The Finnish Environment

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NATURE AND
NATURAL RESOURCES

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HELSINKI 2001

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The publication is available in the Internet:
http://www.vyh.fi/eng/orginfo/publica/electro/fe489/fe489.htm
ISBN 952-11-0916-5
ISBN 952-11-1072-4 (PDF)
ISSN 1238-7312

Cover photo: Kauhalampi from south-east. Photo: Orvo Yli-Kyyny
Layout: Martti Salo
Printing house: Vammalan Kirjapaino Oy, Vammala 2001, Finland

Contents

Introduction

Ombrotrophic bogs with surface patterning can be found in boreal regions northeast North America, oceanic areas in Europe, northeast Asia, New Zealand and southernmost South America as well as continental areas in western Siberia and Hudson Bay lowlands (Sjörs 1990). Small scale surface patterning in ombrotrophic bogs include hummocks and hollows/pools which are arranged either concentricly or eccentricly, depending on the topography.

Minerotrophic aapamires (string fens) are typical in the boreal and subarctic regions of North America, northern Europe and Siberia. Surface features of aapamires include alternating peat ridges (strings) and depressions occupied by sparse vegetation or by open water (flarks or pools) (Ranckén 1912, Cajander 1913, Foster & King 1984). In Finland, southern minerotrophic fens with only slight or no clear small scale surface patterning, such as *S. papillosum* fens, are also included to aapamires. Surface patterning of Finnish aapamires becomes clearer towards north (Ruuhijärvi 1960).

Ombrotrophic bogs have traditionally been a focus of studies of the developmental history of mires (Aario 1932, 1933, Иванов 1957, 1981, Aartolahti 1965, 1966, Tolonen 1967, Foster & Glaser 1986, Foster et al. 1988, Korhola 1992). Studies of the development of aapamires and the origin of their surface patterns have been made much less (Богдановская-Гиенэф 1936, Галкина 1959, Tolonen 1967, Foster & King 1984, Seppälä & Koutaniemi 1985, Kuznetsov 1986, Foster & Fritz 1987).

Mire ecosystems can be classified on several hierarchy levels: mire site, mire massif (mire complex) and mire system (Галкина 1959, Masing 1984, Moen 1995, Yurkovskaya 1995). In Fennoscandia, mire ecosystems consisting of different kinds of massifs are widespread. Detailed developmental studies in mire systems, including both bogs and aapamires mixed in one mire area, have been rarely done in Finland (Tolonen 1967, 1968a). Tolonen (1967, 1968b) mapped the main vegetation units of large mire systems separating ombrotrophic and minerotrophic sites. However, only Tolonen and Seppä (1994) have earlier attempted to define different complexes in Kananiemensuo mire system in southern Finland and roughly to estimate their areas. Nevertheless, some materials about the development of similar mire systems, are available from Karelia (Галкина 1959, Yurkovskaya 1995, Елина et al. 1984). Kauhaneva mire system, in the Kauhaneva-Pohjankangas national park, is an example of a complicated system including concentric, eccentric and *Sphagnum fuscum* bogs, and aapamires, located near the boundary of bog and aapa zones (Ruuhijärvi 1960, 1988).

The Russian classifications of mire sites (facies) include 3-4 hierarchy levels of their structure (Лопатин 1954, Елина 1968, Козлова 1974): **1) classes** are distinguished according to the nutrient status (from ombrotrophic to eutrophic); **2) groups** are distinguished in accordance with plant cover types (woody, herb, moss); **3) subgroups** are separated on the basis of the structure (simple or combinated); **4) types** are identified according to dominating plant associations on general patterns of facia microtopography (microrelief). The name of the mire type includes its trophic status, names of main elements of microtopography (if it has), and dominant species of communities. For example the Finnish keidasräme is called ombrotrophic ridge-hollow mire site (complex) (*Sphagneta fusci + Sphagneta baltici*, for the associations see Braun-Blanquet 1964). For simple types names are short; oligotrophic *Carex-Sphagnum* fen (*Carex rostrata-Sphagnum fallax*).

Due to the diverse structure of mires, it is important to study and understand mires as whole, and the relations of its parts to the whole and with each other as Ranckén (1912) has stated.

One aim of this study is to investigate the natural history of the minero-ombrotrophic Kauhaneva mire system and the stratigraphic evidence for the process of small scale pattern (hummock-hollow) formation on concentric bogs. Another aim is to study how the palaeoecology explains the present structure of the mire system, and to compare the natural history of Kauhaneva mire system with other studied mires in Finland and Karelia, especially on White sea coast.

The third aim of this study is to describe the structure of the vegetation in different morphological levels and its connections to the flora. One of the main ideas for this work is to integrate the knowledge of the present vegetation and flora to the succession series of the past plant communities and flora of the last millenia.

This study is a part of the East Fennoscandian mire protection work between Russian Karelian and Finnish scientists, and also a part of the joint nature conservation work between Russia and Finland.

Study area

2

Kauhaneva-Pohjankangas national park consists of several large mire complexes and parts of the chain of Pohjankangas esker. Kauhaneva mire system, which is the subject of this study, forms the core area of Kauhaneva-Pohjankangas national park.

Kauhaneva-Pohjankangas is situated in the middle boreal forest zone, and its mires belong to the Concentric bogs zone, in the subzone of Western Finland (Ruuhijärvi 1988) (Fig. 1). Mire complexes in the area are usually concentric bogs. Aapamires are not very common and they are mostly unpatterned and poor in nutrients.

Kauhaneva is one of the largest and most representative examples of raised bogs in Southern Ostrobothnia and thus one of the key areas for protecting ombrotrophic bogs (Aapala & Lindholm 1995). It has also international value, as it is both a Ramsar (Finnish Environment Institute 1996) and Natura 2000 site (Ympäristöministeriö 1996).

Annual precipitation of the study area is 650 mm, of which 200 mm is snow. The annual mean temperature is +3 °C and the length of the growing season is 164 days. The duration of snow cover is in average 140 days (Alalammi 1987).

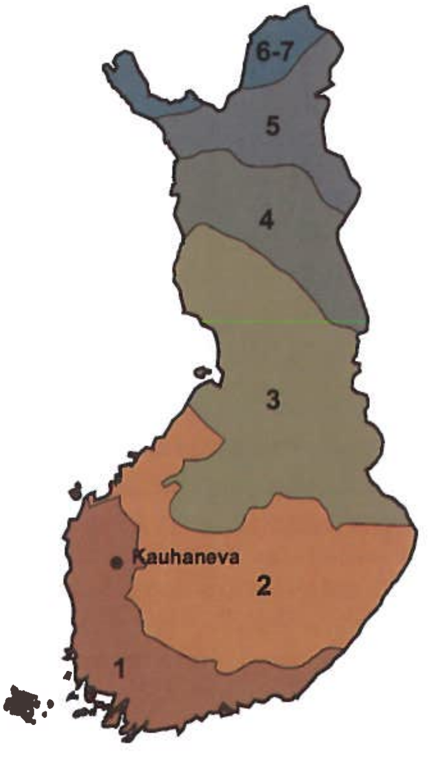


Fig. 1. Mire vegetation regions in Finland (Ruuhijärvi 1988) and the location of the study area. 1 = Concentric bogs, 2 = Eccentric bogs and Sphagnum fuscum bogs, 3 = Sedge aapa mires, 4 = Flark aapa mires, 5 = Northern aapa mires, 6-7 = Palsa and orohemiarctic mires in Lapland.

Tall sedge fen in the northwestern part of Kauhaneva in winter. Photo Raimo Heikkilä 1978.

Kauhaneva-Pohjankangas was included in the national park programme (Komiteanmietintö 1976: 88) and it was established in 1982. The total area of the present national park is 3 264 ha. Most of this area is mires (2 878 ha), of which Kauhaneva mire system covers approximately 87% (2 506 ha). The planned extension for the national park covers 1 000 ha. The extension consists of areas included in the National Mire Protection Programme (1981), areas bought to the state for conservation purposes, and extension areas proposed by Heikkilä (1986). Forestry drainage, agricultural use and peat mining in mires in the surroundings of Kauhaneva is very intensive. In the drainage basin of the river Kyrönjoki only 8% of the original mire area is in natural state (Heikkilä 1999).

The Kauhaneva-Pohjankangas national park is situated in Karvia and Kauhajoki communes in western Finland, at the southwestern part of the Suomenselkä watershed. Soils are very poor and on dry places dominated by pine forests (*Calluna*-type, *Cladina*-type, *Vaccinium*-type). These pine dominated forests and extensive concentric bogs are characteristic to the watershed area. Waters are mainly humic small ponds and brooks. Springs and places with groundwater influence with more rich vegetation types (spruce mires and rich fens) are rather common near the Pohjankangas esker (Fig 2).

The bedrock in the Kauhaneva-Pohjankangas national park is poor. It belongs to an extensive area of archaean rocks of Middle-Finland and it is formed of porphyric granite (Sederholm 1909). The bedrock is covered by a thick layer of loose quaternary deposits, gravel and sand in most parts of the park, mainly overlain by peat.

Pohjankangas-Nummikangas esker lines the national park and its mires in the east. The esker has been developed during the last ice age between two lobes of ice sheet (Hellemaa 1980). Beside Kauhaneva the Pohjankangas esker is mainly sand and gravel. Several beach ridges and dunes can be found beside the esker. Also in the western part of Kauhaneva, there are some dunes. The landforms have developed during the deglaciation, which occurred ca. 9400 years B.P. (Salomaa 1982, Salomaa & Alhonen 1983). After a short period, the Ancylus Lake retreated due to the land uplift, and Kauhaneva area was above the water level ca. 9000 years B.P. (Salomaa 1982, Salomaa & Alhonen 1983). These dates are not calibrated, and probably the deglaciation and retreat of Ancylus Lake occurred ca. 1000 years earlier (Atte Korhola 1998, pers. comm).

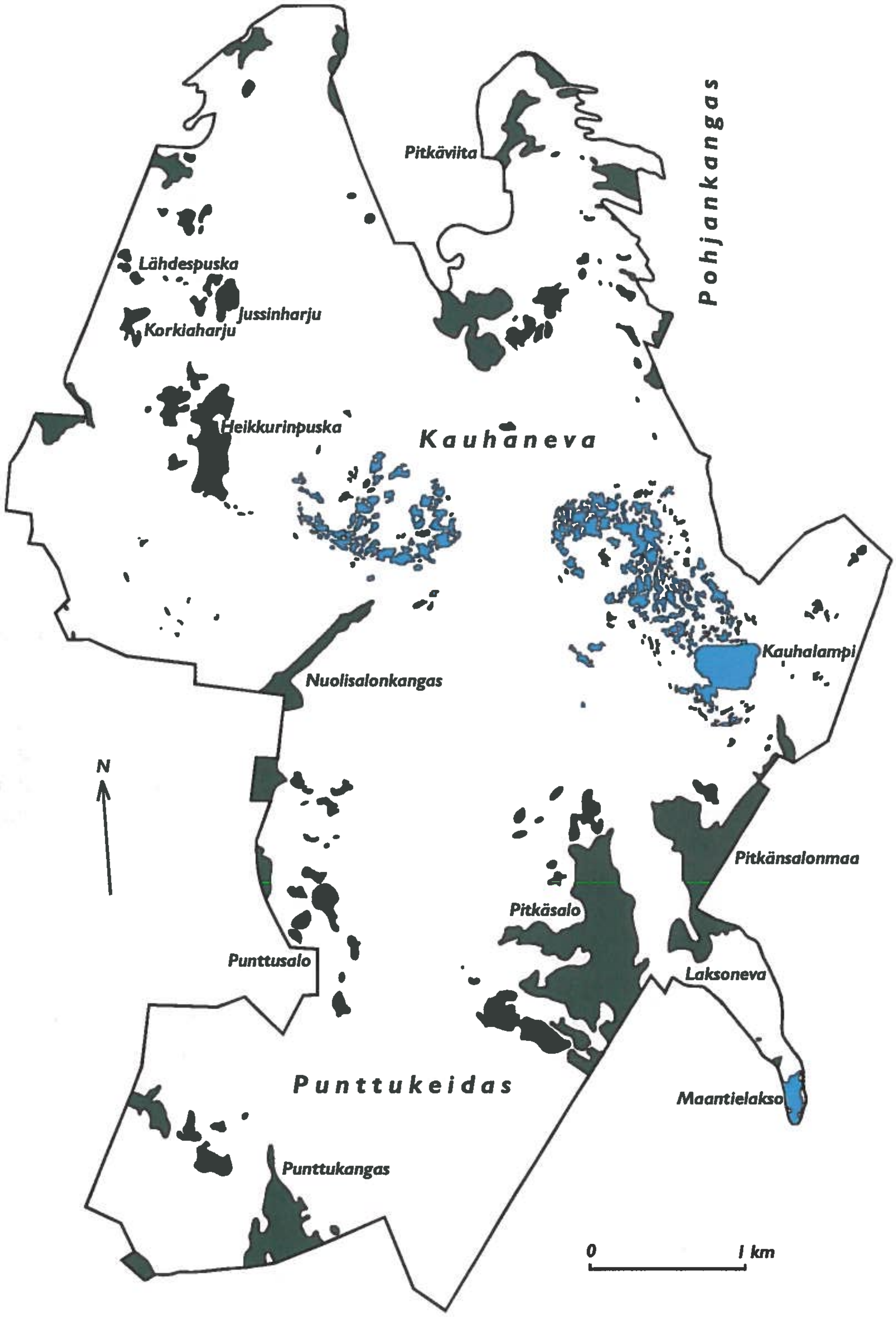


Fig. 2. Detailed map of the study area. Mineral soil areas are shown as green and ponds as light blue. The names of places mentioned in the text are given as well as the boundary of the national park.

3 Materials and methods

Kauhaneva mire system was studied in several morphological levels. We analysed the diversity and structural pattern of mire site types for the whole system (according to Галкина 1959, Moen 1995), and we studied the variation of mire sites (according to Ruuhijärvi 1960, Eurola 1962, Ruuhijärvi 1983, Eurola et al. 1984, 1994, Heikkilä 1987; facies in Russian sense, Лопатин 1954, Елина et al. 1984) and their pattern for every type of mire complexes (according to Rancken 1912, Sjörs 1948, Ruuhijärvi 1960, Eurola 1962, Moen & Singsaas 1994; mire mesolandscape (massif) in Russian literature, Галкина 1959, Иванов 1957, Юрковская 1975, Yurkovskaya 1995). In different mire sites also plant communities (Сукачёв 1922, Osvald 1923, Waren 1926, Paasio 1939, Лопатин 1949, Мазинг 1975, Masing 1984) were studied.

Mapping of the mire site types and flora of Kauhaneva-Pohjankangas national park was made in summer 1985 (Heikkilä 1986). In connection with the field work, site types were delimited in 1:10 000 aerial photographs taken in 1984. Field work included determining the mire site types according to Eurola and Kaakinen (1978) and verifying their boundaries. The site type map with each vegetation pattern numbered, includes a separate table where the area, the site type of the pattern, and also some interesting features, like communities included in the site, characteristics of the tree stand and rare plant species, are explained. No vegetation relevés were made, but dominant and indicator species were determined in thefield. The nomenclature of Ruuhijärvi (1983) for site types is mainly used in this paper.

The flora of the national park was also studied in 1985. Some new records were made in 1987 and 1994. The present study area covering approximately 75% of the national park was divided into 34 quadrats, 1 km^2 each. In each 1 km^2 quadrat all vascular plant and bryophyte species, excluding liverworts, were recorded. The abundance of each species was estimated in relative, three-step scale: 1. sparsely, 2. moderately, 3. abundantly.

Most of the information about current vegetation and flora of the study area in this paper comes from Heikkilä (1986) unless otherwise noted, and reference to that publication will, therefore, not be repeated.

In 1994 Karelian scientists made vegetation community descriptions of all the main mire sites along the two study profiles. Plant cover of mire sites usually consists of small patches (from 1-2 to some tens of square metres) of plant communities confined to different patterns of microtopography. Descriptions were made in all forms of microtopography / morphological patterns (hummock, hollow, pool). Thus there were 2 to 5 vegetation community descriptions of every mire site. In site types, the percentage cover of each microtopography type, its size (length, width), height or depth, was estimated. Percentage cover of each community was estimated too. Cover of each plant species in community were estimated using the Braun-Blanquet' (1964) scale.

Community types (associations) were named according to dominating species on every layer (trees, field layer, ground layer). This dominant (physiognomic) principle is common in Fennoscandian (Osvald 1923, Warén 1926, Paasio 1933, Sjörs 1948) and in Russian (Сукачёв 1922, Богдановская-Гиенэф 1928, Лопатин 1954) phytocoenological tradition.

To study the stratigraphy and developmental history of the Kauhaneva mire system two profiles were made in 1994: a 4 km longitudinal profile from north to south and 3.5 km cross profile from east to west (Fig. 3). Levelling of mire surface (every 100 metres), measuring peat thickness (every 50 metres) and description of mire sites (facies) were carried out along both profiles. Twenty-nine peat cores for the stratigraphic analysis were taken with a Russian corer (Tolonen 1967) along the two transects. Macrosubfossil analysis were made from all 29 cores.

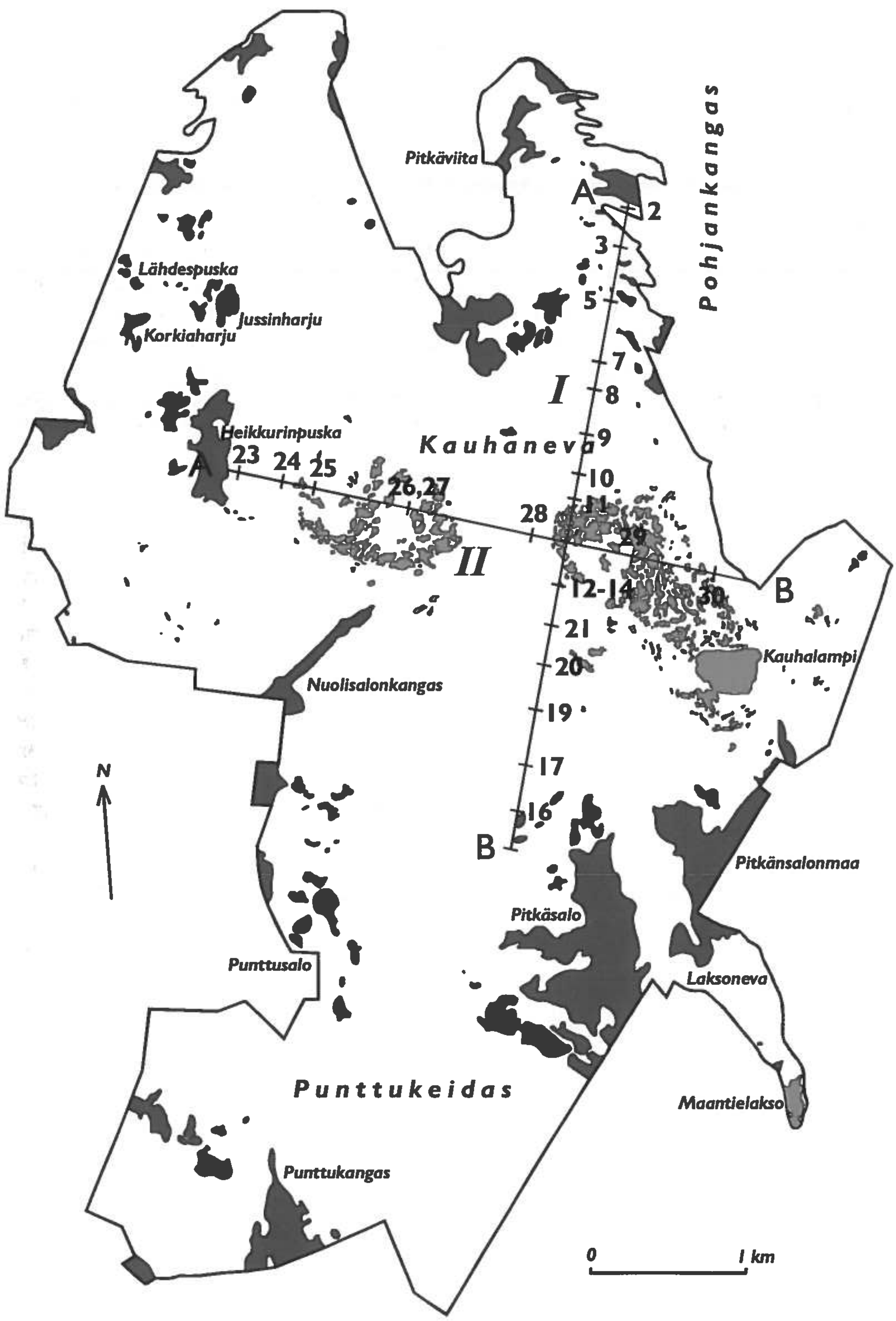


Fig. 3 Location of the two study profiles and numbers of peat sampling sites (cores).

Pavel Shevelin setting the transect across concentric bog I. Photo Raimo Heikkilä 1994.

Stratigraphy of the peat cores was described in the field. Samples (304 altogether) for the macrofossil analysis were taken already in the field, and only these samples (approximately 100 g fresh peat) were taken to the laboratory. From thin stratigraphic layers (up to 20-30 cm) one sample was taken from the middle of the layer, from thicker layers, control samples were taken every 20-30 cm. At the laboratory, samples were first studied under microscope to analyze the degree of decomposition, as amount of humus, at the precision of 5% (Минкина & Варлыгин 1939). After this samples were sieved from humus with water through a 0.25 mm mesh. Botanical macrosubfossil analyses of samples were made with a microscope method (Короткина 1939) at the precision of 5% and the fossils of every species were indentified according to the atlas of macrofossils by Кац et al. (1977). Macrosubfossil analyses were made in the Laboratory of Mire Ecosystem in Petrozavodsk by N. Stoikina.

Data of macrofossil analyses were used for dividing peats into classes (types in Russia): ombrotrophic (верховой), mesotrophic (переходный) and eutrophic (низинний) (Тюремнов 1949, Лопатин 1973, Boch and Masing 1983, Елина et al. 1984). Peat classes are distinguished on the basis of plant macrofossil composition. Peats completely composed of eutrophic plants refer to eutrophic class. The ombrotrophic class includes peat which consists solely of ombrotrophic plants macrofossils. The mesotrophic class unifies peat types with *Sphagnum* moss remains of both ombrotrophic and minerotrophic ecological groups.

The ombrotrophic ecological group generally includes *Eriophorum vaginatum*, *Trichophorum cespitosum*, *Sheuchzeria palustris*, *Spahgnum fuscum*, *S. magellanicum*, *S. angustifolium*, *S. balticum*, *S. majus*, *S. cuspidatum*, *S. lindbergii*, *S. capillifolium* and *S. rubellum*; the mesotrophic group *S. fallax*, *S. flexuosum*, *S. riparium*, *S. papillosum*, *S. centrale*, *S. angstroemii*, *S. jensenii* and *S. russowii*; and the eutrophic group *Betula pubescens*, *Phragmites australis*, *Carex lasiocarpa*, *C. rostrata*, *C. chordorrhiza*, *Menyanthes trifoliata*, *Equisetum fluviatile*, *E. palustre*, *Eriophorum angustifolium*, *E. gracile*, *Trichophorum alpinum*, *Molinia caerulea*, *Epilo-*

bium palustre, Scorpidium scorpioides, Tomentypnum nitens, Warnstorfia exannulata, Paludella squarrosa, Meesia triquetra, Sphagnum warnstorfii, S. subsecundum, S. platyphyllum, S. obtusum, S. subfulvum and *S. squarrosum*.

Finnish mire researches have another ecological scale of mire plants (Eurola et al. 1984, Antipin et al. 1997), but it is not difficult to make compromise in discussion of results. Finnish eutrophic group is more narrow than in Russian school. It includes only species of very rich fens with high content of Ca and high pH.

A majority of peat producing plants of eutrophic mires (*Phragmites australis, Menyanthes trifoliata, Equisetum fluviatile, Betula pubescens, Carex lasiocarpa* and *C. rostrata*) have a very wide ecological amplitude and continue to dominate together with *Sphagnum* mosses of mesotrophic and ombrotrophic ecology at mesotrophic mire sites. The occurrence of the above mentioned species at poor minerotrophic mire sites is explained to be relicts from an earlier stage of succession (Лопатин 1972). That is mainly due to the deep root penetration into peat. Vascular mire plants typically indicate nutrient conditions at 20-30 cm depth and mosses point out to trophic status of a 5-10 cm peat layer (Елина et al. 1984). All the minerotrophic species are eliminated entirely in clear ombrotrophic conditions.

Peat types (виды in Russian terminology) are the primary units of the peat classification and are used widely for a presentation of peat deposits stratigraphy. Peat types are distinguished on the basis of plant remains content and classified according to a dominance of certain plant fossils in a peat type. A decay resistance of different plant species is always taken into account (Тюремнов 1949, Классификация видов торфа и торфяных залежей. 1951, Елина et al. 1984). Woody plant species are included into a name of peat type if their macrofossils amount in peat sample is not less than 15% (for instance: woody-sedge, woody-*Sphagnum* etc.). If peat is generally formed by woody remains (40% and more) it is considered as woody peat (for instance: birch peat, spruce peat etc.). Herbs are included into a name of peat type when a content of their remains contains more than 25%. If the percentage of herb macrofossils is more than 60% and the amount of woody ones less than 15% in a peat sample, it should be called herb (for instance: sedge peat, horsetail peat etc.). Mosses are included into a peat type name if their remains are 35-60% of the total macrofossil amount in a sample. Peat is considered as moss peat when it contains moss remains more than 65% of all the macrofossils in a sample (for instance: *Sphagnum* mesotrophic, *Bryales* peat, *Fuscum* peat).

Two samples for the radiocarbon dating were taken from the deepest point of the peat deposit. Samples were dated at the Institute of Geography, University of Sankt-Peterburg.

Nomenclature follows Hämet-Ahti et al. (1998) for vascular plants and Koponen et al. (1998) for bryophytes.

