1,0	8	1,4	22	0,5	0,4		
	max	95,8	100,4	3,0		6,9	66,4	6,8		3520	13641	507	60	1675	984	15	955	100	6830	12	20	9	72	2	2		
	min	89,7	40,1	2,0		3,6	6,6	6,1		1488	8176	343	24	1378	401	0	174	28	838	9	2	5	10	0,4	1,0		
	n	7	7	5		7	7	7		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7		1
Hepaticae	x	87,7	64,6	2,3	7,7	11,7	4,4	3,97	255	1816	4674	173	7	1050	119	9	1286	61	5341	565	93	4	13	0,1	0,2	0,7	
	sd	3,7	42,2	1,4	7,8	3,2	4,3	1,12	27	3466	3491	215	7	489	72	7	1334	49	10466	275	90	1	18	0,1	0,2	0,2	
	max	90,8	152,6	5,0	13,2	17,1	13,3	6,4	280	9624	12064	507	23	2010	228	19	3534	163	28438	855	209	7	41	0,2	0,6	0,8	
	min	82,4	34,4	1,0	2,1	9,0	1,2	3,1	226	282	1729	3	2	467	21	2	143	22	261	308	0,6	3	0,8	0,1	0,0	0,5	
	n	7	7	7	2	7	7	7	3	7	7	7	7	7	7	6	7	7	7	3	7	7	7	7	7	3	6
Marchantia	x	89,8	48,9	2,5	7,6	9,7	3,9	4,85	260	191	11532	110	4	2682	38		363	16	451	254	10	4	41	0,2	0,1	2	
	sd	2,3	14,4	0,7	0,0	1,8	3,4	1,91	28	51	11512	115	1	2263	3		135	3	120	35	12	1,0	47	0,1	0,1	0,2	
	max	91,4	59,0	3,0	7,6	11,0	6,3	6,2	280	227	19672	191	4	4282	40		458	18	535	278	18	5	74	0,3	0,1	1,9	
	min	88,2	38,7	2,0	7,6	8,4	1,5	3,5	240	155	3391	29	3	1081	36		267	14	366	229	2	3	7	0,2	0,1	1,6	
	n	2	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	1
Lichenes	x	88,5	54,3	2,0	5,3	11,1	3,1	4,03	290	282	6086	52	6	1433	182	14	1106	37	554	509	43	4	17	0,2	0,2	1,7	
	sd	4,6	12,1	1,0	3,1	4,4	1,8	1,48	50	74	7624	49	3	1606	122	6	899	17	228	286	71	0,8	31,9	0,1	0,1	1,7	
	max	95,2	64,2	3,0	7,6	17,1	6,3	6,2	350	404	19672	130	9	4282	330	19	2644	60	915	855	170	5	74	0,3	0,4	4,6	
	min	82,4	36,2	1,0	1,0	4,7	1,6	2,9	240	227	1705	3	3	437	40	6	267	14	280	201	4	3	1,3	0,1	0,0	0,6	
	n	5	5	5	4	5	5	4	4	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	2
***Cladonia* spp.**	n=1	95,2	36,2	1,0		4,7	2,4			228	2592	68	8	877	330	6	864	32	915	201	13	3	3	0,3	0,4	5	1
Cenococcum graniforme	x	84,7	149,0	4,6	49,4	11,9	14,4	4,89	120	4528	6532	153	22	1289	172	9	316	35	7699	1018	155	6	43	1,4	0,8	11	
	sd	7,3	92,5	1,3	18,0	3,1	17,8	0,90	104	4536	8526	397	31	1277	391	12	377	54	14787	1013	272	6	63	2	0,8	16	
	max	95,6	717,0	8,0	89,8	19,4	88,7	6,5	315	28862	40258	3820	257	6145	4360	74	2973	430	155070	8540	2533	63	470	26	6,5	91	
	min	45,7	30,0	1,0	0,9	4,4	1,1	3,3	-155	115	89	1	2	11	9	0	18	3	104	204	1	1	1	0,04	0,05	0,2	
	n	141	141	142	116	141	141	143	103	139	139	136	140	140	137	140	140	140	139	91	136	139	139	140	137	90	51
Cristatella mucedo	n=1	82,2	229,9	5,0	46,1	13,6	23,5	3,80	200	3456	609	30	16	254	304	10	182	10	1219	587	41	2	3	2	2	2	1
Unknown	x	89,0	103,5	3,9	47,0	9,7	9,0	5,20	90,0	3406	4657	115	17	875	176	8	764	57	10833	982	134	6	43	1,0	1,2	17	
	sd	4,6	49,1	0,9	16,2	3,1	9,6	0,54	85,5	7098	2571	75	23	437	159	9	2361	129	13095	1132	179	3	35	1,4	0,9	15	
	max	93,8	269,0	6,0	78,6	18,2	43,8	6,2	300	35505	9566	315	102	1959	691	29	12154	593	63861	5162	899	14	118	7	4	60	
	min	72,7	55,1	3,0	22,1	5,8	1,7	4	-70	130	0	7	2	106	34	0	47	4	67	4	0,4	0,0	0,0	0,0	0,0	2	
	n	26	26	27	17	26	26	27	22	26	26	26	26	26	26	26	26	26	26	20	26	26	26	26	26	20	19

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