4 Results

4.1 Flora

Altogether 173 vascular plant species and 68 moss species have been found in the study area (Appendix 1). The distribution and abundance of each species in the study area was mapped in a 1 km^2 grid (Appendix 2). Many of the frequent species are also abundant, being the most important formers of peat and determining the ecological status of the present habitat. Some of the abundant species are forming large stands or carpets where they are dominating, e.g. *Andromeda polifolia, Betula nana, Carex lasiocarpa, C. rostrata, Eriophorum vaginatum, Ledum palustre, Rubus chamaemorus, Scheuchzeria palustris, Sphagnum angustifolium, S. balticum, S. fallax, S. fuscum, S. majus* and *S. papillosum*, while other abundant species have a scattered but continuous distribution, e.g. *Drosera rotundifolia, Aulacomnium palustre, Dicranum bergerii, D. polysetum, Polytrichum strictum, Sphagnum compactum, S. magellanicum, S. capillifolium, S. russowii* and *S. tenellum*.

The species were divided into four groups: mire plants, forest plants, hydrophytes and anthropochore species on the basis of observations in the study area. Mire species were defined as species which were found in natural vegetation on peat soil, even though they often grow also in other kinds of habitats. On the other hand, some forest species were found in mires, e.g. *Epilobium angustifolium* and *Dryopteris carthusiana* in seagull's nest sites with abundant nitrogen, which is rather typical in many mires.

In the study area forest species were found in mineral soil islands in the mire and in the narrow forest strips surrounding the mire, which are included in the national park. Floristically the forests are poor. Aquatic flora was found in small brooks and two ponds which have connection to mineral soil. It included the vascular plants *Nymphaea tetragona, Sparganium hyperboreum, S. minimum* and *Callitriche palustris*, and the bryophyte *Fontinalis antipyretica*.

Anthropochore species grow along the roads and paths, in two small gravel pits, in ditches and in fireplaces. Along the roads grow e.g. *Agrostis capillaris, Rumex acetosella, Festuca ovina* and *Poa pratensis*. In the gravel pits there is waste from burnt houses, which is the reason for the growing of *Calystegia sepium* subsp. *sepium, Phlox paniculata* and *Sedum acre*. Surprisingly there were three bushes of *Potentilla fruticosa* in the bog nearby the pond Kauhalampi, where the local people go swimming. In 1994 they had disappeared. In a fireplace in Nuolisalonkangas grew *Funaria hygrometrica*.

The total amount of species in each square kilometer varied between 30 and 149 (Fig. 4). The smallest numbers of species, between 30 and 49 occur in the quadrats containing the largest ombrotrophic bogs. The most species rich squares are those with spring effect and strongest human influence.

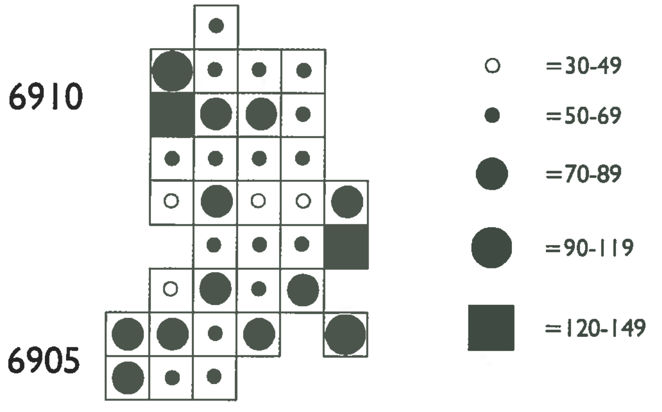


Fig. 4. Total amount of vascular plant species in each 1 km² quadrat in Kauhaneva–Punttukeidas study area.

Of the mire species found in the study area, 66 grew only in one, two or three 1 km² quadrats (Fig. 5), e.g. *Alnus glutinosa, Angelica sylvestris, Calla palustris, Carex diandra, C. dioica, C. loliacea, C. panicea, Crepis paludosa, Equisetum palustre, Juncus bulbosus, J. stygius, Luzula sudetica, Poa alpigena, Polygonum viviparum, Rubus arcticus, Salix myrsinifolia, Viola epipsila, Calliergon cordifolium, Helodium blandowii, Paludella squarrosa, Sphagnum auriculatum* var. *inundatum, S. fimbriatum, S. subsecundum* and *Tomentypnum nitens*. They are plants of small fertile habitats like springs, spruce mires, swamps and mesotrophic fens.

Juncus stygius northwest of Pitkäsalo. Photo Raimo Heikkilä 1994.

On the other hand, 21 species were found in every studied square km quadrat, and 8 were missing in only one or two quadrats. They contain species of ombrotrophic and oligotrophic mires, e.g. *Andromeda polifolia, Betula nana, B. pubescens, Calluna vulgaris, Carex globularis, C. lasiocarpa, C. pauciflora, Drosera rotundifolia, Empetrum nigrum, Eriophorum vaginatum, Ledum palustre, Pinus sylvestris, Rubus chamaemorus, Vaccinium oxycoccos, V. uliginosum, Pleurozium schreberi, Polytrichum strictum, Sphagnum angustifolium, S. balticum, S. magellanicum, S. capillifolium, S. papillosum* and *S. rubellum* (Appendix 1). In other frequency classes there are very few species. Approximately in every other square occur e.g. *Carex canescens, C. chordorrhiza, Juncus filiformis* and *Molinia caerulea*, which are species of oligo-mesotrophic fens.

Carex globularis in the northeastern margin of Kauhaneva. Photo Raimo Heikkilä 1987.

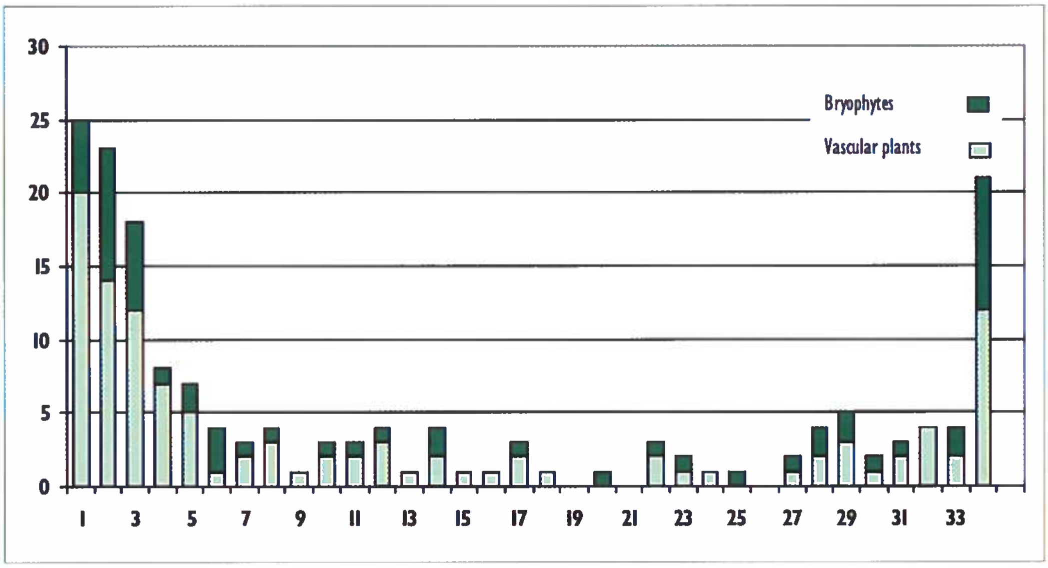


Figure 5. The distribution of vascular plant and bryophyte species according to the number of occurrence in the 1 km² quadrats.

The number of plant species in Kauhaneva mire system is not very high. The most representative species group is mosses. We found 29 of Finland's 38 species of *Sphagna* in the mire system. Most of the species are ombro-oligotrophic, but in mire sites with spring effect also some meso-eutrophic species can be found.

Several rare plant species were found in the study area. *Rhynchospora fusca* and *Juncus stygius* were found in Kauhaneva, northwest from Pitkäsalo (Site 1, Fig. 6). The former one was also found in the southwestern part of Punttukeidas, growing abundantly in a large mesotrophic flark (Site 2, Fig. 6). *Pedicularis sceptrum-carolinum* is abundant in a spring-fed spruce-mire in the northwestern part of Kauhaneva (Site 3, Fig. 6). *Carex dioica, C. diandra* and *Poa alpigena* grow in a rich spring fen in Lähdespuska, northwestern part of Kauhaneva (Site 4, Fig. 6). *Carex panicea* forms a large stand in a thin-peated meso-trophic sedge fen in Punttukeidas (Site 5, Fig. 6). *Sparganium hyperboreum* grows in a little pool in Punttukeidas in one of its southernmost locations in Finland (Site 6, Fig. 6).

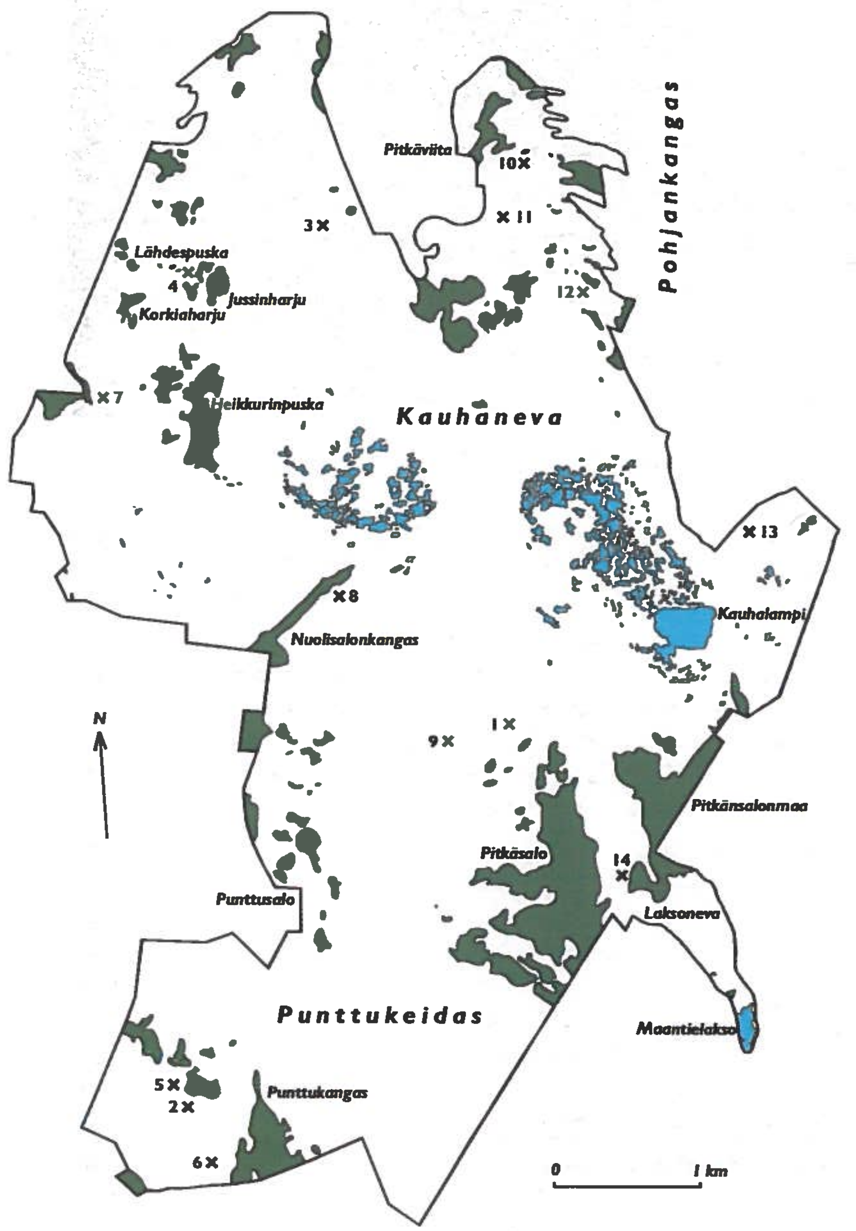
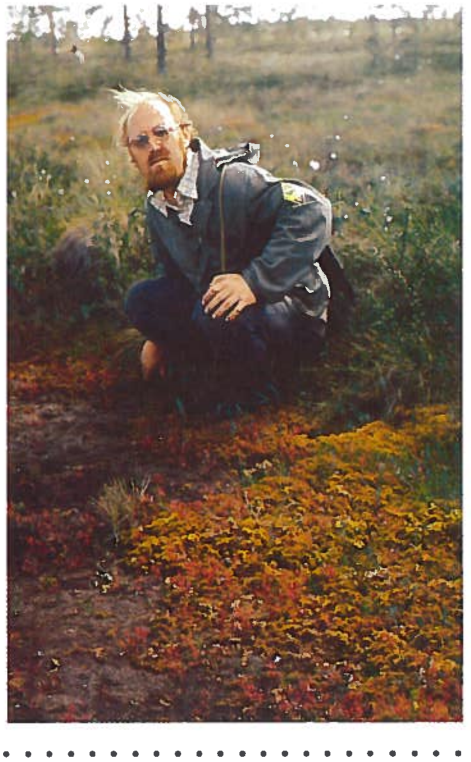


Figure 6. Location of the sites with rare plant species in Kauhaneva mire system.

One of the most notable species in Kauhaneva–Punttukeidas is *Sphagnum molle*, which was found in eight of the 1 km2 quadrats (Sites 1, 2, 7-14, Fig. 6). In July 1994, during an extremely dry period, Sphagnum moss carpets were typically very dry and brown in Kauhaneva. Only stands of *S. molle* had been able to preserve water, and they were very easy to find because of the green colour, even though the patches are rather small, typically less than one square metre. Other regionally rare moss species in Kauhaneva are *Helodium blandowii*, *Tomentypnum nitens* and *Paludella squarrosa*, which grow in the rich spring fen in Lähdespuska and in spring-fed spruce mires.

Sphagnum pulchrum grows in Kauhaneva with *S. majus* and *S. papillosum* in typical ombrotrophic hollows forming narrow strips along the margins of mud surfaces in the central part of the ombrotrophic bog. Macrosubfossils of *S. pulchrum* have been found here only in the top 10 cm of the peat.

A patch of Sphagnum molle (light green), with abundant Drosera rotundifolia, among dry S. papillosum and S. compactum in the northern part of Aapa II. Photo Raimo Heikkilä 1994.



Oleg Kuznetsov studying a fringe of Sphagnum pulchrum in the margin of a mud-bottom hollow in the centre of Bog I. Photo Raimo Heikkilä 1994.

4.2 Site types of the study area

Mire sites of Kauhaneva can be divided into two types according to the way they receive water and nutrients: ombrotrophic mires (bogs) receive only atmospheric water, whereas minerotrophic mires (fens) receive, in addition, water from the mineral soil. Altogether 45 site types have been indentified in Kauhaneva mire system (Tables 1 to 5).

4.2.1 Minerotrophic mires

4.2.1.1 Spruce mires

Spruce mires are minerotrophic mires, with hummock and intermediate level vegetation. Spruce (*Picea abies*) and/or deciduous trees and shrubs (e.g. *Betula pubescens, Alnus glutinosa, Salix* species) form the tree and shrub layers. Vegetation in the field layer is dominated by grass and herb species (e.g. *Calamagrostis purpurea, Equisetum sylvaticum, Cirsium helenioides*), with *Vaccinium myrtillus* and *V. vitis-idaea*. The ground layer consists of forest moss species and *Sphagnum* species (e.g. *Polytrichum commune, Pleurozium schreberi, Sphagnum girgensohnii, S. centrale*).

Table 1. Spruce mire types in study area.

Site type	No. of patterns	Mean size of pattern (ha)	Total area (ha)
Spring spruce mire	3	0.6	1.8
Myrtillus spruce mire	2	0.8	1.6
Thin-peated spruce mire	2	0.5	1
Equisetum sylvaticum spruce mire	1	0.9	0.9
Total	8	0.7	5.3

Spruce mires are very rare in the study area and they form clearly less than one percent of the whole mire area. Four different spruce mire types were found. Two patches of thin-peated spruce mire were found, one in Kauhaneva, near the southern end of Pitkäviita and the other in Punttukeidas. Equally rare types are *Equisetum sylvaticum* and *Myrtillus* spruce mires.

In the western part of the area there are two isolated patches of spring spruce mires, and northwards from these is another small, but drained patch. These spring spruce mires are the most species rich habitats in the whole study area. Tree layer is dominated by spruce and shrub layer by *Alnus glutinosa, A. incana, Salix* species and *Betula pubescens*. In the field and ground layers grow several nutrient-demanding species, e.g. *Carex dioica, Pedicularis palustris, P. sceptrum-carolinum, Helodium blandowii, Rhizomnium punctatum* and *Warnstorfia exannulata*.

4.2.1.2 Pine mires

Pine mires are oligotrophic, sometimes partly ombrotrophic mires where pine (*Pinus sylvestris*) is the dominant tree species. Height of the pine trees is 6 - 10 m. Field layer is dominated by dwarf shrubs (*Ledum palustre, Vaccinium uliginosum, Chamaedaphne calyculata, Betula nana, Empetrum nigrum, Calluna vulgaris*), or in some cases by *Carex globularis* or *Eriophorum vaginatum*. Different *Sphagnum* species (*Sphagnum angustifolium, S. capillifolium, S. fuscum, S. magellanicum, S. russowii*) with some forest mosses (*Dicranum polysetum, D. bergerii, Pleurozium schreberi, Polytrichum strictum*) and *Cladina* lichens are characteristic for the ground layer.

Eriophorum vaginatum pine mire in middle June in the margin of bog VII. Photo Raimo Heikkilä 1985.

Table 2. Pine mire types in study area.

Site type	No. of patterns	Mean size of pattern (ha)	Area (ha)
Thin-peated pine mire	43	1.3	57.6
Thin-peated pine mire with S. fuscum hummocks	7	1.5	10.3
E. vaginatum pine mire with S. fuscum hummocks	2	5.2	10.3
Eriophorum vaginatum pine mire	4	2.3	9.3
Carex globularis spruce-pine mire	3	0.6	1.9
Spruce-pine mire	1	0.6	0.6
Total	60	1.5	90

Pine mires are especially common at the margins of the studied mire area. Patterns of six different pine mire site types cover altogether 4% of the whole mire area. In most pine mires in the study area, tree cover is very sparse and *Sphagnum fuscum* hummocks are typical.

Thin-peated pine mires are the most common type of pine mires, and they occur as narrow strips or small patches around forests on mineral soil. Some small *Eriophorum vaginatum* pine mire patches can be found, especially in mire margins. Spruce-pine mires are rare in the area, and only a couple of *Carex globularis* spruce-pine mire patches in the northwestern part of Kauhaneva and a patch of spruce-pine mire in northeastern part of Punttukeidas exist.

Thin-peated pine mire in the southeastern margin of Kauhaneva. Photo Raimo Heikkilä 1985.

4.2.1.3 Fens

Fens (including oligotrophic, mesotrophic and meso-eutrophic fens) are open mires with intermediate or flark level vegetation. Sedges and *Sphagnum* species form the dominant vegetation.

Fens are the most common site types in Kauhaneva and they cover 30% of the total mire area. Twelve different site types were found.

Table 3. Fen types in the study area.

Site type	No. of patterns	Mean size of pattern (ha)	Area (ha)
Tall-sedge fen	29	6.0	174.3
Sphagnum flark fen	18	8.6	154.5
S. papillosum short-sedge fen	19	5.5	103.6
S. papillosum tall-sedge fen	8	11.4	91.1
S. papillosum fen with Sphagnum flarks	8	8.1	65.1
Short-sedge fen	16	2.9	46.3
S. papillosum short-sedge fen with S. fuscum hummocks	5	4.7	23.6
Mud bottom flark fen	6	3.9	23.3
Herb-rich mud bottom flark fen	4	1.9	7.6
Swampy tall-sedge fen	3	1.3	3.8
Tall-sedge fen with S. fuscum hummocks	2	1.6	3.1
Short-sedge fen with Sphagnum flarks	1	2.5	2.5
Total	119	5.9	698.8

Extensive tall-sedge fens are typical in the aapa mire between the large ombrotrophic bogs of the Kauhaneva mire system. They occur also in the laggs of the bogs. Most of the tall-sedge fens are *Sphagnum fallax* tall-sedge fens, but also *S. papillosum* tall-sedge fens and *S. papillosum* sedge fens with flarks are common. Somewhat more rare are tall sedge fens with *S. fuscum* hummocks or with surface water effect. Typical dominant tall sedges in these fens are *Carex lasiocarpa* and *C. rostrata*.

Another common group of fens are low-sedge fens of which the most common site types are low-sedge fens and *S. papillosum* low-sedge fens, typically dominated by *Carex pauciflora*, *C. limosa* and *Eriophorum vaginatum* in the field layer.

The third large group of fens are flark fens. The most common flark fen types are *Sphagnum* -flark fens. In addition, some patches of mud bottom flark fen and mesotrophic mud bottom flark fens occur.

Low-sedge fen in the northern part of Kauhaneva. Photo Raimo Heikkilä 1985.

Wet flark fen in the southern part of Aapa II. Photo Raimo Heikkilä 1985.

4.2.1.4 Rich fens

Rich fens are open mires with brown mosses (e.g. *Campylium stellatum, Cinclidium stygium, Tomentypnum nitens, Limprichtia revolvens,*) dominating the ground layer. Eutrophic species are characteristic also to the field layer (e.g. *Saxifraga hirculus, Carex flava, Eriophorum latifolium*).

There is only one, small, rich spring fen patch (0.1 ha) in the western part of Kauhaneva. Several demanding species grow in this spring fen, such as *Tomentypnum nitens, Carex diandra, Poa alpigena, Carex dioica* and *Pedicularis sceptrum-carolinum*.

Rich spring fen in Lähdespuska in late autumn. Photo Raimo Heikkilä 1975.

4.2.1.5 Combination types

Combination site types are formed as a combination of spruce/pine mire types at hummock level and of fen/rich fen mire types at intermediate–flark level. Most of the combination site types in Kauhaneva–Punttukeidas have pine mires in the hummock level and oligotrophic fen at the flark level. There are thirteen different combination site types covering 15% of the total mire area.

Table 4. Combination mire types in study area.

Site type	No. of patterns	Mean size of pattern (ha)	Area (ha)
Short-sedge pine fen	48	2.9	137
Short-sedge pine fen with S. fuscum hummocks	22	4	87.6
Tall-sedge pine fen	19	2.3	42.8
Short-sedge S. papillosum pine fen	7	4.3	29.9
Short-sedge S. papillosum pine fen with S. fuscum hummocks	1	13.8	13.8
Tall-sedge pine fen with S. fuscum hummocks	3	3.6	10.9
Short-sedge S. papillosum pine fen with Sphagnum flarks	1	8.7	8.7
Pine fen with Sphagnum flarks	1	8.5	8.5
Herb-rich S. papillosum pine fen with mud bottom flarks	1	4	4
Eriophorum vaginatum spruce fen	2	1.3	2.6
S. papillosum tall-sedge pine fen	1	1.3	1.3
Molinia caerulea pine fen	1	0.4	0.4
Herb-rich tall-sedge birch fen	1	0.3	0.3
Total	108	3.2	347.8

Molinia caerulea pine fen in the northeastern part of Kauhaneva. Photo Raimo Heikkilä 1985.

Only two combination site type patches with spruce mires occur in Punttukeidas; one is *Eriophorum vaginatum* spruce mire and the other is herb-rich tall-sedge birch fen.

The combination types with pine mires have either tall-sedge, short-sedge or flark fen as an intermediate–flark level part. Both tall- and short-sedge pine mires are most common at the margins of Kauhaneva mire system. Pine mires with flark fens are rare in the area.

4.2.2 Ombrotrophic bogs

Ombrotrophic bogs include forested and open mires as well as their combination types. Height of the pine trees in ombrotrophic bogs is 3-5 m. Bogs are very common in Kauhaneva and they cover 50% of the whole mire area. Nine different ombrotrophic site types were found.

Table 5. Ombrotrophic bog types in study area.

Site type	No. of patterns	Mean size of pattern (ha)	Area (ha)
S. fuscum bog with hollows	21	27.5	577.8
Short-sedge bog with S. fuscum hummocks	16	9.7	155.7
Empetrum-Fuscum bog	5	17.5	87.5
Calluna-Fuscum bog	34	2.4	81.6
Short-sedge bog	9	7.5	67.9
Hollow bog	4	16.9	67.5
Dwarf-shrub pine bog	30	2.2	65.8
S. fuscum bog with ombrotrophic short-sedge bog	12	4.5	53.5
Dwarf-shrub pine bog with S. fuscum hummocks	5	2.9	14.4
Total	136	8.6	1171.7

Sphagnum fuscum hollow bogs are the most common mire types in Kauhaneva. At the centers of the concentric bogs flark level is dominated by hollows and pools, and at the margins and in the eccentric bogs by drier, short-sedge bogs. The *Calluna-S. fuscum* bogs form the hummocks in both cases.

S. fuscum bogs are also very common in Kauhaneva. They occur both in mire margins and center, but the most extensive *S. fuscum* bogs are in the center. Both *Calluna-* and *Empetrum-Fuscum* bogs can be found.

Short-sedge bogs are common and extensive mire type in the bog parts of Kauhaneva area. Most of the short-sedge bogs have some *Sphagnum fuscum* hummocks. On carpet level they are dominated by *S. angustifolium*. There are also some individual hollow bogs, although they usually occur as a part of a *S. fuscum* hollow bog combination type.

Short-sedge bog in the southeastern part of Kauhaneva. Photo Raimo Heikkilä 1985.

Dwarf-shrub pine bogs, usually dominated by *Ledum palustre*, are rather common at the mire margins. Dominance of *Ledum palustre* is characteristic for the southern dwarf-shrub pine bogs. Only one patch is dominated by *Betula nana*, which is the dominant species in the northern dwarf-shrub pine bogs. Dwarf-shrub pine bogs with *Sphagnum fuscum* hummocks are dominated by *Ledum palustre* and *Calluna vulgaris*, of which the latter is a characteristic species for western Finland.

Dwarf-shrub pine bog in the southeastern part of Kauhaneva. Photo Raimo Heikkilä 1985.

4.2.3 Drained mire sites

Ditching in the study area has been only sporadic. Most intensive effects of ditching can bee seen in Punttukeidas, where a several kilometers long ditch dissects the mire. The drainage effect does not extend to a very large area, but along the ditch mires have been dried to a considarebale amount. Most of the drained mires have been different types of open and forested bogs, pine mires and fens.

Drained short-sedge fen in the northern part of aapa I, 10 years after ditching, with no significant improvement in timber growth. Photo Raimo Heikkilä 1985.

Table 6. Drained mire types in study area. The drained sites have been divided into three groups according to the change in vegetation and tree stand, caused by ditching: 1) drained sites where the vegetation and tree growth have not significantly changed after ditching (D), 2) drained sites where the vegetation has changed but it is still possible to determine the natural site type, and where tree growth has improved due to ditching (C), and 3) sites which have changed to resemble mineral soil forest sites as different kinds of peatland forests.

Site type	No. of patterns	Mean size of pattern (ha)	Area (ha)
Thin-peated pine mire (D)	3	3.6	10.7
Dwarf-shrub pine bog (D)	4	1.6	6.4
Thin-peated pine mire (C)	5	1.2	6.1
Tall-sedge fen (C)	1	5	5
Myrtillus peatland forest	2	1.9	3.7
Tall-sedge fen (D)	3	1	3.1
Short-sedge bog with S. fuscum hummocks (C)	1	3	3
Short-sedge bog (C)	1	2	2
Calluna-fuscum bog (D)	1	1.7	1.7
Spring spruce mire (C)	1	1.2	1.2
Drained Polytrichum mire where the natural type is undeterminable	1	1.2	1.2
Spruce-pine mire (D)	1	1.1	1.1
Short-sedge pine fen (C)	1	1.1	1.1
Spring spruce mire (D)	1	1	1
Molinia pine fen (D)	2	0.5	1
Short-sedge pine fen (D)	1	1	1
Swampy herb-rich spruce mire (D)	1	0.8	0.8
Sphagnum flark fen (D)	1	0.3	0.3
Short-sedge fen (D)	1	0.7	0.7
Total	33	1.5	51.1

4.2.4 Forests and other habitats

Forests cover about 8% of the study area. Most of the forests are pine-dominated dry heath forests of *Calluna* site type. In the ground layer *Cladina* spp. and *Pleurozium schreberi* dominate while the field layer consists of *Calluna vulgaris, Empetrum nigrum* subsp. *nigrum* and *Vaccinium vitis-idaea.* Also a little more fertile pine forests of *Vaccinium* type and *Empetrum-Vaccinium* site type are rather common. In those, *Pleurozium schreberi* and *Dicranum* spp. dominate in the ground layer, and *Vaccinium vitis-idaea, Empetrum nigrum* subsp. *nigrum* with sparse *Vaccinium myrtillus* form most of the field layer. There are also a few patches of spruce forests of *Myrtillus* site type. There *Hylocomium splendens* and *Pleurozium schreberi* form the ground layer, and *Vaccinium myrtillus* dominates in the field layer. Especially in mire margins there are many paludified strips of forests. Extremely dry heath forests of *Cladina* site type are very rare in the study area. *Cladina* spp. form the ground layer entirely, and the field layer is very sparse.

Most of the forests are young. Only in Pitkäsalo they are older than 100 years, but also there the tree stands have been influenced by selective cuttings before the year 1950.

It has often been difficult to distinguish between thin-peated spruce or pine mires and paludified forests on the basis of vegetation. Due to uneven peat depth, areas with peat layer have been defined as mires and those without peat as paludified forests, when there has been vegetation consisting of mire plants.

In the marginal western slope of Pohjankangas esker there are a few small shallow depressions, which have a special vegetation. They are waterlogged in spring and early summer, and therefore they are treeless. The vegetation consists of *Polytrichum* spp. in the ground layer, and sparse *Juncus filiformis* and *Nardus stricta* in the field layer.

In the study area there are two ponds with minerogenic water. In Maantielakso beside the Pohjankangas esker there are sedges (*Carex rostrata, C. limosa*) in the shoreline, and in the bottom of the shallow pond grows *Nymphaea tetragona.* In Punttukeidas there is a small pond with *Sparganium hyperboreum.*

In Pohjankangas there is a small old gravel pit in the national park with ruderal vegetation on the bottom of, due to dumping of waste from a burnt house in the pit around the year 1980. After the compilation of the species list in 1985, many anthropochorous species have already disappeared.

Table 7. Forest site types and other habitats in study area.

Site type	No. of patterns	Mean size of pattern (ha)	Area, ha
Calluna type	86	1.5	129.7
Empetrum-Vaccinium type	3	6.8	20.4
Vaccinium type	12	1.5	17.4
Myrtillus type	7	2.1	14.6
Paludified Vaccinium type	4	2.1	8.5
Paludified Calluna type.	23	0.3	7.5
Cladina type	3	1.4	4.3
Paludified Empetrum-Vaccinium type	1	1.2	1.2
Empetrum-Calluna type	1	0.6	0.6
Waterlogged depression	6	0.4	2.5
Pond	2	5.5	11
Gravel pit	1	0.3	0.3
Total	149	1.5	218

4.3 Structure of mire system and complexes

Kauhaneva is a complicated mire system with several bog and aapa mire complexes (Fig. 7, 8). There are three well-developed concentric bog complexes which cover 36% of the whole mire system, six eccentric bog complexes with 7% cover, one *Sphagnum fuscum* bog complex with 9% cover and four aapa mire complexes with 48% cover (Table 8).

Fig. 7. A false-colour infrared aerial photo of Kauhaneva mire system. Published by permission nr 80/MYY/01 of the National Board of Survey.

Table 8. The area of the mire complexes in Kauhaneva mire system

Mire complex	Area hectares
Concentric bog I	326.2
Concentric bog II	317.1
Concentric bog III	269.4
Eccentric bog IV	38.4
Eccentric bog V	29.7
Eccentric bog VI	29.5
Eccentric bog VII	40.9
Eccentric bog VIII	15.5
Eccentric bog IX	9.4
Sphagnum fuscum bog X	217.6
Aapa I	266.3
Aapa II	824.2
Aapa III	67.3
Aapa IV	32.8

Fig. 8. Mire complexes in Kauhaneva including three concentrig bog complexes (Bog I-Bog III), six eccentric bog complexes (Bog IV-Bog IX), one S. fuscum bog complex (Bog X) and four aapamire complexes (Aapa I-Aapa IV).

4.3.1 Site types of bogs

4.3.1.1 Concentric bogs

Concentric bogs have ridges and hollows surrounding the highest point of the bog in concentric circles. The three concentric bogs in Kauhaneva are large and well developed. They all have very distinctive morphological pattern consisting of wide areas of open water pools and high (60 - 70 cm), sharp-edged, *Calluna-Fuscum* hummocks. Old, dwarfed, pines grow on hummocks. In the centre in addition to open water pools, there are ombrotrophic hollows, dominated by *Sphagnum majus, S. lindbergii* and *S. pulchrum*. On the edge of the bogs, the hollows are dominated by ombrotrophic short-sedge communities with *S. balticum* and *S. tenellum*. Altogether 22 different site types were found from these concentric bogs (Table 9).

The centre of concentric bog I with large pools. Photo Raimo Heikkilä 1975.

The eastern bog (Bog I) is largest (Table 1) and its surface patterning has developed to an intricate network of hummocks and hollows. The centre is covered by 196, irregularly shaped, open water pools, separated by broad hummocks. Most of the pools are less than 0.5 ha in area, but there are also few pools over one hectare (Fig. 8). The open water pools cover altogether 32 ha. Largest pools are concentrated at the gently sloping surfaces in the northern part of the bog. On steeper slopes on the eastern part and at the edges of the bog, pools and hollows are narrower and elongated along the contours. Hollows are here either mud bottom hollows or drier *Sphagnum* hollows dominated by *S. lindbergii, S. majus* or *S. balticum*. In the west-southwestern part of the complex the surface patterning is more irregular and the mire types are hollow and short-sedge bogs. Minerotrophic lagg on the western side of the bog can not be distinguished from the adjoining aapamire. In the northern part of the bog, southwest from Nummikangas, a wet *Sphagnum* flark fen forms a narrow lagg covering approximately 9 ha. Another clear minerotrophic lagg (mud bottom flark fen and short-sedge fen) has been formed at the southern edge of the bog, covering approximately 7 ha. Small part of the eastern edge of the bog complex is outside the current national park boundaries.

Table 9. Site type characteristics in three concentric bog complexes in Kauhaneva (for the location of individual complex see Fig. 3, for the abbreviations for drained mires see Table 6).

	Bog I		Bog II		Bog III	
Site type	Area (ha)	%	Area (ha)	%	Area (ha)	%
Sphagnum fuscum bog with hollows and pools	204.5	63.0	207.1	65.0	48.4	18.0
S. fuscum bog with short-sedge bog hollows	30.1	9.0			97.8	37.0
Hollow bog	48.0	15.0	19.5	6.0		
Short-sedge bog	9.3	3.0	14.2	4.0	19.4	7.0
Short-sedge bog with S. fuscum hummocks	2.1	0.6			39.1	15.0
Calluna-Fuscum bog			16.1	5.0		
Equisetun sylvaticum spruce mire					0.9	0.3
Dwarf shrub pine bog	2.9	1.0				
Thin-peated pine mire	0.4	0.1	3.0	1.0	2.8	1.0
Thin-peated pine mire with S. fuscum hummocks			0.8	0.3	1.6	0.6
E. vaginatum pine mire with S. fuscum hummocks					1.8	0.7
Short-sedge pine fen	7.6	2.0	3.0	1.0	10.4	4.0
Short-sedge pine fen with S. fuscum hummocks			11.1	4.0		
Tall-sedge pine fen					5.9	2.0
Tall-sedge fen			12.1	4.0	10.8	4.0
Short-sedge fen	2.8	1.0	2.0	0.6		
Short-sedge fen with Sphagnum flarks			2.5	0.8		
S. papillosum short-sedge fen	2.0	0.6			26.0	10.0
S. papillosum short-sedge fen with S. fuscum hummocks			13.2	4.0		
Sphagnum flark fen	6.6	2.0	12.5	4.0	1.0	0.4
Mud bottom flark fen	3.9	1.0			1.1	0.4
Herb-rich mud bottom flark fen					1.4	0.5
Sphagnum fuscum hollow bog (C)	0.4	0.1				
Short-sedge bog (C)	2.0	0.6				
Thin-peated pine mire (C)	2.4	0.7				
Dwarf shrub pine bog (D)	1.2	0.4				
Short-sedge pine fen (D)					1.0	0.4
Total	326.2		317.1		269.4	

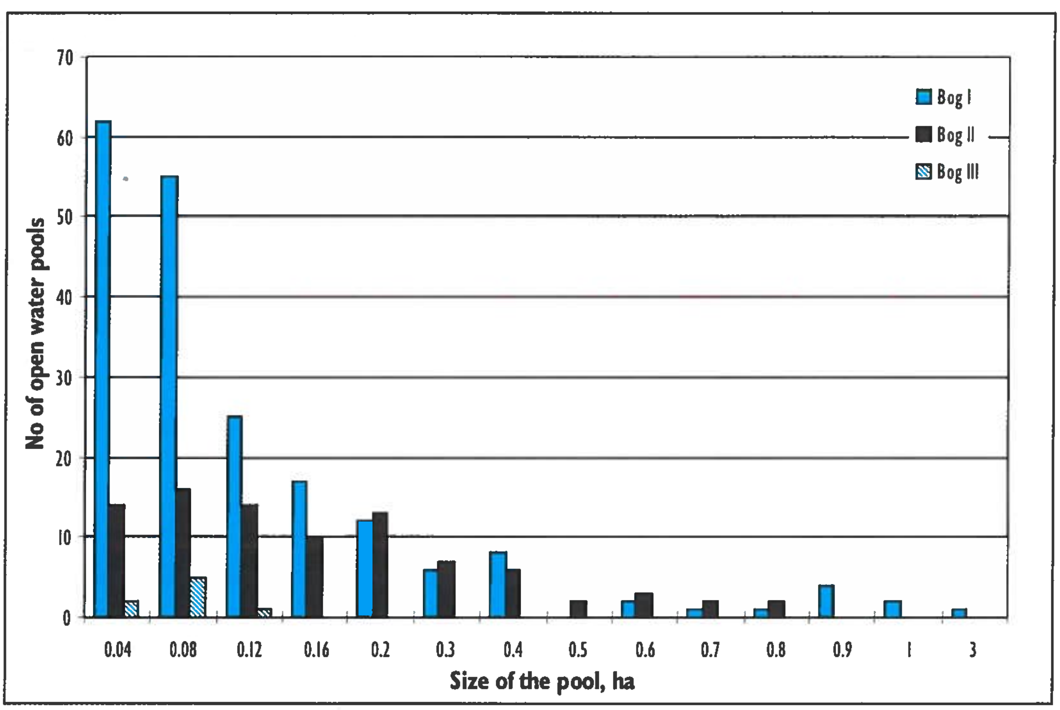
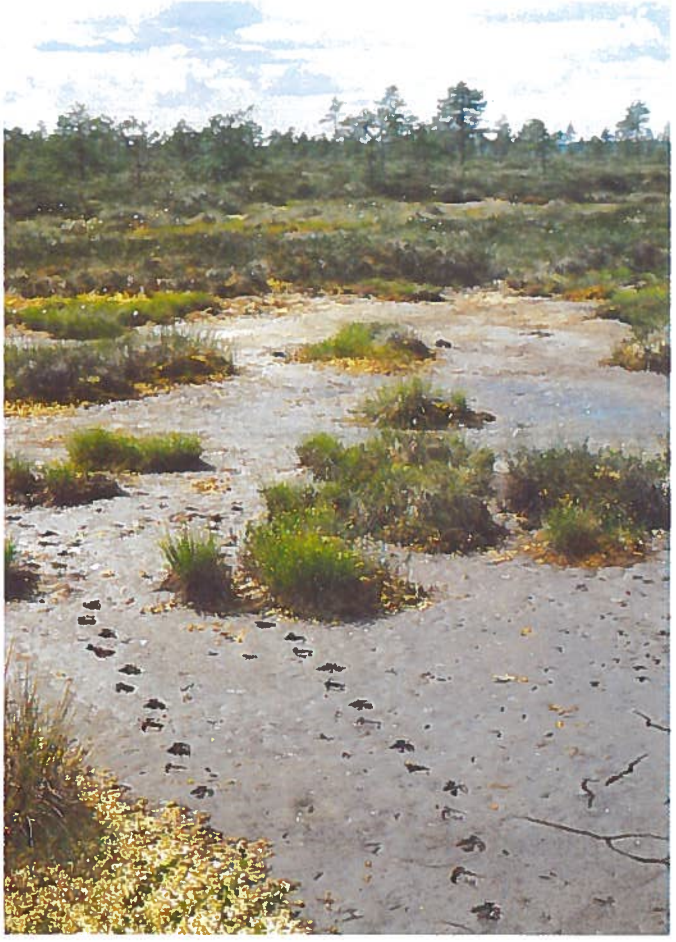


Fig. 9. Size distribution of open water pools in the concentric bog complexes of Kauhaneva.



Mud bottom hollow (black hollow) in the concentric bog I. Photo Raimo Heikkilä 1977.

The middle bog (Bog II) is a little smaller (Table 1) and there are less (90) open water pools (Fig. 9) than in the eastern bog, but the site types at the centre are similar. The centre (144 ha) is covered by *Fuscum* hollow bog where the hollows are dominated by *S. lindbergii* or *S. majus*. The open water pools are all smaller than 1 ha in area and they are concentrated at the southeastern part of the bog, covering altogether 19 ha. Surrounding the centre there are drier (i.e. no open water pools) ombrotrophic bogs either with hollows dominated by *S, majus*, *S. balticum* or *S. tenellum* or with ombrotrophic short-sedge site types. Minerotrophic lagg at the north and eastern-southeastern edge of the bog can not be distinguished from the adjoining aapamire. At the western edge of the bog complex the lagg between the bog and the mineral soil at Heikkurinpuska consists of tall-sedge fen. Also near Pitkäviita, in the northeastern part of the complex, patchy minerotrophic site types (tall- and short-sedge fens) can be interpreted as forming a lagg. At the southwestern edge of the bog there is a strip of *Sphagnum* flark fen between the two westernmost bogs. This can hardly be regarded as lagg, since it is nearly ombrotrophic. At the northeastern part of the complex there are different types of fens and pine fens, both with abundant *S. fuscum* hummocks. Along Nuolisalonkangas and Heikkurinpuska, narrow strips of paludified pine forests can be found.

The westernmost concentric bog (Bog III) is smallest (Table 1) and almost treeless. The central part has some open water pools (9 altogether, 0.6 ha total area, Fig. 9), but mostly it is covered by mud bottom or *S. lindbergii*, *S. majus* dominated hollows. The centre is only 46 ha. The drier part of the bog with *S. balticum - S. tenellum* hollows is much larger and sloping mainly to the west. In the upper parts the slope is rather steep and hollows are very narrow and elongated along the contours. Downwards hollows become wider, forming part of another, older and larger concentric bog under the current dome. Clear, minerotrophic laggs have been formed mainly in the northern part of the bog complex, where tall-sedge fens and short-sedge *S. papillosum* fens line the ombrotrophic centre. Even two small patches of mesotrophic sites (herb-rich mud bottom flark fen and *Equisetum sylvaticum* spruce mire) can be found at the lagg. Parts of the western and southern edges of the concentric bog complex outside the national park boundaries have been drained.

4.3.1.2 Eccentric and Sphagnum fuscum bogs

Eccentric bogs have a parallel ridge - hollow pattern which is perpendicular to the hydrological gradient. Ridges in eccentric bogs are rather low, usually some 20-30 cm. Six, small (9-41 ha) eccentric bogs can be distinguished in Kauhaneva mire. Of the three bog complex types in the study area eccentric bogs are smallest covering on average 30 ha. Altogether 16 site types were found in these eccentric bogs (Table 10).

There are two eccentric bogs in the northern part of Kauhaneva, east of Pitkäviita, (Bogs IV, V, Table 2, Fig 7,8). In the northenmost bog, a clear eccentric pattern can be distinguished only from two separate patches, covering together fifth of the complex area. The rest of the bog complex is covered mainly by different pine mires. Few small patches of flark and *S. papillosum* fens are situated in the northern part of the complex, where there is local ground water influence. 5.9 ha of pine mires and pine fens at the western part of the complex have been drained.

The other eccentric bog (Bog V) southeast from Pitkäviita consists of different types of pine mires. Central part of the complex is covered by eccentric *S. fuscum* bog with hollows, where the hollows are covered with ombrotrophic short sedge bog communities. Minerotrophic lagg has not developed.

The eccentric bog complex southeast from Nuolisalonkangas (Bog VI, Table 2, Fig 7) has a core area of eccentric *S. fuscum* bog with hollows, with patches of *Calluna - Fuscum* bog to the north and south. This core area is surrounded by short-sedge pine fen with *S. fuscum* hummocks, part of which is outside the national park boundaries.

Table 10. Site types of eccentric bog complexes in Kauhaneva (for the location of individual complexes see Fig. 3)

	Bog IV		Bog V		Bog VI		Bog VII		Bog VIII		Bog IX	
Site type	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Sphagnum fuscum bog with hollows and pools							6.0	15.0				
S. fuscum bog with short-sedge bog hollows	7.2	19.0	12.7	43.0	3.8	13.0	16.0	39.0	15.5	100.0	2.0	21.0
Calluna-Fuscum bog	1.5	4.0	1.5	5.0	6.7	23.0	6.3	15.0			1.5	16.0
Dwarf shrub pine bog	0.8	2.0			0.2	0.7						
Thin-peated pine mire	4.8	13.0	12.1	41.0			4.2	10.0			0.4	4.0
Thin-peated pine mire with S. fuscum hummocks							0.6	1.0				
Carex globularis spruce-pine mire	0.2	0.5										
Short-sedge pine fen	4.0	10.0	2.0	7.0	2.5	8.0	3.8	9.0			1.5	16.0
S. papillosum short-sedge pine fen							4.0	10.0				
S. papillosum short-sedge pine fen with S. fuscum hummocks	11.3	29.0	1.4	5.0	14.3	48.0					4.0	43.0
Molinia pine fen	0.4	1.0										
Tall-sedge fen					2.0	13.0						
S. papillosum tall-sedge fen	0.3	0.8										
S. papillosum short-sedge fen	1.2	3.0										
Sphagnum flark fen	0.4	1.0										
Mud bottom flark fen	0.4	1.0										
Short-sedge fen (C)	1.1	3.0										
Thin-peated pine mire (C)	3.1	8.0										
Calluna-Fuscum bog (D)	1.7	4.0										
Total	38.4		29.7		29.5		40.9		15.5		9.4	

Eccentric bog VII. Photo Raimo Heikkilä 1985.

Table 11. Site types of Sphagnum fuscum bog complex in Kauhaneva (for the location of the complex see Fig.6)

Site type	Bog X Area (ha)	%
Short-sedge bog with S. fuscum hummocks	63.5	29
Empetrum S. fuscum pine bog	87.5	40
Dwarf shrub pine bog	5.7	3
Dwarf shrub pine bog with S. fuscum hummocks	10.8	5
Thin-peated pine mire	0.7	0.3
Thin-peated spruce mire	0.2	0.1
Tall-sedge pine fen	1.2	0.6
Tall-sedge pine fen with S. fuscum hummocks	3	1
Tall-sedge fen	5.5	3
S. papillosum tall-sedge fen	7	3
S. papillosum short-sedge fen	7.2	3
S. papillosum short-sedge fen with S. fuscum hummocks	3	1
Dwarf shrub pine bog (D)	3.3	2
Thin-peated pine mire (D)	0.4	0.2
E. vaginatum pine mire with S. fuscum hummocks (C)	6.8	3
E. vaginatum pine mire (C)	4.5	2
Dwarf shrub pine bog (C)	4	2
Myrtillus peatland forest	3.3	2
Total	217.6	

The eccentric bog complex in the southeastern part of Kauhaneva, east of Pitkäsalo, (Bog VII, Table 2, Fig 7,8), is somewhat larger and wetter than the eccentric bogs in the northern part of Kauhaneva. The eccentric pattern is again clearest in the centre of the complex. In the eastern part hollows are mud bottom hollows and in the western part they are dominated by *S. balticum*. The *S. fuscum* bog with hollows is surrounded by *Calluna - Fuscum* bog in the west and short-sedge pine fen in the south and east. Narrow strip of paludified pine forest lines the complex in the east and northwest.

The eccentric bog in the southwestern corner of the area (Bog VIII, Table 2, Fig. 8) is only partly inside the national park boundaries. The part, approximately two-thirds, of the *S. fuscum* bog with hollows that has been left outside the national park has been drained.

Southeast from Bog VIII, a rather small (9 ha) eccentric bog complex (Bog IX, Table 2, Fig. 8) has been formed. The clearest eccentric part is in the northwestern corner of the complex. South from this is a small area of *Calluna-Fuscum* bog. Most of the complex is covered by short-sedge pine fen.

There is one, rather large, *S. fuscum* bog complex in Punttukeidas. The most common site types at the complex are *Empetrum-Fuscum* bog and short-sedge bog, covering approximately 70% of the total area. The eastern part of the complex has been drained and the sites (mainly different types of pine mires) are in different stages of drainage succession. In the south-western part, the ombrotrophic centre is lined with a narrow strip of short-sedge *S. papillosum* fen. In northeastern part the short-sedge bog is dissected with a long, narrow strip of tall-sedge fen. To the west and north of this part, short- and tall-sedge *S. papillosum* fens form a lagg zone between the ombrotrophic centre and the mineral soil at Punttusalo. The northwestern corner of the complex is outside the national park. Fourteen site types were found from this *S. fuscum* bog complex (Table 11).

4.3.2 Site types of aapamires

Four separate aapamire complexes can be distinguished in Kauhaneva mire system. The largest aapamire (Aapa II, Table 12, Fig. 7,8) extends through the whole mire system from north to south and covers over 800 ha. The other three aapamires are much smaller. Aapamires at Kauhaneva are mostly only weakly minerotrophic. The clearest string - flark pattern has developed in to the middle part of the Aapa II. Other aapamires are mostly patternless. Altogether 42 different site types were found in the aapamires (Table 12).

Sedge fen in the southern part of aapa II. Photo Raimo Heikkilä 1985

Table 12. Site types of aapamire complexes in Kauhaneva (for the location of individual complexes see Fig 6).

	Aapa I		Aapa II		Aapa III		Aapa IV	
Site type	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Rich spring fen	0.1	0.1						
Sphagnum flark fen	2.9	1.0	124.4	15.0			6.7	20.0
Mud bottom flark fen			17.9	2.0				
Herb-rich mud bottom flark fen			2.7	0.3	3.5	5.0		
S. papillosum tall sedge fen with Sphagnum flarks			57.6	7.0	3.7	5.0	3.8	12.0
S. papillosum short-sedge fen with Sphagnum flarks			34.0	4.0	2.1	3.0		
Sphagnum flark pine fen			8.5	1.0				
S. papillosum short-sedge pine fen with Sphagnum flarks			8.7	1.0				
Herb-rich mud bottom S. papillosum pine fen					4.0	6.0		
Short-sedge fen	7.3	3.0	29.3	4.0			7.9	24.0
S. papillosum short-sedge fen	18.0	7.0	62.2	8.0	16.4	24.0	11.4	35.0
Tall-sedge fen	27.5	10.0	101.5	13.0	19.5	29.0		
S. papillosum tall-sedge fen	15.7	6.0	60.6	7.0	7.5	11.0		
Swampy tall-sedge fen	1.3	0.5						
Short-sedge pine fen	13.4	5.0	78.8	10.0	5.0	7.0		
S. papillosum short-sedge pine fen			24.2	3.0	1.0	1.0		
Tall-sedge pine fen	20.8	8.0	14.2	2.0	0.6	0.9		
S. papillosum tall-sedge pine fen	1.3	0.5						
Herb-rich tall-sedge spruce fen	0.3	0.1						
Spring spruce mire	1.2	0.5						
Thin-peated spruce mire			0.8	0.1				
Myrtillus spruce mire	0.5	0.2						
Eriophorum vaginatum spruce fen			2.6	0.3				
Spruce-pine mire			0.6	0.1				
Thin-peated pine mire	7.6	3.0	15.8	2.0	1.0	1.0		
Carex globularis pine mire	1.7	0.6						
Eriophorum vaginatum pine mire			4.8	0.6				
Dwarf shrub pine bog	16.3	6.0	34.6	4.0				
Calluna-Fuscum pine bog	28.9	11.0	21.5	3.0	2.0	3.0		
Empetrum-Fuscum pine bog			34.7	4.0				
S. papillosum short-sedge fen with S. fuscum hummocks	3.4	1.0			1.0	1.0		
Tall-sedge fen with S. fuscum hummocks	3.1	1.0						
Short-sedge pine fen with S. fuscum hummocks	5.5	2.0	33.8	4.0			2.0	6.0
S. papillosum short-sedge pine fen with S. fuscum hummocks			13.8	2.0				
Tall-sedge pine fen with S. fuscum hummocks	1.1	0.4	6.8	0.8				
Thin-peated pine mire with S. fuscum hummocks	4.7	2.0	1.6	0.2			1.0	3.0
E. vaginatum pine mire with S. fuscum hummocks			1.7	0.2				
Dwarf-shrub pine bog with S. fuscum hummocks			2.6	0.3				
Short-sedge bog	25.0	9.0						
Short-sedge bog with S. fuscum hummocks	38.3	14.0	15.7	2.0				
Short-sedge fen (D)	0.7	0.3						
Tall-sedge fen (D)	3.1	1.0						
Sphagnum flark fen (D)	0.3	0.1						
Thin-peated pine mire (D)	10.3	4.0						
Molinia tall-sedge pine fen (D)	1.0	0.4						
Spring spruce mire (C)	0.4	0.2						
Thin-peated pine mire (C)	0.6	0.2						
Dwarf-shrub pine bog (C)	2.7	1.0	0.9	0.1				
Tall-sedge fen (C)			5.0	0.6				
Drained Polytrichum mire where the natural type is undeterminable	1.2	0.5						
Myrtillus peatland forest	0.4	0.2						
Total	266.3		824.2		67.3		32.8	

The aapamire in the northwestern part of Kauhaneva (Aapa I, Table 4, Fig. 7,8) is partly ombrotrophic (23% of its area), site type being mostly short-sedge bog. In many site types, a process of ombrotrophication is taking place, which is reflected in the abundance of *Sphagnum fuscum* hummocks. Similar situation occurs also in some marginal northwestern parts of Kauhaneva (Aapa II, table 4, Fig. 7, 8,). Site types in the centre of the complex are different types of short-sedge fens covering rather large, uniform patches. Site types at the edges of the complex occur in smaller patches and represent different types of open fens, pine fens and pine mires. The most nutrient rich sites (spring spruce mires) of the Kauhaneva mire occur at this aapamire complex; one near Heikkurinpuska and the other at the southeastern corner. Almost fourth of this aapamire complex is outside the current national park boundaries.

Transition mire with low Sphagnum fuscum hummocks in the northern part of Aapa II. Photo Raimo Heikkilä 1985.

The general structure in Aapa II is similar to the Aapa I, so that in central parts of the complex individual site types cover large areas, and at the edges, and exceptionally across the whole complex to the west from Pitkäsalo, much smaller areas. In the northern part of the aapamire, there is a thin-peated, sloping area with a mixture of small, open fens and short-sedge pine fens. The clearest string-flark pattern has developed in the *Sphagnum* and mud bottom flark fens situtated between and south from the Bogs I and II. Flark fens, short- and tall-sedge fens and *S. papillosum* fens are the most common and the most extensive site types, covering altogether 61% of the mire complex. On the margins of the mire complex dwarf-shrub pine bogs, short-sedge pine fens and *S. fuscum* bogs dominate.

The small aapamire, west of Punttukeidas (Aapa III, Table 4, Fig. 8), consists mainly of short- and tall- sedge *S. papillosum* fens. There is a mesotrophic flark-fen site with abundant *S. molle*, *Carex panicea* and *Rhynchospora fusca*.

Flarks and strings of an aapamire in Punttukeidas (Aapa III). Photo Raimo Heikkilä 1985.

At Laksoneva, (Aapa IV, Table 4, Fig. 7,8), the aapa mire complex consists of flark fens at the centre, lined from both sides by *S. papillosum* fens and short-sedge fens.

4.3.3 Communities

Most treeless ombrotrophic and oligotrophic mire sites have a mosaic structure of vegetation cover (combination types), because dominant species (mosses, grasses) have a small-scale variation in distribution according to differences in ecological conditions (water table, pH, nutrient content). Typical treeless mire communities are small in size, from one to some tens of square metres. Only tall sedge communities can sometimes be wider. In many combination types there are from 2 to 4-5 communities.

Structure of some mire sites of Kauhaneva was studied along two profiles across two concentric bogs and one aapamire. Most of the 27 sites described along the profiles were combination types including more than one community (Tables 13, 14). The relevés give a full picture of the species composition of the communities (Appendix 3).

4.3.3.1 Communities of concentric bogs

Central parts of concentric bog complexes are occupied by a ridge-hollow-pool mire sites with variating proportion of different elements. Ridges generally cover 20-30% of the sites.

On ridges dominate the communities belonging to associations *Calluna vulgaris – Empetrum nigrum – Sphagnum fuscum*, *Calluna vulgaris – Sphagnum fuscum – Cladina* spp. and *Calluna vulgaris – Cladina* spp. (Appendix 3). A succession series of young *Sphagnum fuscum* hummocks to old hummocks dominated by *Cladina* spp. was observed. On the *Cladina* hummocks there is practically no peat accumulation. Pools without vegetation occupy 30-50% of the sites. Hollows have a large variation in size and water level. Young hollows (lawns) are usually dominated by association *Eriophorum vaginatum – Sphagnum balticum*, sometimes there are *Eriophorum vaginatum – Sphagnum* communities with

Sphagnum lindbergii, S. tenellum and *S. papillosum* (Appendix 3). In deep wet hollows main communities are *Scheuchzeria palustris – Sphagnum majus*. In the middle of the hollows typically there is no moss layer, but only some hepatics and algae. There *Rhynchospora alba* and *Drosera anglica* are common (Appendix 3).

Table 13. Structure of vegetation cover of mire sites in concentric bogs (For the location of the relevés see Figs. 10 and 11).

Number of relevé and nutrient status	Element of microrelief	%	Plant community (association)
23 Ombro			
(dys)	ridge	30	Cladineta + Sphagneta baltici + Sphagneta majusi + Jungermannieta + pools
	sloping ridge	15	
	hollow	15	
	black hollow	10	
	pool	30	
22 Ombro	ridge	35	Cladineta-Sphagneta + Sphagneta majusi + Jungermannieta
	carpet	35	
	hollow	20	
	black hollow	10	
21 Ombro	hummock	20	Sphagneta fusci + Sphagneta baltici
	carpet	80	
24 Ombro	ridge	20	Sphagneta fusci + Sphagneta lindbergii
	hollow	80	
25 Ombro	ridge	15	Sphagneta fusci + Sphagneta papillosi
	carpet	70	
	hollow	15	
27 Ombro (dys)	ridge	20	Cladineta + Sphagneta baltici + Sphagneta majusi + pools
	carpet	40	
	hollow	10	
	Pools		
	60		
11 Ombro (dys)	ridge	30	Cladineto-Sphagneta fusci + pools
	hollow	10	
	pools	60	
17 Ombro	ridge	25	Cladineto-Sphagneta fusci + Sphagneta baltici
	hollow	75	

4.3.3.2 Communities of aapamires

The profiles I and II go across the marginal and poor parts of Aapa II. Mostly the vegetation along the profiles is not very typical for aapamires. There were found patterned and homogeneous mire sites which are mainly oligotrophic (Table 14). Ombrotrophic hummocks are common in most sites with associations *Empetrum nigrum – Sphagnum fuscum, Calluna vulgaris – Sphagnum fuscum* and *Empetrum nigrum – Sphagnum magellanicum* (Appendix 3). On the carpets (dry *Sphagnum* flarks) the main associations are *Eriophorum vaginatum – Sphagnum papillosum* and *Trichophorum cespitosum – Sphagnum papillosum* (Appendix 3). In these communities true minerotrophic species are more or less lacking. In sites with ground water seepage typical minerotrophic communities are found: *Carex lasiocarpa – Sphagnum papillosum* and *Carex rostrata – Sphagnum papillosum* (Appendix 3). More wet flarks with sparse vegetation are sporadically distributed along the profiles.

Table 14. Structure of vegetation cover of mire sites in aapamires (For the location of the relevés see Figs. 10 and 11.

Number of relevé and nutrient status	Element of microrelief	%	Plant community (association)
26 Oligo (Minero)	hummock	10	Sphagneta majusi + Sphagneta papillosi
	carpet	40	
	flark	50	
6, 7, 13 Oligo (Minero)	carpet	100	Cariceto - Sphagneto papillosi
15, 16 Ombro-oligo	carpet	70	Eriophoreto – Sphagneta papillosi
	hummock	10	
	hollow	10	
	flark	10	

In the northern part of Aapa II there is a wide sloping mire area with a very shallow peat layer (relevés 1-6, see Table 14). There are numerous small patches of ground water seepage from the sandy esker below the mire. In such places and below them along the slope there is a very complex vegetation mosaic where mesotrophic strips vary with ombrotrophic sparsely pine growing bogs. This area is included in Aapa II as a marginal part.

4.4 Hydrological patterns of the mire

The main slope in Kauhaneva is from north to south and southwest. The total height difference in the mire system is approximately 15 m (from 175 m a.s.l. in the north to 160 m a.s.l. in the south, distance being 7 km). From the northeastern part of the mire complex most of the surface waters flow to the south between the two easternmost concentric bogs. Part of the waters from the easternmost concentric bog flow to the river Kauhaluoma in the east. Most of the surface waters from the southern part of the mire complex flow to the river Aunesluoma (Fig. 10).

A little brook flowing from the spring in Lähdespuska into Katikanluoma. Photo Raimo Heikkilä 1985.

Pitkäviita functions as a water-divide in the northern part of the mire. To the west of Pitkäviita, surface waters flow towards northwest to brook Katikanluoma. There is some groundwater seeping into the mire from the esker in northeastern soligenous part of the mire system, and flowing between the two eastern concentric bogs, since the track between the two bogs has remained minerotrophic. Some groundwater inflow, in a form of small springs, was also detected in few places in the middle of the mire between the two large concentric bogs. Runoff from surrounding mineral soils is reflected in the occurence of minerotrophic mires at the edges of the complex.

In the eastern part of the mire, there is a flowless primary lake, Kauhalampi. The lake, however, has typical characteristics of a pool in an ombrotrophic bog. Probably deposition of peat on the bottom of the lake prevents contact to the mineral soil and minerogenic waters.

In the western part of Kauhaneva there are couple of ditches, which have not had a very strong effect on the mire vegetation. There are also two ditches from Kauhalampi, to the east and southwest, but they have been almost overgrown. The two ditches through Punttukeidas have clearly changed the hydrology and vegetation in this part of the mire. The eastern ditch has been dammed in the late 1980s, and the hydrological conditions have partly recovered.

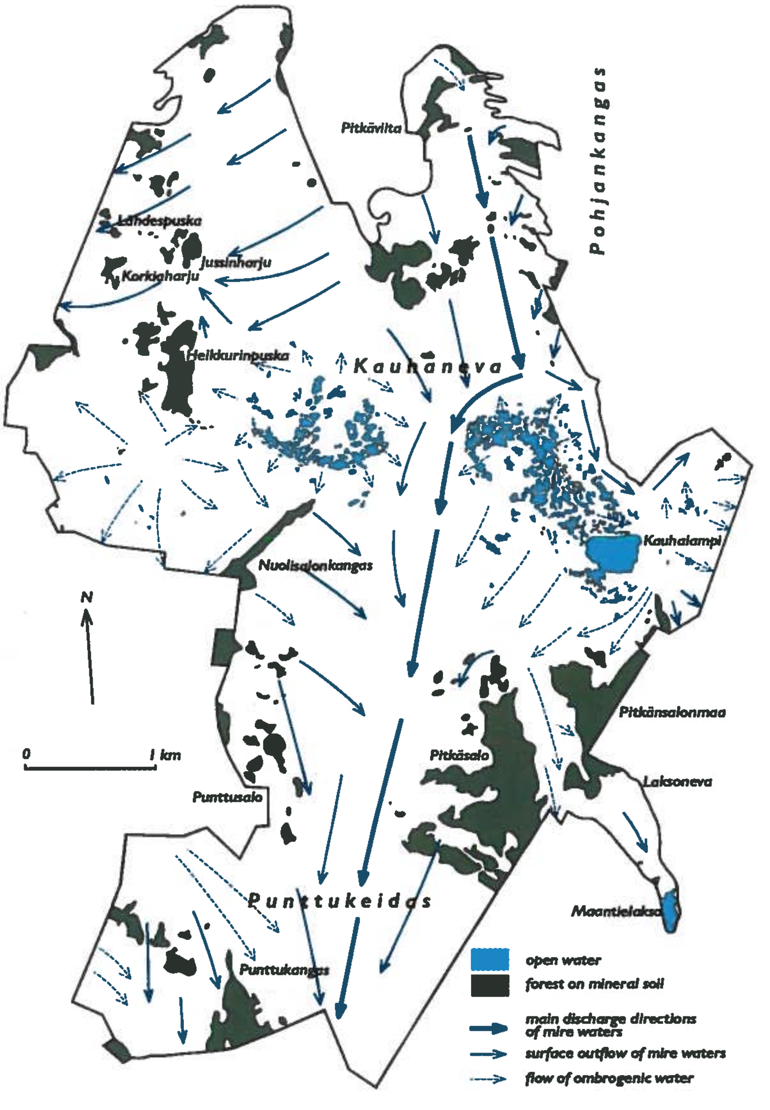


Fig. 10. Main drainage ways in Kauhaneva mire system.

4.5 Genesis and stratigraphy of Kauhaneva mire system

Genesis and stratigraphy of Kauhaneva mire system was studied along two transects (Figs. 3, 11-12). The central part of Kauhaneva mire system has developed as a result of paludification of two shallow depressions (Fig. 11). Two radiocarbon datings from the bottom peat and sapropel layer of the eastern depression, show that paludification started 7940 ± 110 years B.P. (LU-3417) and 8080 ± 80 years B.P.(LU-3416). Datings are not calibrated. Between the depressions, there is a small elevation of mineral soil, which is clearly depicted on the stratigraphic sections (Fig. 11).

The study transects cross the two easternmost concentric bogs and part of the aapamires (Figs. 11, 12). Deepest peat deposits, 4.5meters, or with gyttja layer 4.7 metres, are in the concentrig bogs. The thickness of the minerotrophic peat below the ombrotrophic layer varies between 0.5m to 2.7m, and the thickness of the ombrotrophic peat varies between 1.0 – 2.9 m. The peat layer of aapamires is considerably thinner, only 1-3 metres.

The reconstruction of the dynamics of the vegetation of the mire is based on macrofossil analysis from 29 cores. Ten sample sites, which are interesting and most important for the reconstruction, are presented here. Four of these samples were from the eastern concentric bog, two from the middle concentric bog and four from the aapamire. Special attention was paid to the development of the small-scale surface patterns on the bogs: ridges, hollows and pools.

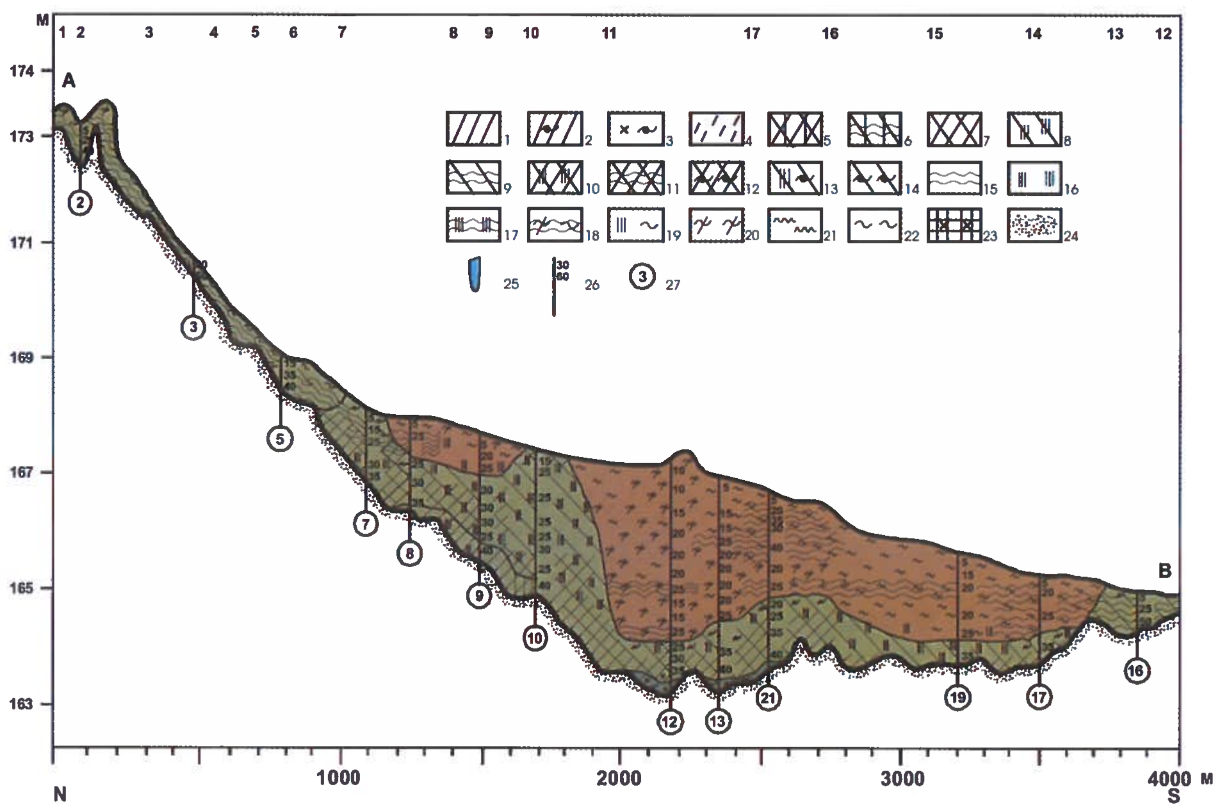


Fig. 11. A stratigraphical cross-section of the peat deposits of an aapamire and a concentric bog along transect I, peat sampling sites for macrosubfossil analysis below and numbers for relevés above the profile. Explanations for the symbols for stratigraphic profiles:

Peat types : Eutrophic (1-4): 1) Carex, 2) Carex-Sphagnum, 3) Equisetum-Sphagnum, 4) Bryales; Mesotrophic (5-14): 5) woody-Carex, 6) woody-Eriophorum, 7) Carex, 8) Scheuchzeria, 9) Eriophorum, 10) Carex- Scheuchzeria, 11) Carex-Eriophorum, 12) Carex-Sphagnum, 13) Scheuchzeria-Sphagnum, 14) Sphagnum; Ombrotrophic (15-22): 15) Eriophorum vaginatum, 16) Scheuchzeria, 17) Eriophorum vaginatum-Scheuchzeria, 18) Eriophorum vaginatum-Sphagnum, 19) Scheuchzeria-Sphagnum, 20) Fuscum, 21) Magellanicum, 22) hollow Spagnum; 23) gyttja with macrofossils, 24) sand, 25) water, 26) degree of decomposition (%), 27) number of core.

The eastern concentric bog is currently occupied by extensive ridge-hollow-pool mire site. The stratigraphy and genesis of these microtopography forms were studied in the northwest part of the complex (Figs 11-14, cores 12-14, 29).

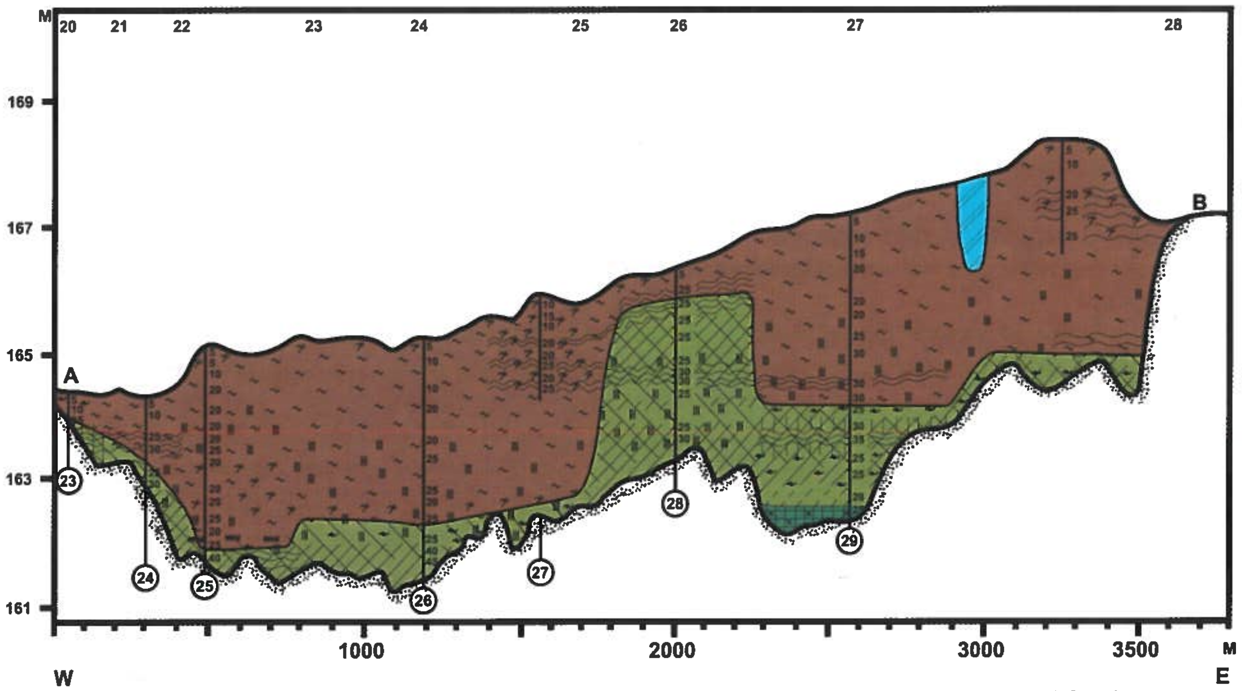


Fig. 12. A cross-section of two raised bogs along transect II and sampling sites for macrosubfossil analysis. For the symbols see Fig. 11.

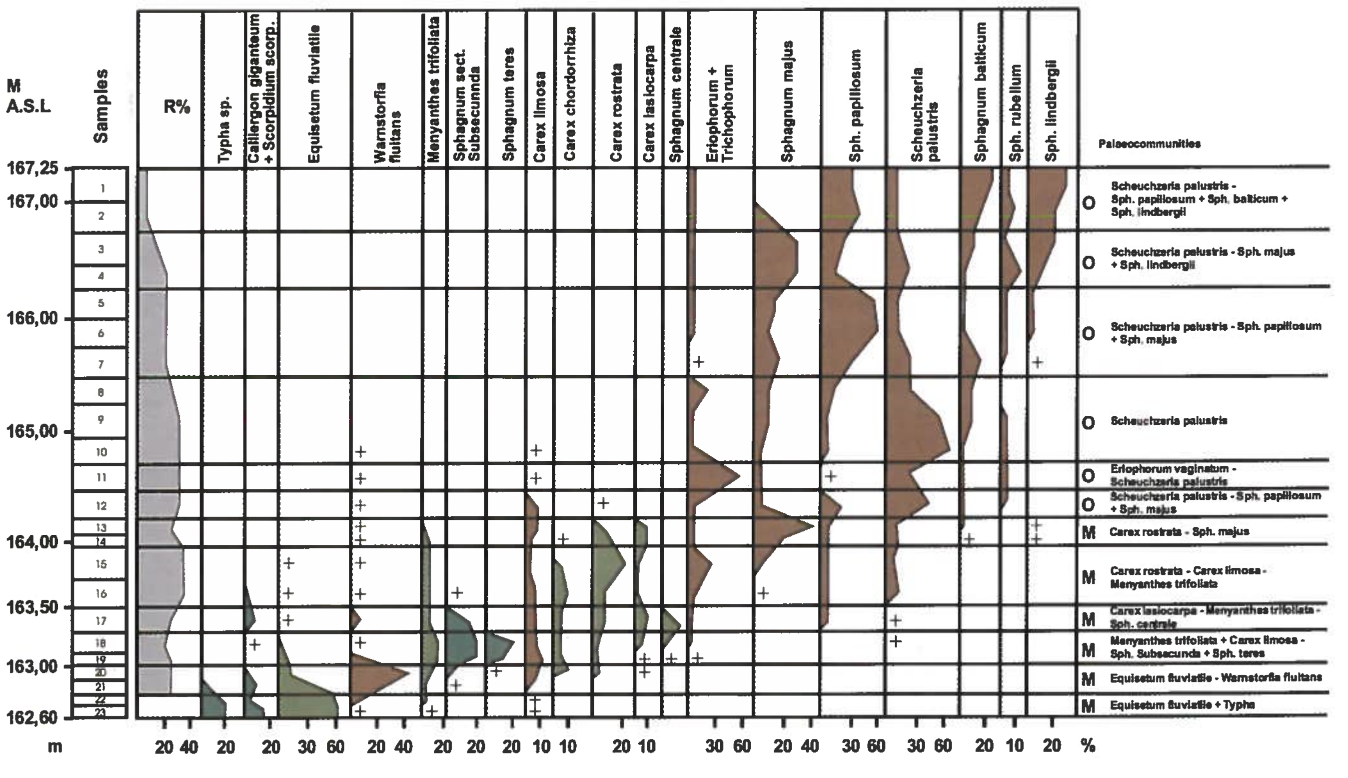


Fig. 13 Macrosubfossil diagram for site/core 29 (hollow). R = degree of the decomposition of peat in %. Nutrient level of the palaeocommunities: O = ombrotrophic, OL = minero-oligotrophic, M = mesotrophic.

The development of present hollow was studied at two cores, 29 and 13. In both hollows the current plant cover is formed by *Scheuchzeria palustris* together with several *Sphagnum* species (*S. majus*, *S. papillosum*, *S. balticum*, *S. rubellum*, *S. lindbergii*).

Lake sediments where found only at the bottom of one core, from the deepest point in the eastern kettle (core 29, Fig. 10). At the time (7940 ±110 B.P., LU-3417) when this kettle was filled up with shallow water, *Equisetum fluviatile* dominated the herb vegetation. In addition, remains of *Typha* sp., *Schoenoplectus lacustris*, *Potamogeton* sp., *Scorpidium scorpioides* and *Calliergon giganteum* were found in the bottom (20 cm) sapropel layer.

The shallow water body gradually filled in and there was, probably a rather fast, succession of vegetation towards more drier communities. First, a short-living quaking mire with *Menyanthes trifoliata-Sphagnum subsecundum + S. teres* community developed, and after that a sedge-*Sphagnum* (*Carex lasiocarpa-Sphagnum centrale*) community formed.

The sedge-*Sphagnum* community gave way to a more flooded sedge- *Menyanthes trifoliata* community and then to the sedge- *Sphagnum majus* community. In the peat formed by the latter, remains of minerotrophic plants were found for the last time. At that time the mire surface was 164.2 metres above sea level. When the ground water supply from the adjacent mineral soils stopped, the ombrotrophic phase of the mire development began. Increase of *Scheuchzeria palustris*, *Sphagnum papillosum*, *S. balticum* and *S. rubellum* and the disappearance of minerotrophic species (e.g. *Menyanthes trifoliata*, *Carex rostrata* and *Carex lasiocarpa*) indicate the transition to the ombrotrophic stage of development. This is a primary hollow. In its development hummock stages with *Sphagnum fuscum* are absent.

The transition to the ombrotrophic phase took place in the Bog I at the time when the mire surface had reached 164.0-164.4 m a.s.l. and in the Bog II at 162.5 m a.s.l. The minerotrophic peat layer is less than one metre in the Bog II and 1.0 - 2.0 meters in the Bog I. The ombrotrophic peat layer is on average 2.7 metres thick in both bogs. Because of the lack of datings, we do not know when the transition to the ombrotrophic phase happened and if it happened at the same time in both bogs.

Since the beginning of the ombrotrophic phase, vegetation has been dominated by hollow communities. During the development of the hollow, the humidity and plant cover have changed several times, which is indicated by layers of both *Scheuchzeria* peat with a little number of *Sphagnum* macrosubfossils and *Scheuchzeria-Sphagnum* peat with

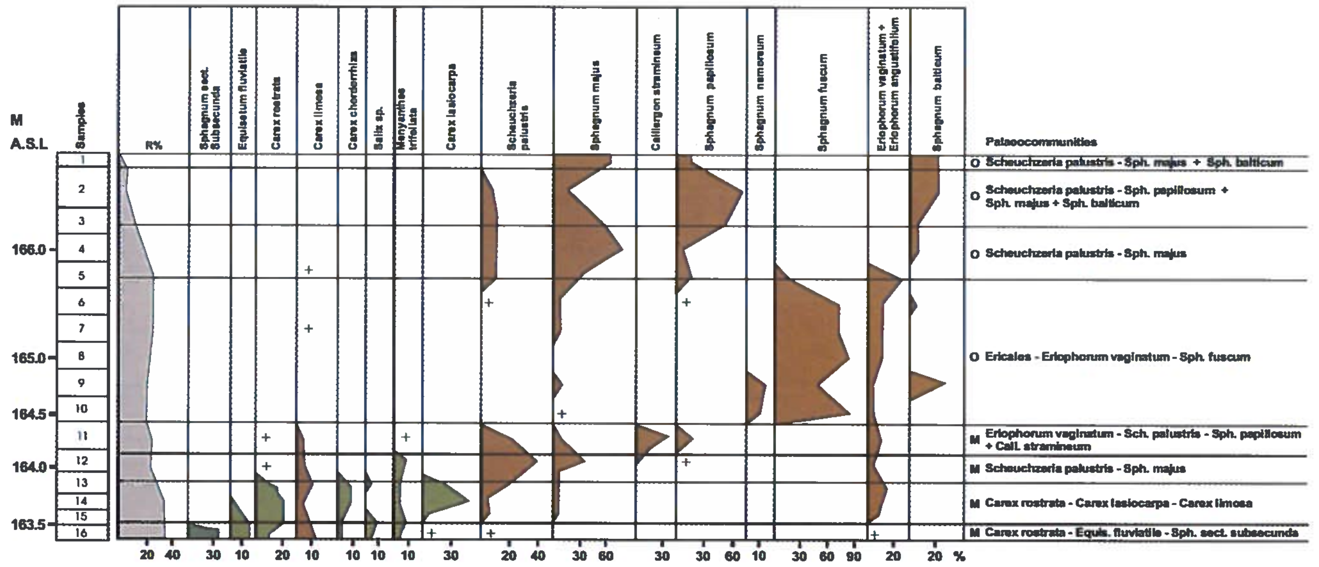


Fig. 14 Macrosubfossil diagram for site/core 13 (hollow).

S. papillosum, *S. majus* and *S. lindbergii*. *Sphagnum lindbergii* was first recorded on the depth of 1.5 meters, and its significance increased much in the upper layers of the peat deposit.

Below another present *Scheuchzeria-Sphagnum* hollow (core 13, Fig. 12) we can see different type of succession. The early minerotrophic phase resembles the earlier described situation and vegetation was dominated by sedges (*Carex rostrata*, *C. lasiocarpa*, *C. chordorrhiza* and *C. limosa*) and species indicating rather wet coniditions (*Menyanthes trifoliata*, *Equisetum fluviatile*, *Scheuchzeria palustris*). But at the beginning of the ombrotrophic phase, instead of hollow communities, vegetation became dominated by dry, ombrotrophic *Ericales-Eriophorum vaginatum-Sphagnum fuscum* community. The *Sphagnum fuscum* stage probably lasted rather long and resulted in the accumulation of 1.25 m of *Sphagnum fuscum* peat. The present *Scheuchzeria-Sphagnum* hollow was then developed on the *Sphagnum fuscum* community, and this is a secondary hollow.

During the development of the vegetation, several changes in the moss layer composition were recorded. At the first stage *Sphagnum majus* dominated. The beginning of the ombrotrophic phase was clearly *Sphagnum fuscum* dominated. It was replaced by *S. papillosum* and *S. balticum* and nowadays *S. majus*, with an insignificant participation of *S. balticum* is predominant again.

The development of present ridge was studied at core 12, which is situated near (3 m) the core 13. The plant cover of the present ridge is formed by ombrotrophic *Calluna – Sphagnum fuscum – Cladina* spp. communities.

Along the western edge of the shallow water basin, in the eastern kettle, pioneer communities were formed of *Carex rostrata*, *Equisetum fluviatile*, *Sphagnum* sect. *Subsecunda* and *Warnstorfia fluitans*. There are no lake sediments at the bottom of core 22 (Fig. 13). The grass-moss layer on the bottom of the peat is dated to 8080 ± 80 years BP (LU-3416).

During the minerotrophic stage there was a succession from *Equisetum-Carex rostrata* communities to *Scheuchzeria-Sphagnum fallax* + *S. balticum* communities. Transition from very wet minerotrophic communities to dry ombrotrophic communities is indicated with a sharp increase in *Sphagnum fuscum*, *Eriophorum vaginatum* and dwarf shrubs. At the depth of 0.75-1.00 m, there was an increase in peat humidity which is indicated by increase of *Sphagnum rubellum*, *S. balticum* and *S. majus* in the peat layer. After that *Sphagnum fuscum* and *Eriophorum vaginatum* became again dominant species of the ombrotrophic community.

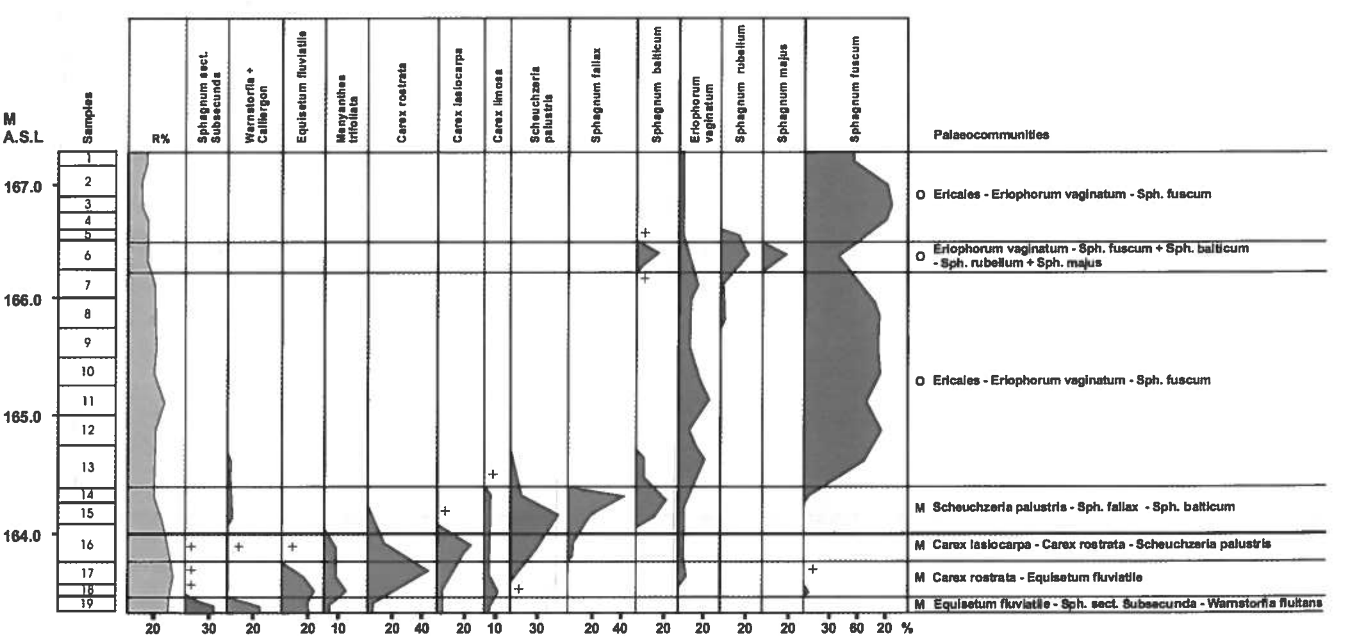


Fig. 15 Macrosubfossil diagram for site/core 12 (hummock ridge).

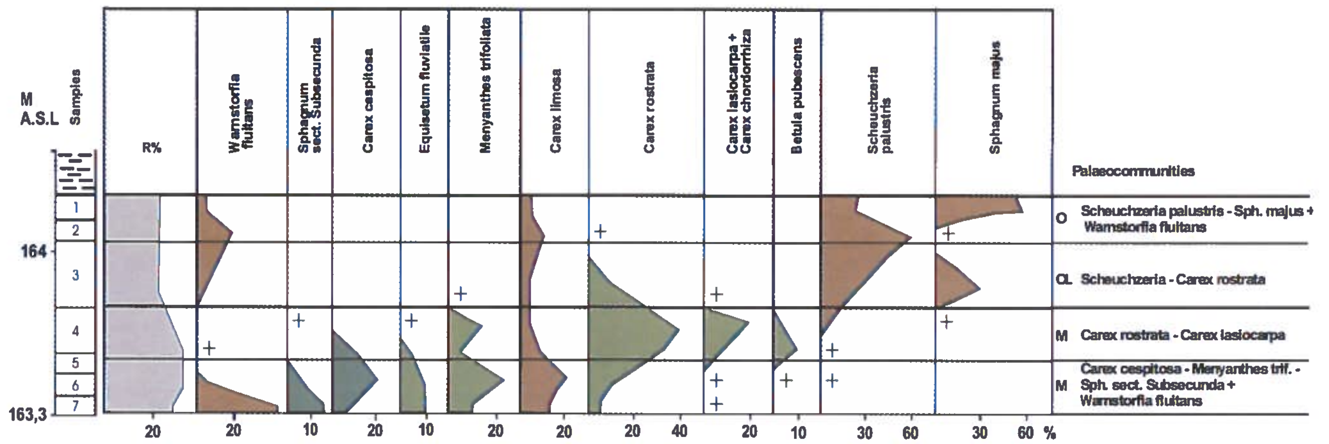


Fig. 16 Macrosubfossil diagram for site/core 14 (pool).

The depth of water in the current secondary pool (Fig. 16) is more than 2 metres. On the bottom there is one metre of peat. Of that 75 cm is minerotrophic peat and 25 cm ombrotrophic *Scheuchzeria-Sphagnum majus* peat. The peat accumulation ended at the height of 164.3 m a.s.l.

The central part of the western bog (Bog II) is occupied by a ridge-hollow-pool mire site, where 30% of the total area is covered by secondary pools, 40% by hollows and 30% by ridges. The ridge vegetation is generally formed by *Calluna vulgaris-Sphagnum fuscum-Cladina* spp. community. Hollows are mainly *Scheuchzeria-Sphagnum* or *Sphagnum* dominated.

Two cores from current hollows were studied. In the western kettle, with mineral bottom heights of 161.5- 162.5 meters above sea level, paludification started from poor minerotrophic sedge-*Scheuchzeria* communities. The thin, 0.5-1.0 m, layer of mesotrophic peats suggests, that the minerotrophic phase with sedge, *Scheuchzeria-Sphagnum* and sedge-cottongrass communities was rather short (Fig. 17, 18). Most of the peat deposit in the western bog is formed of ombrotrophic peat types, and it accumulated in *Sphagnum fuscum* or *Scheuchzeria-Sphagnum* communities.

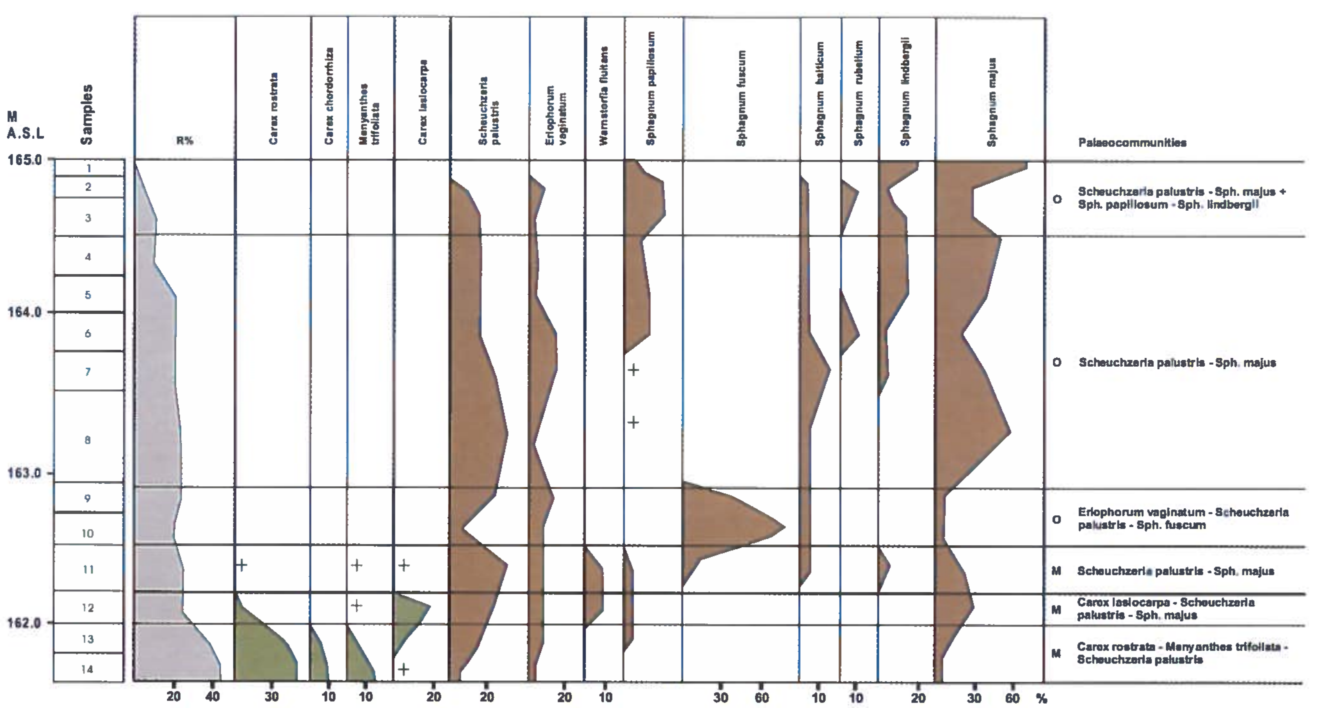


Fig. 17. Macrosubfossil diagram for site/core 26 (hollow

The first phase of mire development at the central part of the western bog complex was dominated by minerotrophic *Scheuchzeria-Carex rostrata* pioneer community (Fig. 17). Very soon also *Sphanum majus* and *S. papillosum* appeared. Minerotrophic peat layer is 85 cm thick. Changes of a hydrological regime are reflected as a transition to the ombrotrophic phase, and the wet *Scheuchzeria-Sphagnum* community was replaced by a community with *Sphagnum fuscum* dominance in the moss layer. This phase was probably rather short as the *S. fuscum* peat is only 40 cm thick. After that, a secondary *Scheuchzeria-Sphagnum* hollow was formed. The thickness of the ombrotrophic hollow peat is 2.1 m. Some *Sphagnum fuscum* communities were permanent, and in them originated the present hummock ridges (Fig. 12, core 27).

In the western marginal part of the western concentric bog complex the development of vegetation (Fig 18) is very similar to the hollow in the central part (Fig. 17). The minerotrophic phase was perhaps shorter, since only 35 cm of minerotrophic peat was deposited. The transition to the ombrotrophic phase took place when mire surface had reached 162.5 m a.s.l. Increase in *Sphagnum fuscum* and disappearance of minerotrophic species (*Carex rostrata* and *Warnstorfia fluitans*) indicate the transition to the ombrotrophic phase. The stage with *Sphagnum fuscum* was probably longer than in the central part and resulted in the accumulation of 85 cm of peat. The *Sphagnum fuscum* dominated hummock community was replaced with *Scheuchzeria-Sphagnum* dominated hollow community. During the hollow phase there has been some fluctuation of *Sphagna* (Fig. 18). Some *Sphagnum fuscum* hummocks have not disappeared and still exist.

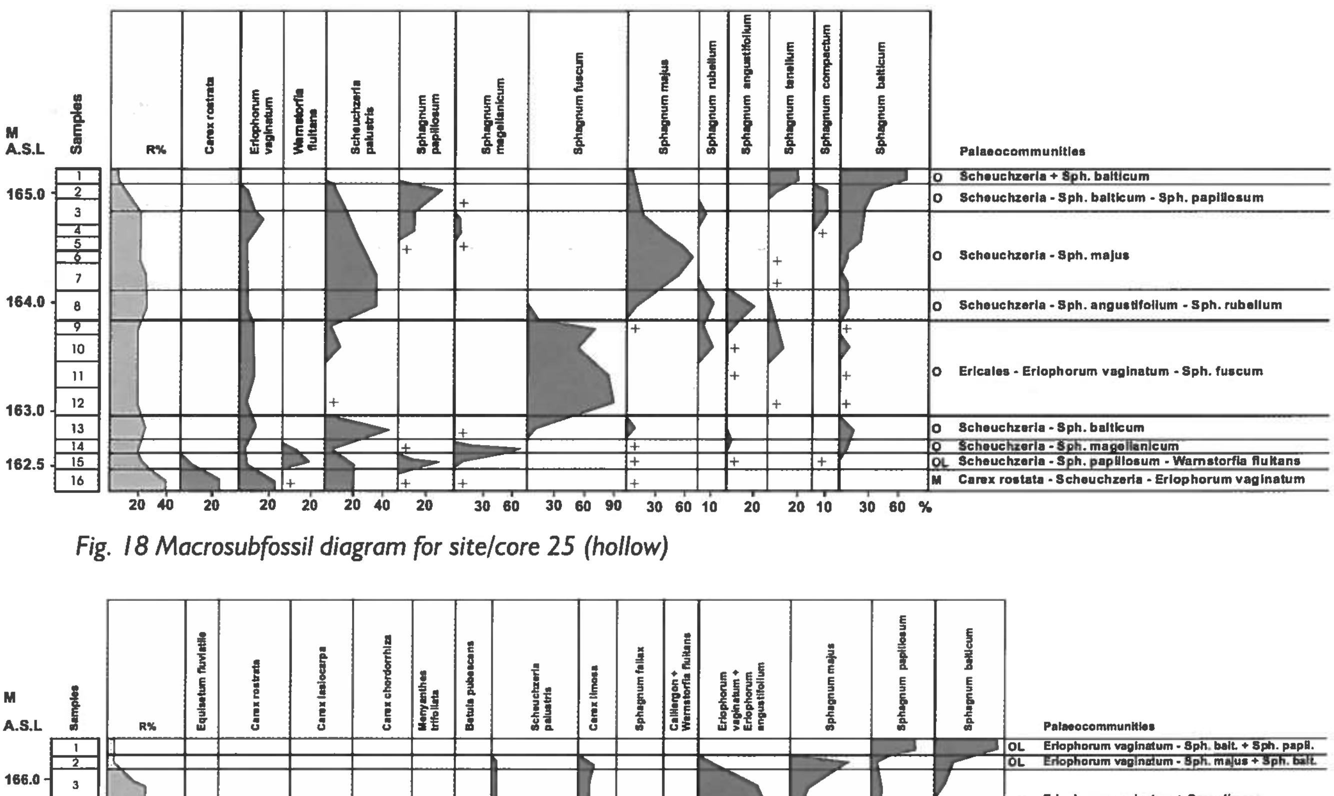


Fig. 18 Macrosubfossil diagram for site/core 25 (hollow)

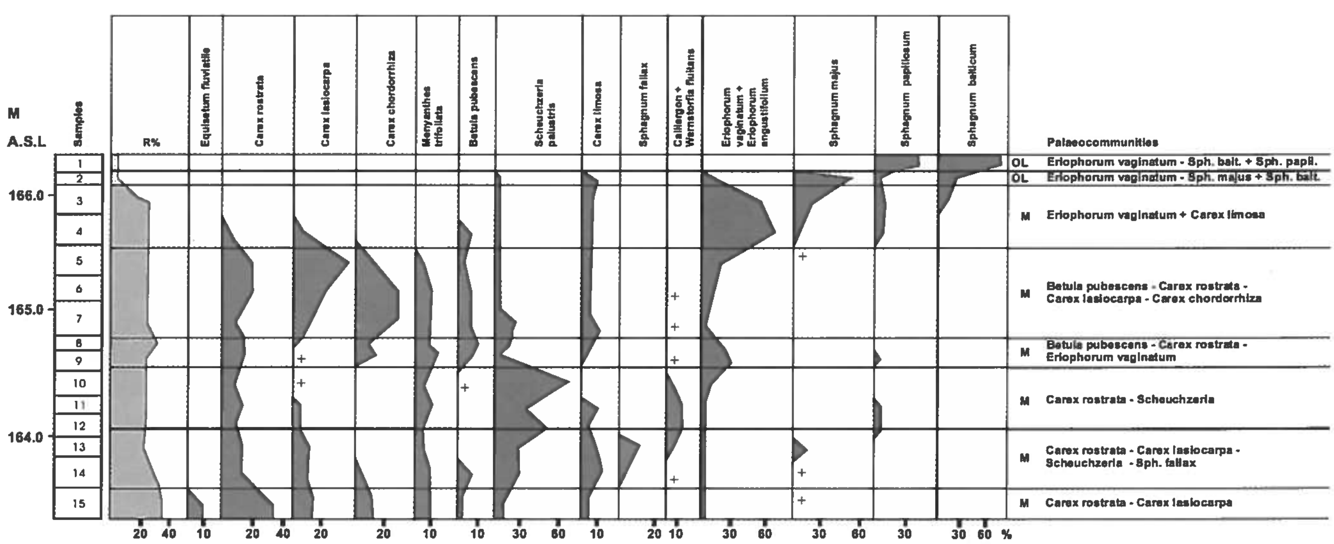


Fig. 19 Macrosubfossil diagram for site/core 28 (lawn/flark)

Stratigraphy and development of aapamires and minerotrophic watertracks were studied mainly along transect I, which follows the extensive aapamire formed between the two concentric bogs (Figs. 11, 12, cores 10, 19, 21 and 28).

The stratigraphy of the aapamire between Bogs I and II was studied in core 28 (Fig. 19). The depth of the peat deposit is 3 metres. Until the topmost 25 cm, vegetation was dominated by sedges, with *Menyanthes trifoliata* and *Scheuchzeria palustris* indicating rather wet conditions. The whole deposit is minerotrophic, but in the topmost 25 cm there are no typical minerotrophic macrosubfossils. Instead, first *S. majus* and then *S. papillosum* and *S. balticum* dominate. In the present vegetation there are no indicators of minerotrophy in general, but there are patches with *Carex rostrata* and "windows" with groundwater flow.

The stratigraphy of an extremely poor aapamire was studied in cores 21 and 19 (Figs. 20, 21). The stratigraphy of core 21 in a *Eriophorum vaginatum-Sphagnum balticum* + *S. majus* flark (Fig. 21) showed that only 1 m on the bottom was undoubtedly minerotrophic peat. During the minerotrophic phase vegetation was dominated with sedges and *Menyanthes trifoliata*, *Scheuchzeria palustris* indicating wet conditions. In the depth of 1.6 m there was a probably rapid succession into more drier *Eriophorum vaginatum-Sphagnum fuscum* community. There accumulated 1 m of *Eriophorum vaginatum-fuscum* peat. Only the topmost 0.5 m is accumulated in a wet *Eriophorum vaginatum-Sphagnum* community.

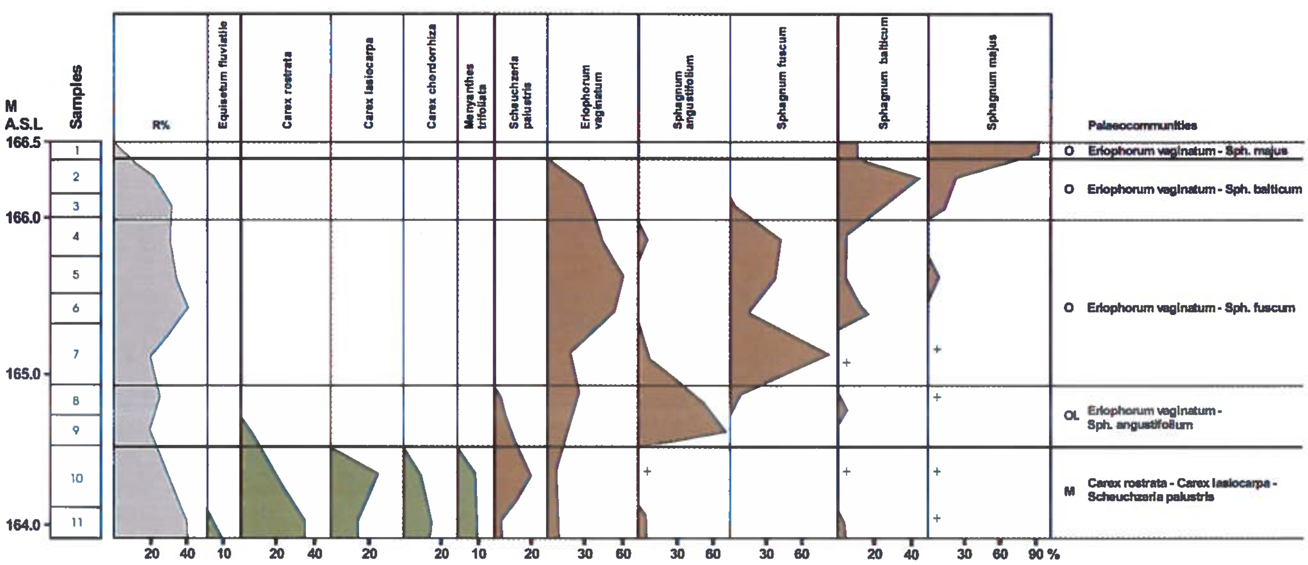


Fig. 20 Macrosubfossil diagram for site/core 21 (flark).

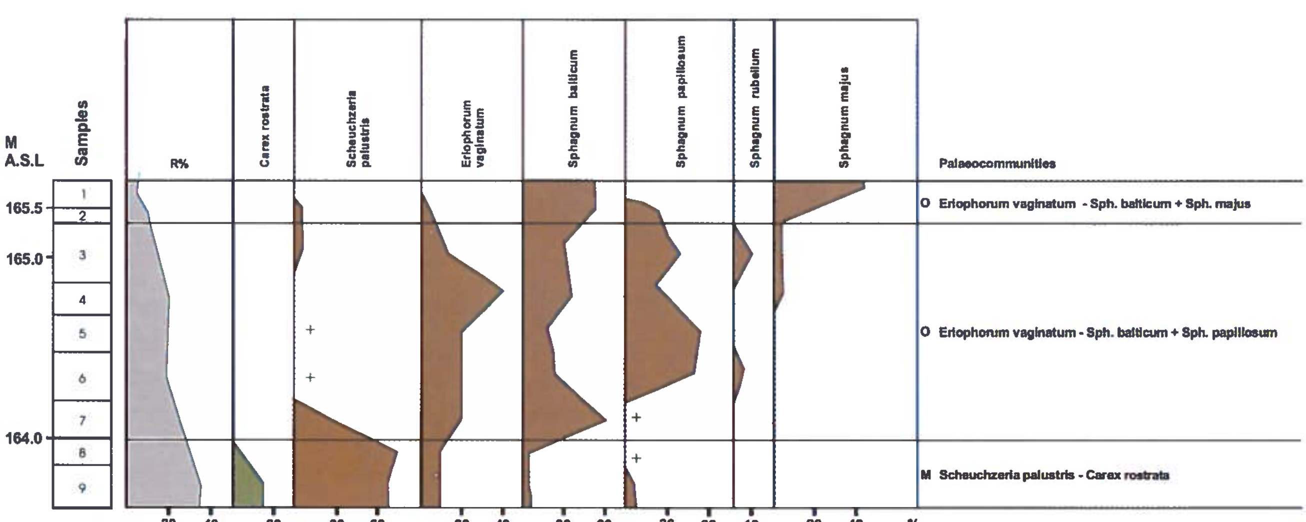


Fig. 21 Macrosubfossil diagram for site/core 19 (flark).

In core 19 the peat layer is only 1.9 m deep (Fig. 21). Typical minerotrophic period was short, too. Only 40 cm in the bottom is clearly minerotrophic peat. Minerotrophic *Scheuchzeria-Carex* community changed into *Eriophorum vaginatum-Sphagnum* communities. No *Sphagnum fuscum* stage was developed.

Core 10 (Fig. 22) is located in a water track in the northern margin of the eastern concentric bog complex (Bog I). The stratigraphy shows a continuous gradual succession of this mire site. Up to present time vegetation has been dominated by a minerotrophic *Scheuchzeria-Carex* community.

The northeastern part of the Kauhaneva mire system (Aapa II) is elevated 3-5 metres above Bog I (Fig. 11). It is rather shallow (the peat deposit is from 0.3 to 2 metres) and looks like an alternation of ombrotrophic and minerotrophic mire sites and plant communities, that is connected with their differentiated ground water supplying. The first sedge-*Sphagnum* stripe occurs near coring point 3 along transect I (Fig. 11). The peat deposit is completely composed of minerotrophic peats in the soligenous part at core 7 (Fig. 11). In that mire site water runoff is directed to the extensive water track between two central ombrotrophic mire complexes. The following site considered is already at the ombrotrophic phase of its development. The transition of the mire site has evidently occurred quite recently on the basis of the thin, about 0.5 m, layer of ombrotrophic peats on the surface (Fig. 11, cores 8, 9).

The southern part of profile I is occupied by juvenile ridge-hollow mire sites. They are formed of low ridges with *Sphagnum fuscum* and *S.magellanicum* in the bottom layer (they occupy about 10% of the total area), carpet level communities with *S.papillosum* and flood hollows with *Sphagnum majus* and little amount of *S. lindbergii*. *S. papillosum* is an ombrotrophic species in these conditions. There are no species indicating minerotrophic conditions in those mire sites. The minerotrophic stage lasted for a short time there, and it was occupied by poor *Scheuchzeria-Carex* communities which produced only 50-70 centimeters of minerotrophic peat (Fig. 11, cores 17, 19). Only the southern marginal shallow part of the mire system around Pitkäsalo mineral island is occupied by an oligotrophic *Eriophorum vaginatum-Sphagnum papillosum* community with a participation of some minerotrophic species (*Carex lasiocarpa*, *C.magellanica* subsp. *irrigua*, *Molinia caerulea*).

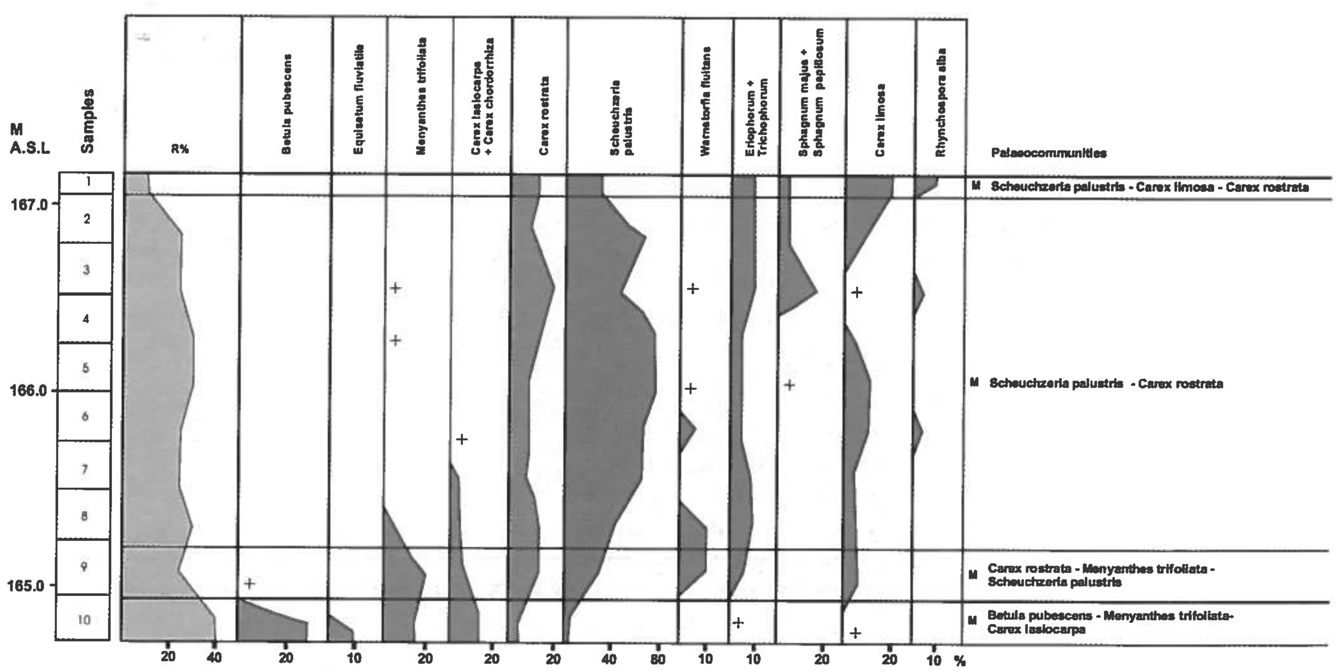


Fig. 22. Macrosubfossil diagram for site/core 10.

5 Discussion

5.1 Flora

About third of the flora in Kauhaneva area consists of species occurring only in a few quadrats, which is a typical feature in mapping of the flora of areas covering at least tens of square kilometres. In areas containing different kinds of habitats rather evenly, typically there are only a few species growing all over the study area (e.g. Suominen & Varkki 1984, Varkki 1985). In Kauhaneva mires dominate the study area, and therefore many common species of poor mires grow in every or almost every quadrat, forming a bimodal distribution.

In the flora of the Kauhaneva mire system boreal features are dominating. Even though the southern species *Carex paniculata* has its globally northernmost occurrence adjacent to the study area (Hultén 1971, Suominen & Varkki 1984) northern species are typical especially in mire flora. For example *Betula nana, Pedicularis sceptrum-carolinum* and *Sphagnum lindbergii* have a boreal and arctic distribution (Hultén 1971, Isoviita 1970). *Sparganium hyperboreum* is at its southern limit in Punttukeidas. It is also clearly continental (see Hintikka 1963).

A more interesting phytogeographical feature is that there grow both species of maritime climate, e.g. *Sphagnum molle* (Heikkilä & Lindholm 1988, 1989) and continental climate, e.g. *Carex chordorrhiza, C. globularis, C. loliacea* and *Ledum palustre* (Hintikka 1963).

There are several rare species in the study area. *Sphagnum molle* is regarded as vulnerable in Finland and in Russian Karelia (Rassi et al. 1992, Ивантер & Кузнецов 1996), and it is defined as a specially protected species in the new nature conservation act of Finland. Some of the species found in Kauhaneva are regarded as regionally threatened; *Rhynchospora fusca* and *Juncus stygius* are vulnerable, and *Poa alpigena, Pedicularis sceptrum-carolinum, Helodium blandowii, Tomentypnum nitens* and *Paludella squarrosa* in need of monitoring in the province of Vaasa (Heikkilä 1990, Rassi et al. 1992). The records of *Rhynchospora fusca, Juncus stygius* and *Carex panicea* were new to their 10 x 10 km grid squares (see Varkki 1985).

Rhynchospora fusca growing in a flark to the northwest from Pitkäsalo. Photo Raimo Heikkilä 1994.

S. molle is one of the rarest *Sphagnum* species in Finland. Globally it has an amphiatlantic distribution pattern (Flatberg & Moen 1972). In Finland it is growing at its ecological and phytogeographical limits, isolated from the main distribution area (Heikkilä & Lindholm 1988, 1989). In Finland *S. molle* is usually found at lawn level, in minerotrophic sparsely treed short-sedge pine bogs or oligotrophic short-sedge fens. It grows only in humid areas where the mineral soil is well drained and poor in nutrients. *S. molle* forms usually small pure stands, or mixed stands with *Sphagnum compactum* or *S. tenellum* (Heikkilä & Lindholm 1988, 1989).

S. molle has been found in almost 30 localities in Finland, most of them in the southwestern part of Suomenselkä watershed. Greatest deal of the known sites are in nature reserves. Nevertheless the future of *Sphagnum molle* is in danger in several of the known localities. For example pumping up the groundwater from the Pohjankangas esker, threatens to destroy the site of *S. molle* in the northern part of Kauhaneva (Heikkilä & Lindholm 1988, 1989).

S. pulchrum seems to have a rather large ecological amplitude, although in Finland it is usually regarded as a minerotrophic species (e.g. Eurola et al. 1984, 1990, 1994). In Elimyssalo in Kainuu *S. pulchrum* occurs in minerotrophic flark vegetation together with *S. majus*, *S. jensenii* or *S. lindbergii* (Heikkilä et al. 1997). In Kauhaneva *S. pulchrum* grows with *S. majus* and *S. papillosum* in typical ombrotrophic hollows in the central part of the ombrotrophic bog. Because its macrofossils have been found only in the top 10 cm of the peat, *S. pulchrum* has probably come to Kauhaneva rather late. The recent occurrence might be due to atmospheric deposition of nitrogen, but there is no direct evidence to support this hypothesis. *S. pulchrum* occurs in ombrotrophic bog vegetation also in Mustaisneva mire in Kauhajoki and Kärkikeidas mire in Lauhanvuori national park in Isojoki (Heikkilä & Lindholm 1989). According to Heikkilä et al. (1997), vegetation community with abundant *S. pulchrum* seems to be rather rare, and they have found only a couple of referencens to such vegetation types (Osvald 1923, Ruuhijärvi 1960).

5.2 Vegetation and complexes

The mapping of the vegetation was a complicated problem. The defining of the boundaries of site type patterns from aerial photographs and in the field is more or less subjective, because sharp boundaries between site types are rare. Typically, vegetation is formed of continuums where it is difficult to define where one vegetation unit ends and another begins. However, in a relatively large area with a high number of patterns it is probable that the relative areas of different site types are approximately correct. Using a point grid would make it easier to quantify the areas of different site types (see e.g. Dierssen & Dierssen 1984, Rummukainen 1998).

There is a lot of internal variation within site types, which is reflected by the multitude of different communities in different site types especially in concentric bogs (see Sjörs 1948, Мазинг 1965, Masing & Paal 1998). In Finland such an approach has not been widely applied (see e.g. Paasio 1939), but typically only site type level has been studied. The study of communities gives much more information on biodiversity, but it is difficult to apply in large areas.

The general structure of the three concentric bogs in Kauhaneva is typical for the region; broad, irregularly shaped pools on the flat domes, narrow, linear hummocks and hollows on steeper slopes surrounding the central plateau and poorly developed minerotrophic lagg (Eurola 1962, Aartolahti 1965). But there are differences in the extent and distribution of site types between these three bogs. The bog complexes get smaller and drier towards west. The centre of the eastern bog is covered with *Fuscum* hollow bog with open water pools or mud bottom and *Sphagnum* hollows. Towards west the open water pools and mud bottom hollows are replaced with drier site types, e.g. short-sedge bogs.

The site type variation at the eccentric bogs of Kauhaneva is not very diverse. The most clearly eccentric part is always *Sphagnum* hollow bog with *S. balticum* dominating at the hollows in most of the cases, and *Calluna-Fuscum* bog at hummocks. This clearly eccentric part covers from 13 to 53% of the whole complexes. The rest of the complex is covered by *Calluna-Fuscum* bog, paludified pine forest or short-sedge pine fen. Only in the northenmost eccentric bog, a minerotrophic lagg with different types of fens can be distinguished.

Aapamires in the southern part of Kauhaneva have not developed string -flark patterns but are instead rather uniform *S. papillosum* fens, which is a typical feature for the southern aapamires (Ruuhijärvi 1960, Eurola 1962). In the central part of the largest aapamire, a pattern of strings and flarks has developed. This is one of the southernmost sites in Finland, where a small-scale patterning can be distinguished in aapamires.

In both aapa and bog complexes, when the complex is large enough, a general structure can be distinguished with large, uniform patches of site types in the central parts of the complex and smaller patch size at the edges of the complex. In Kauhaneva's three concentric bogs the average size of the *Sphagnum fuscum* bogs with hollows in the centre varies from 21.3 ha in the Bog I, 41.4 ha in the Bog II and 16.2 ha in the Bog III. The patch size at the edges varies from 4.2 ha, to 4.8 ha and to 3.7 ha respectively. In Torronsuo mire complex, the average size of the patches of *Sphagnum fuscum* bogs with hollows at the central parts of the bog complex was 7.3 ha, whereas the average size of the mire site type patterns at the edges was only 0.3-0.5 ha (Kotiluoto et al. 1996). The differences in pattern size in the mire margins between Kauhaneva and Torronsuo is due to differences in the surrounding mineral soil areas. Kauhaneva is surrounded by a very gently sloping esker, while around Torronsuo there are rather steep bedrock and moraine slopes and small-scale variation in topography. The size of the few spruce mire patches in Kauhaneva is similar to those in Torronsuo. In the bog centres there is similar difference which is mainly due to climatic differences (Aartolahti 1965).

As far as we know, this is a first attempt to actually distinguish the different mire complexes at site type level. Tolonen (1967) determined minerotrophic and ombrotrophic parts in numerous mires based on a very large material, but he did not separate e.g. minerotrophic margins of bogs from actual aapamires. In Kauhaneva, we encountered two types of problems; first how to separate aapamire from a minerotrophic lagg of a bog, and secondly, how to classify transitional mires, which are somewhere between minerotrophy and ombrotrophy (Raeymaekers 2000). For example in the case of Aapa II (Table 4, Fig. 3), the minerotrophic stripe between the two eastern concentric bogs was considered to be an independent aapamire, since a clear string - flark pattern has been developed. According to Aartolahti (1965) it is quite usual in North-Satakunta to have minerotrophic, wet mires combined with the laggs of concentric bog complexes. Similar structure – minerotrophic stripes defined as aapamires between ombrotrophic bog complexes – have been observed also in Kananiemensuo in the southern coast of Finland (Tolonen & Seppä 1994). However, there is no string-flark pattern in the part of Kananiemensuo mire defined as an aapamire.

Distinguishing between minerotrophic aapamires and ombrotrophic bogs is not always easy. Especially in the northern parts of Kauhaneva, aapamires include also ombrotrophic sites. They seem to be in a transition into ombrotrophy. Similar problems with transitional mires have been encountered also in other parts of the country. For example in Kainuu Heikkilä et al. (1997) were not able to separate minerotrophic oligo-trophic sites from ombrotrophic sites on the basis of the field and ground layer composition. Thus the transition from the minerotrophic to the ombrotrophic habitat is not clear on the basis of the vegetation data.

5.3 Natural history

Most of the peatlands in the North-Satakunta region were initiated on land uplift shores (Aario 1932, Brandt 1948).The initiation time for the Bog I in Kauhaneva is approximately 8 000 ^{14}C yrs (8080 ±80 BP, 7940 ±100 BP). Ylimysneva in Parkano, western Finland, which is situated approximately 30 km east from Kauhaneva, is also approximately 8 000 ^{14}C yrs old (8100 ±160 BP) (Huttunen 1990). In Kauhaneva 4.5 m of peat and in Ylimysneva 2.4 m of peat has been accumulated in 8 000 years.

The general trend in the vegetetation succession of the two concentric bogs in Kauhaneva has been from sedge dominated, minerotrophic, wet (*Menyanthes, Equisetum fluviatile, Scheuchzeria*) communities to ombrotrophic dry hummock or wet hollow communities with different *Sphagnum* species dominating. This is a well documented trend in the long-term succession of bogs after the deglaciation in the boreal regions (Aartolahti 1965, Tolonen 1967, Elina 1985, Елина et al. 1984, 1996, Elina & Kuznetsov 1996, Foster & Glaser 1986).

The general stratigraphy of bogs of southwestern Finland shows following phases: the earliest limnic phase with plenty of *Equisetum* is followed with sedges, after that *Eriophorum vaginatum* peat, followed by a phase with tree stumps and at the top *Sphagnum* phase (Aario 1932, Aartolahti 1965). In Kauhaneva the development of the two bogs follows this line, except no tree stumps were detected.

In southern Finland the ombrotrophic phase has started at fairly different times according to detailed microscopic peat analyses and C^{14} datings: Laaviosuo, Lammi 5620 ± 100 B.P. (450 cm depth), Kaurastensuo, Lammi 3780 ± 110 B.P. (360-370 cm), Varrassuo, Lahti 8600 B.P., Nälköönsuo, Lohja, ca. 1900 B.P. (depth 234 cm), Piilonsuo, Janakkala, ca. 3000 B.P. (depth 82 cm), Haukkasuo, Valkeala, ca. 3535 ± 85 B.P. (depth 108 cm), Konnunsuo, Joutseno, ca. 4000 B.P. (depth 148 cm), Munasuo, Pyhtää ca. 3 500 B.P. (Aartolahti 1965, Tolonen 1966, 1967, 1968, 1987, Donner et al. 1978, Tolonen & Seppä 1994). Thus it is evident that different mires experienced the change from minerotrophic to ombrotrophic stage at very different times, also in a restricted geographical area (Tolonen 1987). A transition into the ombrotrophic stage in a number of mires in Pribelomorskaya lowland in Russian Karelia and Estonian mires is dated to 6 500-7 000 yrs. BP (Елина 1971, Elina 1985, Ilomets 1992). According to Tolonen (1987) there seems to be a general rule, that maximum age of the ombrotrophic stage within european peatlands decreases northwards.

Scheuchzeria palustris, Sphagnum magellanicum, S. majus and *S. papillosum* can be regarded as "indifferent" species in Kauhaneva, since they often occur in the transition zone, both in minerotrophic and ombrotrophic peat layers. Also Aartolahti (1965) and Tolonen (1967) regard *S. magellanicum* as a typical indifferent plant on the boundary of the minerotrophic and ombrotrophic phases.

Hollows, which are formed at the places of minerotrophic herb communities, are called "primary hollows" according to Russian mire reseachers (Богдановская-Гиенэф 1936). The hollows arising at the place of more dry, ombrotrophic communities are called "secondary hollows" (Богдановская-Гиенэф 1936). Both primary and secondary hollows occur in Kauhaneva. According to Елина et al. (1984) secondary hollows occur in Karelia more often than primary ones.

According to Aartolahti (1967) the time of origin of the kermis and hollows in the raised bogs of south-west Finland vary greatly: Linturahka, Mellilä; 3170 ± 105, Pitkäsuo, Urjala; 3220 ± 110, Raholansuo, Lieto; 2090 ± 105, Heinisuo, Renko, Hämeenlinna; 2090 ± 105. Nevertheless there seems to be two main periods for the development of hummocks and hollows, one approximately 3200 and another approximately 2100 ^{14}C years ago.

In Laaviosuo, Lammi, all hollows seemed to be secondary formations and relatively young, with one of the hollows dated to 2320 ± 110 B.P. (Tolonen 1987). In plateau peat bog Munasuo, Pyhtää, southeastern Finland, hummock peat was found under large hummocks almost always down to the early wet phases of the mire development. Whereas all hollows seemed to be secondary hollows and different ages. Oldest hollow was dated to 1050 ± 60 BP (205-210 cm) (Tolonen & Seppä 1994). In another plateau bog, Punassuo, Perniö two hollows have been dated to 1940 ± 130 BP (130-135 cm) and 1020 ± 120 BP (50-55 cm) (Tolonen & Seppä 1994). The hollows at the plateau bogs near the coast seems to be younger than hollows at concentric bogs further north in the interior of the country (Aartolahti 1967, Tolonen 1987, Tolonen & Seppä 1994).

In several Karelian mires origin of secondary hollows have been dated to 2500 - 3000 yrs BP (Елина et al. 1984).

5.4 Concluding remarks

The study of a whole mire system and its parts in relation to the system and each other is needed for planning and evaluation of mire conservation. In addition to the present work, thorough understanding of the drainage basin of the mire and its functioning, as well as understanding of the relations of mire fauna to different scales in mires is necessary. In addition to areas and numbers of species, the structure and dynamics of the mire must be studied (cf. Virkkala et al. 2000, Aapala & Lindholm 1995). The present state and future development of the mire cannot be understood without knowledge of the development history of it.

Acknowledgements

Discussions with Mr. Tapani Sallantaus about the hydrology in relation to vegetation and complexes were very fruitful. Professor Jaanus Paal and professor Kimmo Tolonen read the manuscript thoroughly, and made numerous useful comments. Ms. Natalia Stoikina and Mr. Pavel Tokarev from Institute of Biology, Karelian Research Centre, Mr. Valentin Kalamajev from the Ministry of Ecology of the Karelian Republic and Mr. Timo Jalkanen from Friendship Park Research Centre helped us in the field work. Ms. Natalia Stoikina determined the macrosubfossils from the peat samples. Mr. Armas Heikkilä gave technical support. Ms. Ludmila Filimonova from Institute of Biology, Karelian Research Centre prepared the zonation of the pollen diagrams from Aario (1932). Ms. Pirjo Appelgrén and Mr. Martti Salo from Friendship Park Research Centre prepared the figures in the final form. Ms. Elvi Mannila arranged us a superb accommodation at Nummijärvi camping. Field work was financed by the Finnish-Russian Committee for Nature Conservation, and the preparing of this report by the Nature and Land Use Division of Finnish Environment Institute, Kainuu Regional Environment Centre, Institute of Biology of the Karelian Research Centre, Kauhajoki Cultural Foundation and Western Finland Park Area of the Finnish Forest and Park Service (Metsähallitus). We express our warmest gratitude to all of them.

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Реферат

Болотная система Кауханева: болотные массивы, растительность, флора и динамика

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Болотные экосистемы имеют большое разнообразие и сложное строение. При их изучении выделяется несколько структурных уровней: от ценозов (синузий, ассоциаций) до болотных систем (Cajander 1913, Галкина 1959, Мазинг 1974). Болотные системы, включающие болотные массивы разных типов, широко распространены в восточной Фенноскандии. Здесь они состоят в основном из массивов, относящихся к сфагновым омбротрофным и аапа типам. Растительность и стратиграфия омбротрофных сфагновых и аапа болот Фенноскандии хорошо изучены и описаны в многочисленных публикациях. Однако до настоящего времени слабо исследованы генезис и динамика сложных болотных систем.

Данная работа является результатом совместных исследований финских и русских болотоведов, выполненных на болотной системе Кауханева площадью 2506 га, расположенной в национальном парке Кауханева-Похъянкангас в западной Финляндии в среднебореальной зоне. При проведении этих работ ставились задачи по сближению и согласованию методов исследований, терминологии и объему основных понятий, используемых финскими и русскими болотоведами. Большинство противоречий в ходе работы были успешно преодолены, а исполнители взаимно обогатились знаниями своих коллег.

Ранее была исследована флора сосудистых растений и листостебельных мхов национального парка Кауханева – Похъянкангас с использованием метода квадратов площадью 1 км^2 (Heikkilд 1986), обобщенные и дополненные материалы по флоре включены в данную работу. На исследованной территории выявлено 173 вида сосудистых растений и 68 видов листостебельных мхов. Число видов сосудистых растений на 1 км^2 варьирует от 30 до 149, наиболее бедна флора квадратов, включающих верховые болота, а наиболее разнообразна в местах выходами грунтовых вод и сильным антропогенным воздействием. Из мхов наиболее хорошо представлено разнообразие рода *Sphagnum*, из 38 видов известных в Финляндии, здесь встречается 29 видов. В целом флора этого парка довольно бедная, из довольно редких для этого региона Финляндии следует отметить такие виды: *Rhynchospora fusca, Juncus stygius, Pedicularis sceptrum-carolinum, Poa alpigena, Carex panicea, Sparganium hyperboreum, Sphagnum molle, Helodium blandowii, Paludella squarrosa* и некоторые другие.

Болотная система Кауханева включает 14 болотных массивов, из них 10 являются омбротрофными сфагновыми (3 – концентрические грядово-озерковые, 6 – эксцентрические грядово-мочажинные, 1 – кустарничково-сфагновый), а 4 относятся к южному варианту аапа типа (sedge aapa mires) со слабо развитым микрорельефом. Омбротрофные типы массивов (верховики) занимают 52% площади системы, а минеротрофные (аапа) – 48%. По материалам аэрофотосъемки в сочетании с наземными исследованиями составлена карта болотных участков (фаций по русской терминологии) всей системы, определены их типы (по классификациям Eurola, Kaakinen 1978, Ruuhijдrvi 1983), ?лощади каждого выдела. На Кауханева выявлено около 60 типов болотных участков, что свидетельствует о довольно высоком разнообразии его растительного покрова. Однако здесь практически не представлены евтрофные типы участков, так как болото развивается среди мощных песчаных флювиогляциальных отложений, что обусловливает слабую минерализацию грунтовых вод, поступающих на его минеротрофные части.

Более половины площади (55-70%) концентрических верховиков занимают грядово-озерковые и грядово-мочажинно-озерковые комплексы (типы участков) с многочисленными вторичными озерками (295), большинство которых небольшие (менее одного гектара). На грядах и кочках в этих комплексах преобладают кустарничково-лишайниковые сообщества, характерные для омбротрофных болот приморских регионов Европы. На большинстве эксцентрических верховиков этой системы грядово-мочажинные комплексы занимают менее половины их площади, при этом наряду с типично омбротрофными фациями широко развиты мелкоосоково-сфагновые со *Sphagnum papillosum*, трофический статус которых является дискуссионным.

Фациальная структура всех 4 болотных массивов аапа типа является сложной, на них выделено 40 типов естественных болотных участков (mire sites) и 11 типов осушенных участков. Фации с выраженным микрорельефом (кочковато-мочажинным, равнинно-мочажинным) и комплексами сообществ занимают на них от 15 до 30%, наряду с ними широко распространены осоково-сфагновые, пушицево-сфагновые и сосново-травяно-сфагновые типы участков. На окрайках аапа болот имеются и омбротрофные фации, а также мелкозалежные облесенные участки разной трофности. Русские болотоведы такие болотные массивы не относят к аапа типу, а выделяют самостоятельный мезотрофный осоково-сфагновый тип (Юрковская 1975, Елина и др. 1984), имеющий свои особенности генезиса и дальнейшей динамики в сторону омбротрофности.

Для выявления генезиса, стратиграфии и динамики болотной системы на ней были проложены два стратиграфических профиля общей протяженностью 7,7 км, на которых в 29 скважинах сделан подробный ботанический анализ торфа по русским методикам, для двух придонных образцов определен абсолютный возраст по C_{14}. На основании данных ботанического состава торфов выполнена реконструкция динамики растительности в отдельных частях Кауханева.

Глубина торфяной залежи на Кауханева достигает 4,5 метра, в наиболее глубокой части системы имеется тонкий (20 см) слой сапропеля. Мощность слоя верховых торфов на омбротрофных массивах варьирует от 1,0 до 2,9 метра, подстилающие их слои минеротрофных (в основном переходных) торфов имеют толщину от 0,5 до 2,7 метра. Это свидетельствует о разной длительности минеротрофной и омбротрофной стадий развития в различных частях системы. Глубины торфяной залежи под одним исследованным массивом аапа типа варьируют от 0,5 до 3,0 метров, в ряде скважин здесь верхние слои залежи (до глубины 1,0 – 1,5 метра) сложены пушицево-сфагновым и сфагновым торфами, не содержащих остатков типично минеротрофных видов, но часто со значительным количеством остатков *Sphagnum papillosum.* Такие торфа и отложившие их палеосообщества были нами отнесены к олиготрофным (мезоолиготрофным по русской типологии). В дальнейшем требуется проведение специальных исследований по выявлению критериев разграничения омбротрофных и минеротрофных местообитаний в различных климатических условиях Фенноскандии и в других регионах.

Установлен значительный уклон поверхности болота с севера на юг и юго-запад, перепад высот составляет 15 метров. Образование центральной части системы Кауханева началось с заболачивания двух плоских депрессий, занятых в настоящее время концентрическими верховиками I и II. В центре восточной котловины (верховик I) около 8 000 лет назад (7940 ± 110 л.н., LU-3417) существовал небольшой мелководный водоем с зарослями *Equisetum fluviatile* и с участием *Typha sp., Schoenoplectus lacustris, Potamoge-*

ton sp., Scorpidium scorpioides, Calliergon giganteum. Мелководная стадия была кратковременной, под современной шейхцериево-сфагновой мочажиной она сменилась вахтово-сфагновыми, а затем осоково-сфагновыми сообществами. Минеротрофная стадия развития в этой части болота была довольно длительной, здесь отложилось 1,5 м переходных торфов. Омбротрофная стадия началась с шейхцериево-сфагновых сообществ, которые и занимают эти первичные мочажины. Слой верховых торфов под ними составляет 3,0 м.

На северо-западном краю этого верховика было выполнено параллельное бурение гряды, мочажины и вторичного озерка. Здесь отсутствует мелководная стадия и заболачивание началось с осоково-сфагновых (*Sphagnum* sect. *Subsecunda)* сообществ. Придонный слой торфа имеет возраст 8080 ± 80 л.н. (LU-3416). Минеротрофная стадия под всеми элементами микрорельефа была довольно кратковременной, слой переходных торфов имеет мощность 75-100 см. Омбротрофная стадия началась после резкой смены условий увлажнения с распространения кочковых сообществ со *Sphagnum fuscum* как под современными грядами так и мочажинами. Мощность слоя фускум-торфа под мочажиной составляет 1,25 м, только позднее здесь сформировались вторичные шейхцериево-сфагновые мочажины. Исследованное озерко имеет слой воды около 2,5 метра, под ним лежит 25 сантиметровый слой шейхцериево-сфагнового верхового торфа, подстилаемого 75 см пластом переходных торфов. Оно образовалось на месте первичной мочажины, что характерно для таких озерков на верховых болотах в различных регионах Евразии.

Формирование второго исследованного концентрического верховика началось в плоской котловине с осоково-шейхцериевых сообществ, минеротрофная стадия была довольно кратковременной, за это время отложилось от 40 до 80 см переходных торфов. Во всех исследованных здесь мочажинах омбротрофная стадия началась после резкого уменьшения увлажнения с распространения кочковых пушицево-сфагновых (*Sphagnum fuscum)* сообществ, которые отложили от 50 до 80 см фускум-торфа. После этого на фоне пушицево-сфагновых сообществ здесь началось формирование грядово-мочажинных комплексов со вторичными мочажинами. Эти шейхцериево-сфагновые мочажины довольно старые, мощность слоя мочажинных торфов достигает в них двух метров.

Массив аапа типа, расположенный между этими верховиками, имеет мощность торфяной залежи до 3 метров. Придонные слои залежи сложены осоковым и осоково-шейхцериевым переходными торфами, которые в большинстве скважин перекрыты пушицево-сфагновыми и сфагновыми торфами разной мощности, являющихся согласно русской классификации верховыми. Только наличие в их составе остатков *Sphagnum papillosum* позволяет условно отнести отложившие их сообщества к олиготрофным по финской типологии.

Комплексные исследования флоры, растительности и стратиграфии болотной системы Кауханева позволили установить большое разнообразие ее растительного покрова, высокую природоохранную значимость для западной Финляндии и восточной Фенноскандии. Подробные реконструкции сукцессий палеорастительности позволили установить большое сходство в динамике верховых болот западной Финляндии и на побережье Белого моря в России.

Работа выполнена в рамках Финляндско-Российской программы по научно-техническому сотрудничеству в области охраны окружающей среды по проекту «Структура и растительность болотных экосистем восточной Фенноскандии и их охрана.», (1993-1996), финансировавшемся Министерством окружающей среды Финляндии и Министерством экологии и природных ресурсов Республики Карелия. Авторы выражают свою признательность за поддержку исследований и постоянный интерес к нашим работам профессору Рауно Руухиярви.

Appendix 1. Vascular plant and bryophyte species found in Kauhaneva-Punttukeidas. The figures show the number of 1 square kilometre quadrats with records of each species. The total number of quadrats was 34.

Vascular flora of Kauhaneva-Punttukeidas

Achillea millefolium	3
Achillea ptarmica	2
Agrostis canina	6
Agrostis capillaris	7
Alchemilla monticola	1
Alnus glutinosa	2
Alnus incana	11
Alopecurus aequalis	1
Alopecurus geniculatus	2
Andromeda polifolia	34
Angelica sylvestris	2
Antennaria dioica	1
Anthoxanthum odoratum	2
Arctostaphylos uva-ursi	6
Athyrium filix-femina	2
Betula nana	34
Betula nana x pubescens	9
Betula pendula	21
Betula pubescens	34
Calamagrostis canescens	3
Calamagrostis epigejos	15
Calamagrostis purpurea subsp. phragmitoides	12
Calamagrostis stricta	2
Calla palustris	1
Callitriche palustris	1
Calluna vulgaris	34
Caltha palustris	3
Calystegia sepium subsp. sepium	1
Carex acuta	8
Carex aquatilis	1
Carex brunnescens var.brunnescens	3
Carex canescens	15
Carex chordorrhiza	17
Carex diandra	2
Carex dioica	2
Carex echinata	14
Carex globularis	32
Carex lasiocarpa	33
Carex limosa	30
Carex loliacea	1
Carex magellanica subsp. irrigua	23
Carex nigra subsp. nigra	24
Carex ovalis	3
Carex paniculata	1
Carex pauciflora	32
Carex rostrata	32
Cerastium fontanum	2
Chenopodium album	2
Cirsium helenioides	3
Cirsium palustre	4
Convallaria majalis	1
Crepis paludosa	1
Dactylorhiza maculata	10
Deschampsia cespitosa	6
Deschampsia flexuosa	21
Drosera anglica	28
Drosera rotundifolia	34
Dryopteris carthusiana	5
Elymus repens	2
Empetrum nigrum subsp. nigrum	34
Epilopium angustifolium	16
Epilobium palustre	4
Equisetum fluviatile	5
Equisetum palustre	2
Equisetum sylvaticum	13
Eriophorum angustifolium	32
Eriophorum vaginatum	34
Festuca ovina	4
Festuca pratensis	1
Festuca rubra subsp. rubra	2
Filipendula ulmaria	1
Frangula alnus	1
Galeopsis bifida	3
Galium palustre	1
Galium trifidum	1
Geranium sylvaticum	1
Gymnocarpium dryopteris	5
Hieracium pilosella	1
Hieracium sylvatica	3
Hieracium umbellata	1
Huperzia selago	3
Juncus articulatus var. articulatus	1
Juncus bufonius	1
Juncus bulbosus	1
Juncus conglomeratus	1
Juncus effusus	2
Juncus filiformis	18
Juncus stygius	1
Juniperus communis	14

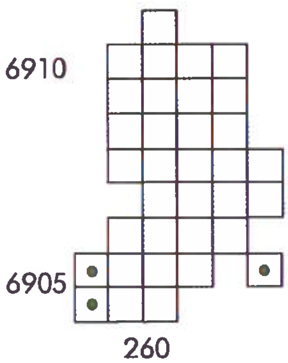
Ledum palustre	34
Leontodon autumnalis	2
Leucanthemum vulgare	1
Linnea borealis	3
Luzula multiflora	4
Luzula pilosa	9
Luzula sudetica	1
Lycopodium annotinum	4
Lycopodium clavatum	1
Lysimachia thyrsiflora	2
Maianthemun bifolium	8
Melampyrym pratense	12
Melampyrym sylvaticum	3
Menyanthes trifoliata	22
Molinia caerulea	17
Moneses uniflora	2
Nymphaea tetragona	1
Orthilia secunda	5
Paris quadrifolia	3
Pedicularis palustris	2
Pedicularis sceptrum-carolinum	3
Phalaris arundinacea	2
Phleum pratense	4
Phlox paniculata	1
Phragmites australis	12
Picea abies	29
Pinus sylvestris	34
Plantago major	2
Poa alpigena	1
Poa annua	1
Poa pratensis	5
Polygonum aviculare	1
Polygonum viviparum	1
Populus tremula	19
Potentilla erecta	10
Potentilla fruticosa	1
Potentilla palustris	7
Pyrola chlorantha	1
Pyrola minor	5
Ranunculus acris	4
Ranunculus repens	4
Rhynchospora alba	22
Rhynchospora fusca	3
Rubus arcticus	2
Rubus chamaemorus	34
Rubus saxatilis	3
Rumex acetosa subsp. acetosa	3
Rumex acetosella	7
Rumex longifolius	2
Salix aurita	28
Salix aurita x repens	1
Salix caprea	3
Salix cinerea	2
Salix lapponum	4
Salix myrsinifolia	1
Salix myrtilloides	11
Salix pentandra	3
Salix phylicifolia	7
Salix repens	27
Scheuczeria palustris	29
Sedum acre	1
Solidago virgaurea	4
Sorbus aucuparia	2
Sparganium hyperboreum	1
Sparganium minimum	3
Spergula arvensis	1
Stellaria graminea	1
Stellaria media	2
Taraxacum spp.	2
Trichophorum cespitosum	31
Trientalis europaea	8
Trifolium repens	2
Tripleurospermum inodorum	1
Utricularia intermedia	1
Vaccinium microcarpum	31
Vaccinium myrtillus	29
Vaccinium oxycoccos	34
Vaccinium uliginosum	34
Vaccinium vitis-idaea	33
Veronica chamaedrys	1
Vicia cracca	1
Viola canica subsp. montana	1
Viola epipsila	1
Viola palustris	3

Bryophyte flora of Kauhaneva-Punttukeidas

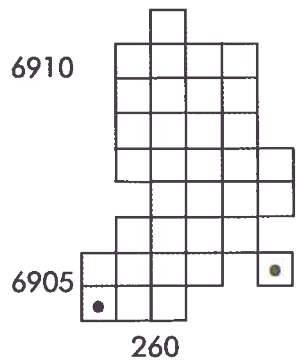
Aulacomnium palustre	34
Brachythecium rivulare	3
Bryum weigelii	2
Calliergon cordifolium	1
Calliergon stramineum	12
Calliergonella cuspidata	2
Campylium protensum	2
Ceratodon purpureus	6

Dicranella cerviculata	2
Dicranum fuscescens	23
Dicranum majus	2
Dicranum polysetum	33
Dicranum scoparium	17
Dicranum undulatum Brid.	27
Fontinalis antipyretica	2
Funaria hygrometrica	1
Helodium blandowii	2
Hylocomium splendens	6
Paludella squarrosa	2
Plagiomnium ellipticum	3
Plagiothecium denticulatum	1
Pleurozium schreberi	34
Pohlia nutans	20
Polytrichum commune	28
Polytrichum juniperinum	13
Polytrichum piliferum	4
Polytrichum strictum	34
Pseudobryum cinclidioides	3
Ptilium crista-castrensis	7
Racomitrium fasciculare	1
Racomitrium microcarpon	4
Rhizomnium punctatum	2
Rhytidiadelphus triquetrus	1
Sphagnum angustifolium	34
Sphagnum annulatum var. porosum	29
Sphagnum auriculatum var. inundatum	1
Sphagnum balticum	34
Sphagnum centrale	6
Sphagnum compactum	25
Sphagnum cuspidatum	14
Sphagnum fallax	30
Sphagnum fimbriatum	1
Sphagnum flexuosum	7
Sphagnum fuscum	33
Sphagnum girgensohnii	14
Sphagnum lindbergii	28
Sphagnum magellanicum	34
Sphagnum majus	29
Sphagnum molle	10
Sphagnum nemoreum	34
Sphagnum obtusum	2
Sphagnum papillosum	34
Sphagnum platyphyllum	8
Sphagnum pulchrum	5
Sphagnum riparium	6
Sphagnum rubellum	34
Sphagnum russowii	31
Sphagnum squarrosum	3
Sphagnum subsecundum	1
Sphagnum tenellum	22
Sphagnum teres	3
Sphagnum warnstorfii	4
Splachnum ampullaceum	3
Splachnum luteum	2
Tetraphis pellucida	1
Tomentypnum nitens	2
Warnstorfia exannulata	5
Warnstorfia fluitans	11

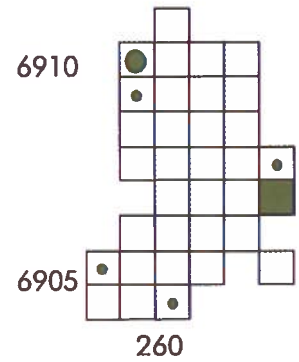
Appendix 2. Distribution of vascular plants and bryophytes in Kauhaneva-Punttukeidas in one square km grid. Small dots show sparse occurrence, large dots rather abundant occurrence and filled squares abundant occurrence.



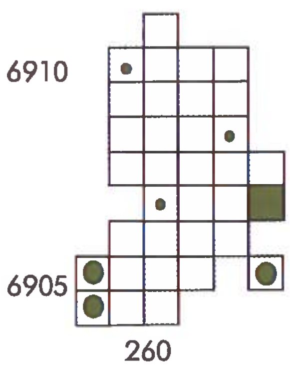
Achillea millefolium



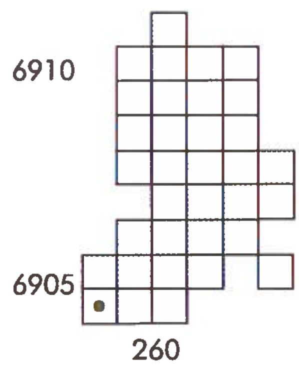
Achillea ptarmica



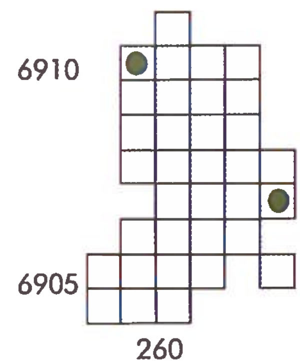
Agrostis canina



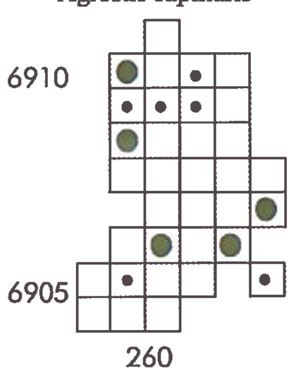
Agrostis capillaris



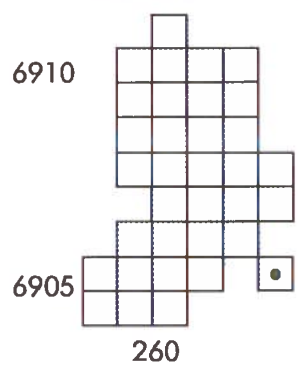
Alchemilla monticola



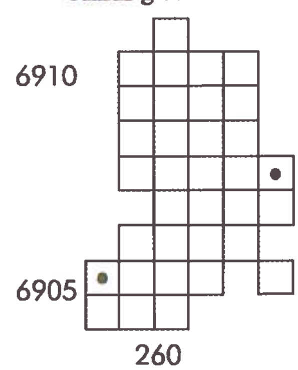
Alnus glutinosa



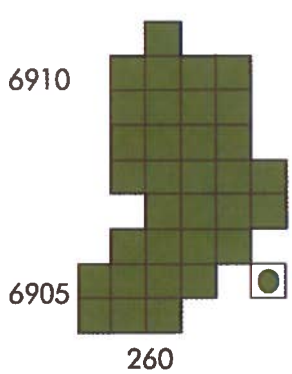
Alnus incana



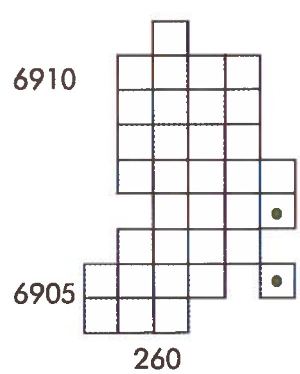
Alopecurus aequalis



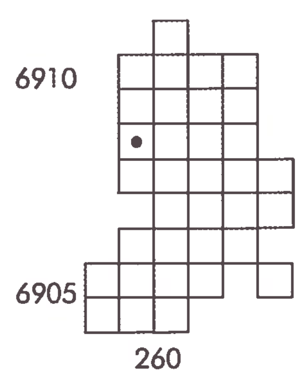
Alopecurus geniculatus



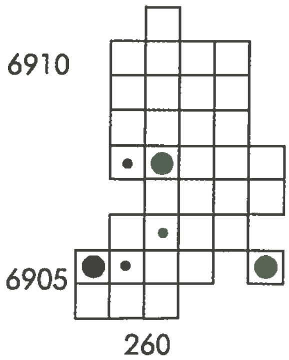
Andromeda polifolia



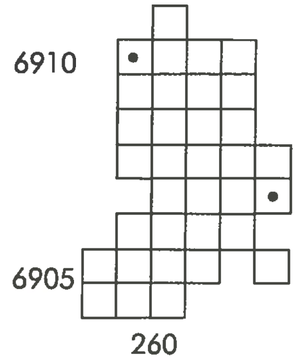
Angelica sylvestris



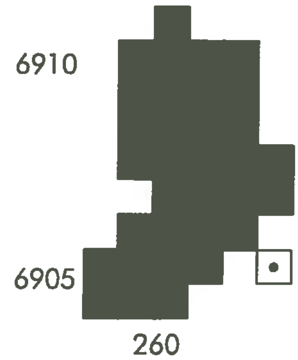
Antennaria dioica



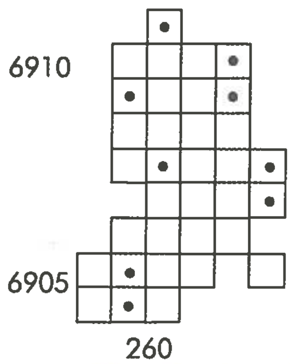
Arctostaphylos uva-ursi



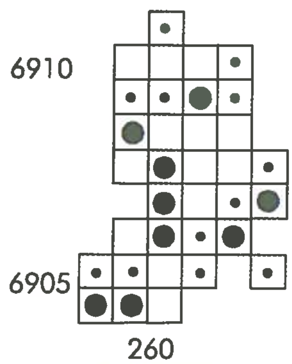
Athyrium filix-femina



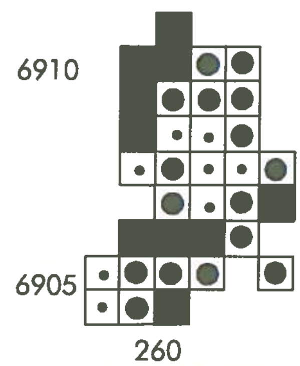
Betula nana



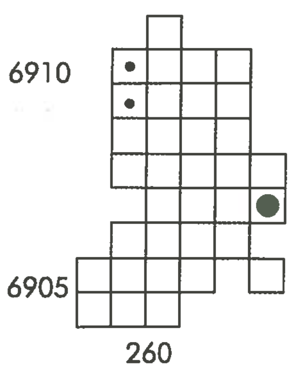
Betula nana x pubescens



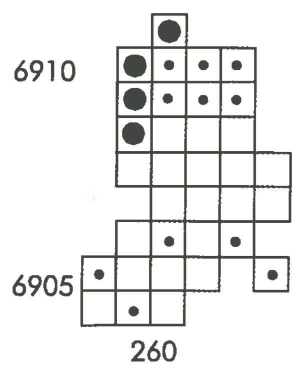
Betula pendula



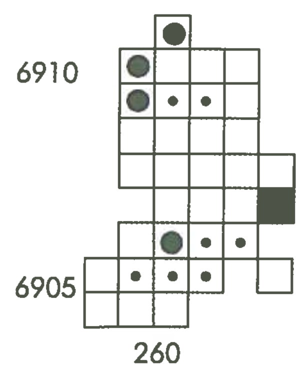
Betula pubescens



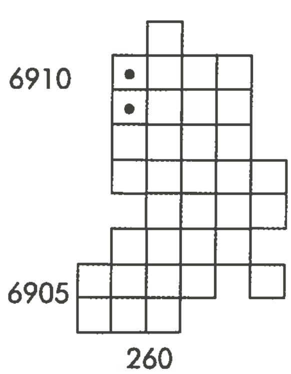
Calamagrostis canescens



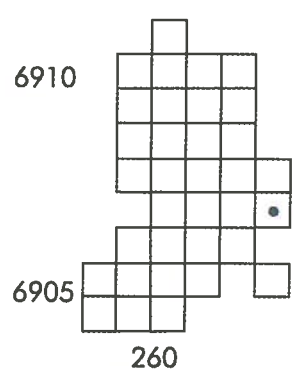
Calamagrostis epigejos



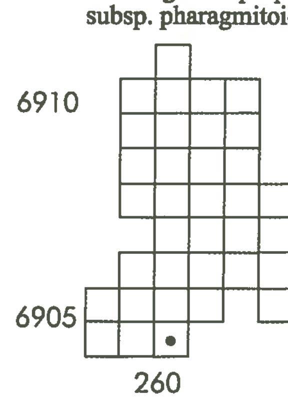
Calamagrostis purpurea subsp. pharagmitoides



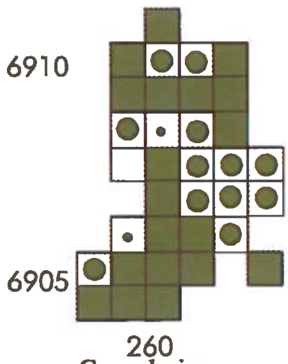
Calamagrostis stricta



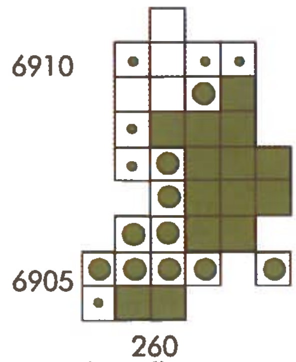
Calla palustris



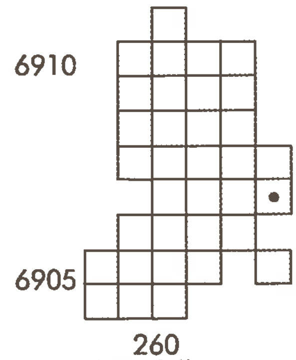
Callitriche palustris



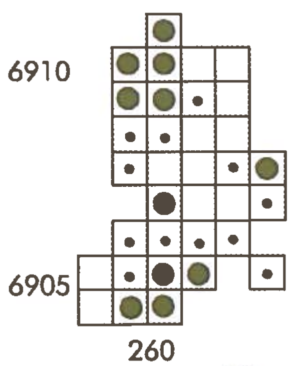
Carex lasiocarpa



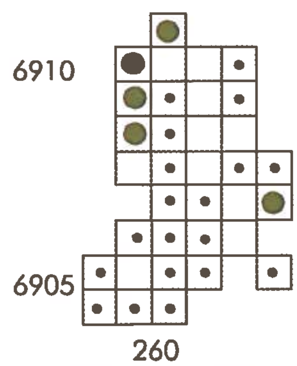
Carex limosa



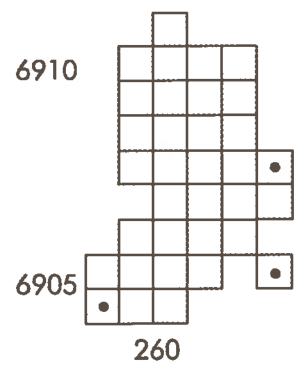
Carex loliacea



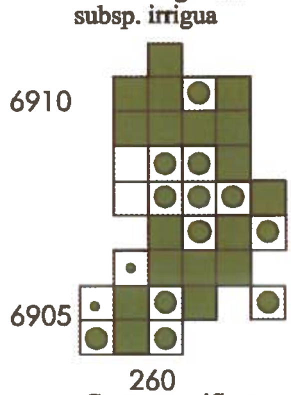
Carex magellanica subsp. irrigua



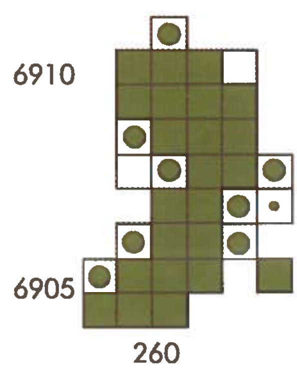
Carex nigra subsp. nigra



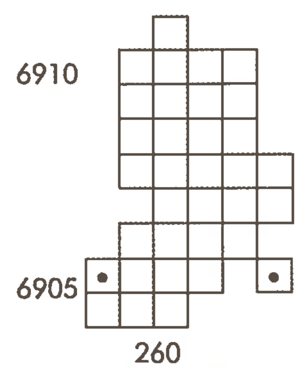
Carex ovalis



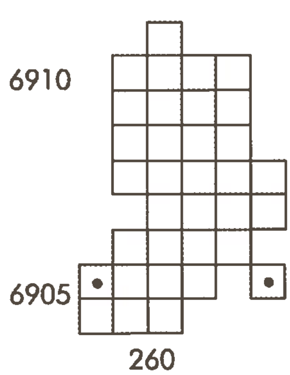
Carex pauciflora



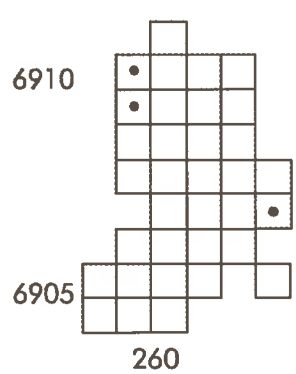
Carex rostrata



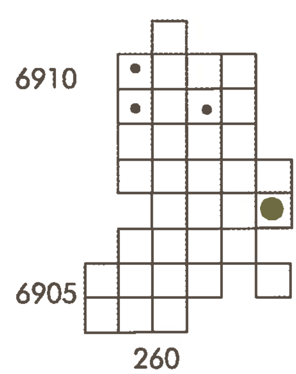
Cerastium fontanum



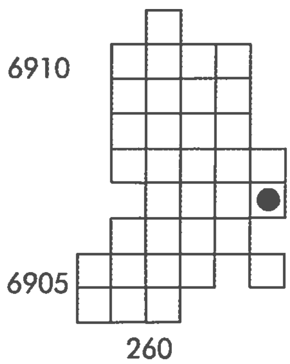
Chenopodium album



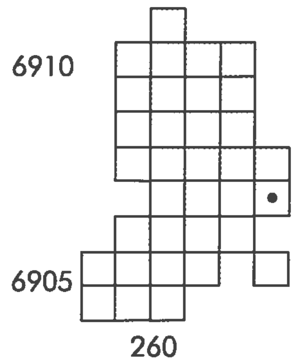
Cirsium helenoides



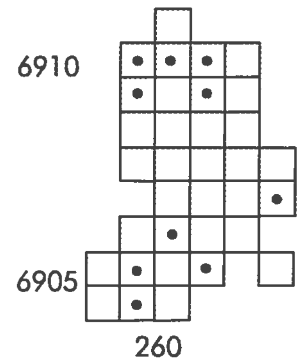
Cirsium palustre



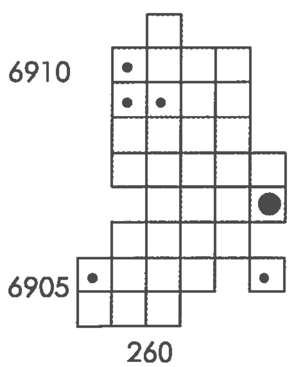
Convallaria majalis



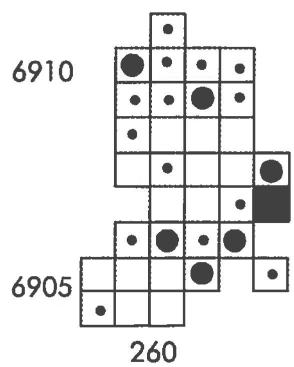
Crepis paludosa



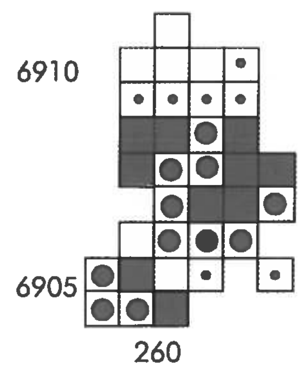
Dactylorhiza maculata



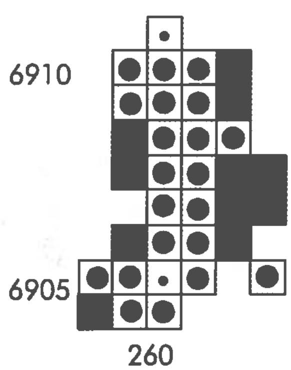
Deschampsia cespitosa



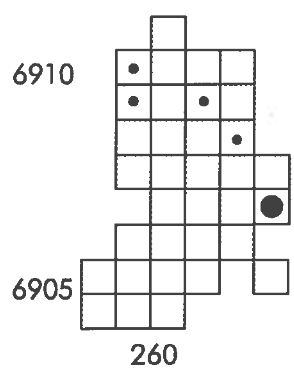
Deschampsia flexuosa



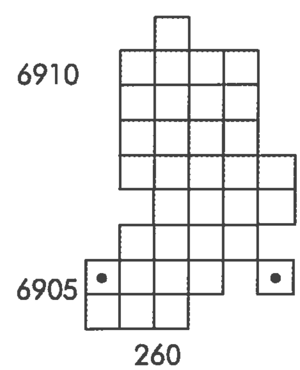
Drosera anglica



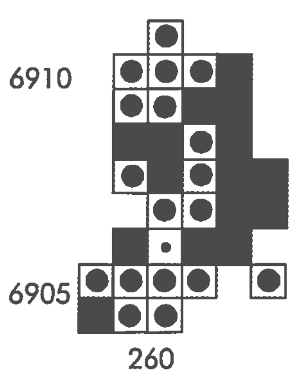
Drosera rotundifolia



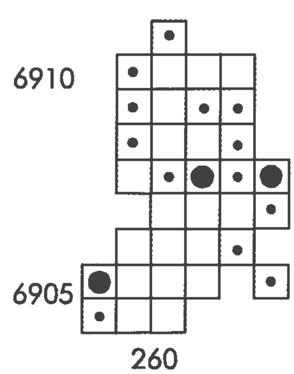
Dryopteris carthusiana



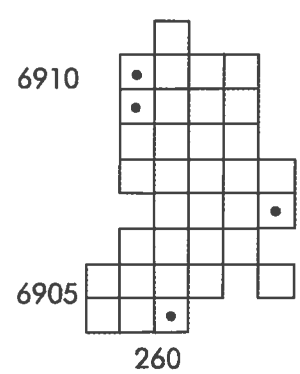
Elymus repens



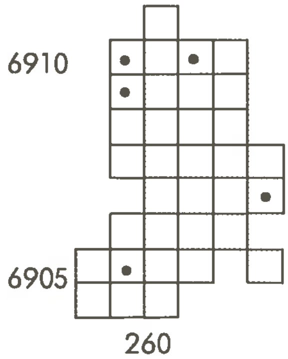
Empetrum nigrum
susp. nigrum



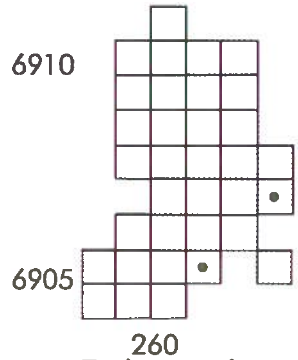
Epilobium angustifolium



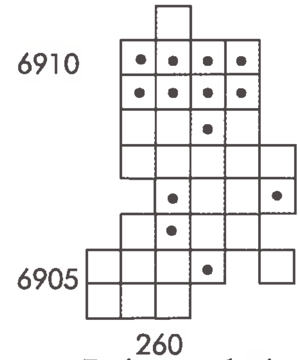
Epilobium palustre



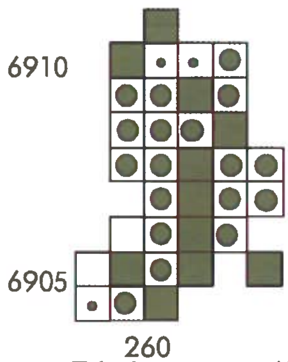
Equisetum fluviatile



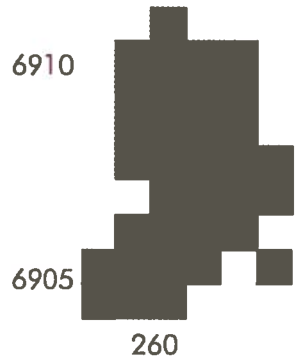
Equisetum palustre



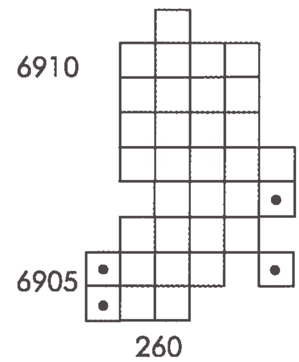
Equisetum sylvaticum



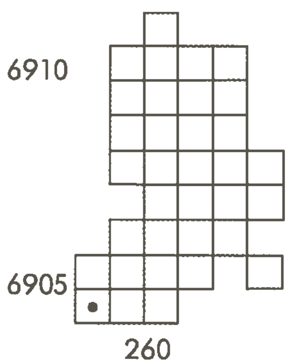
Eriophorum angustifolium



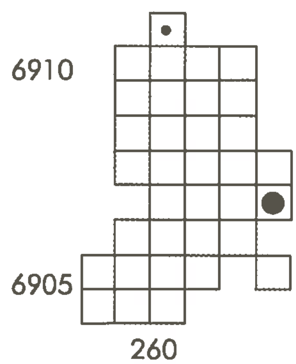
Eriophorum vaginatum



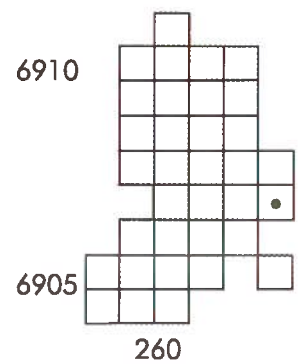
Festuca ovina



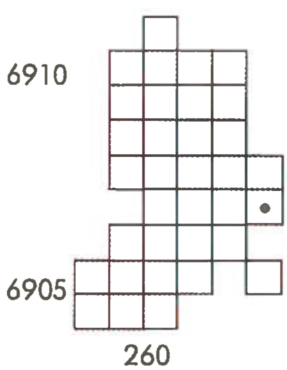
Festuca pratensis



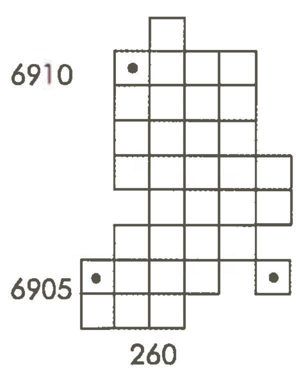
Festuca rubra subsp. rubra



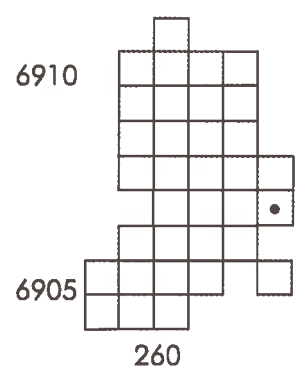
Filipendula ulmaria



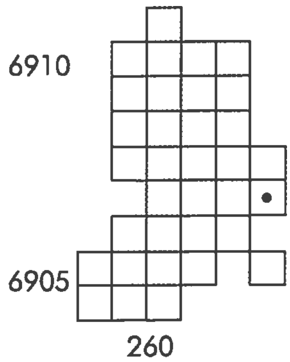
Frangula alnus



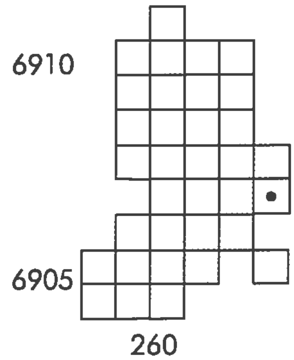
Galeopsis bifida



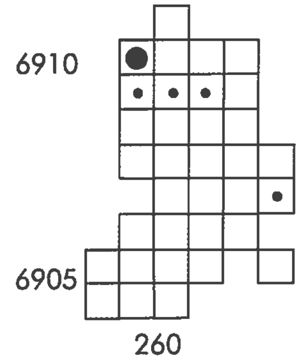
Galium palustre



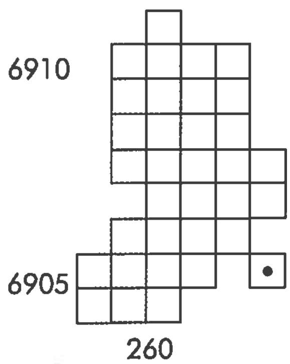
Galium trifidum



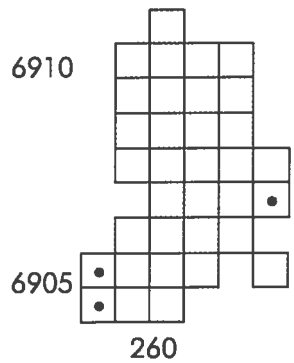
Geranium sylvaticum



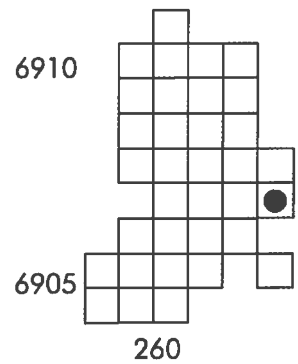
Gymnocarpium dryopteris



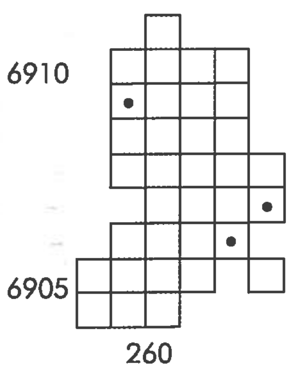
Hieracium pilosella



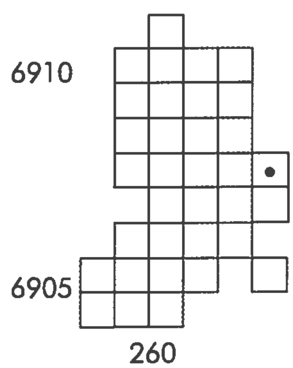
Hieracium sylvatica



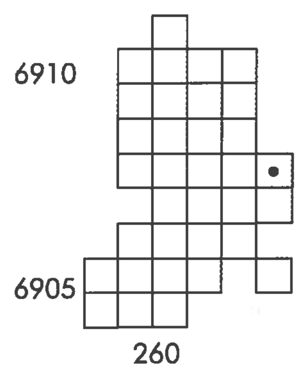
Hieracium umbellata



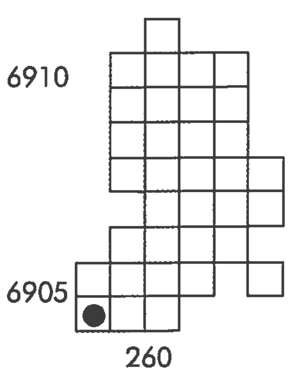
Huperzia selago



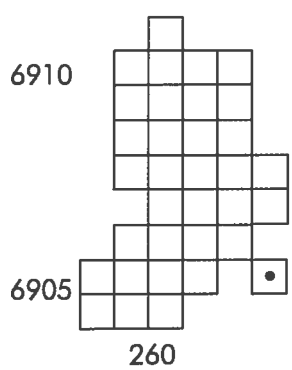
Juncus articulatus var. articulatus



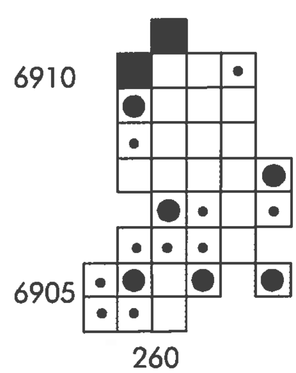
Juncus bufonius



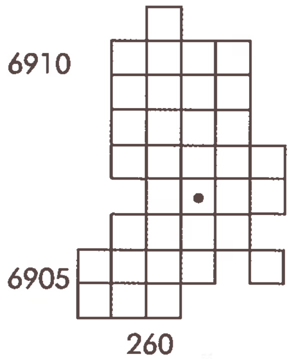
Juncus bulbosus



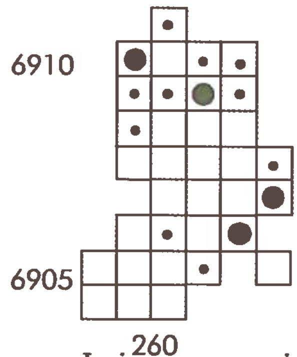
Juncus conglomeratus



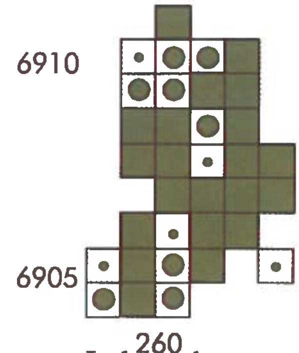
Juncus filiformis



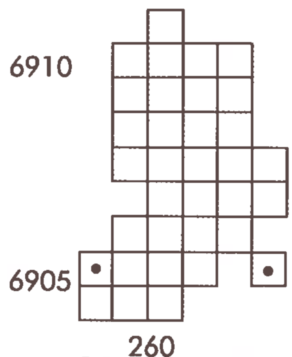
Juncus stygius



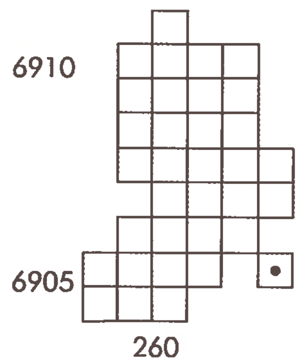
Juniperus communis



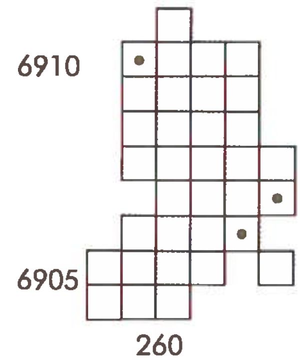
Ledum palustre



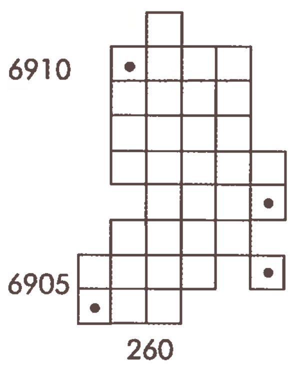
Leontodon autumnalis



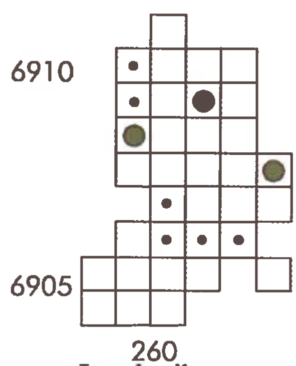
Leucanthemum vulgare



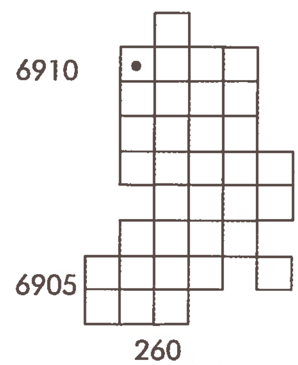
Linnaea borealis



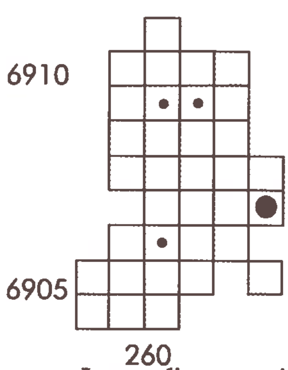
Luzula multiflora



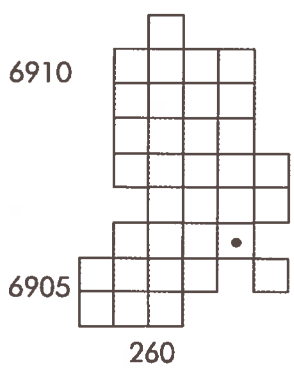
Luzula pilosa



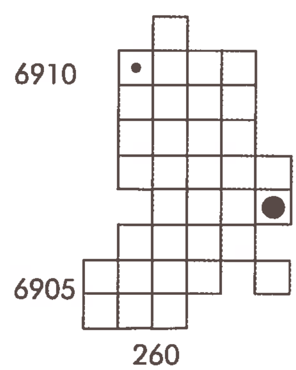
Luzula sudetica



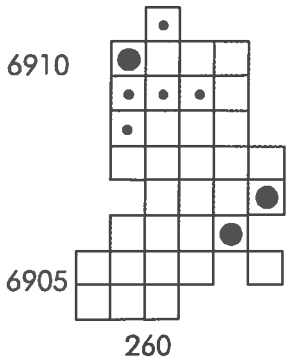
Lycopodium annotinum



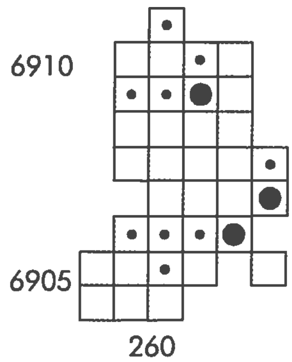
Lycopodium clavatum



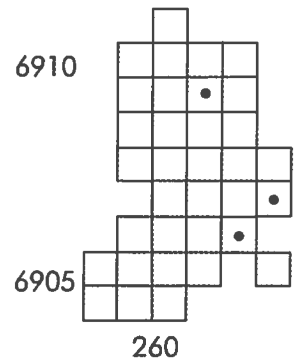
Lysimachia thyrsiflora



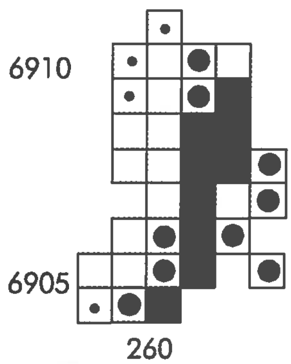
Maianthemum bifolium



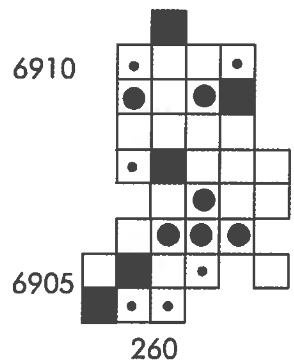
Melampyrum pratense



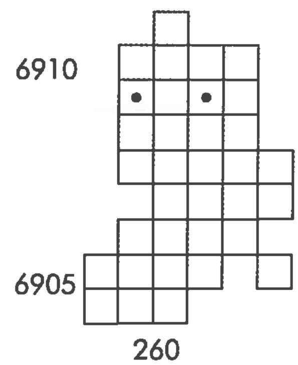
Melampyrum sylvaticum



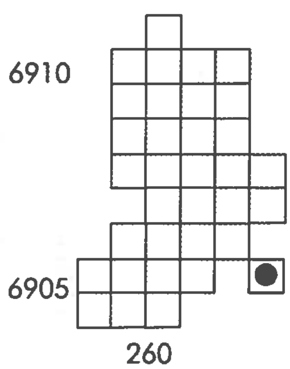
Menyanthes trifoliata



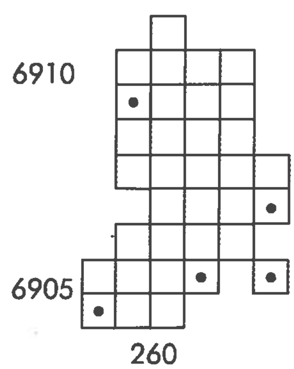
Molinia caerulea



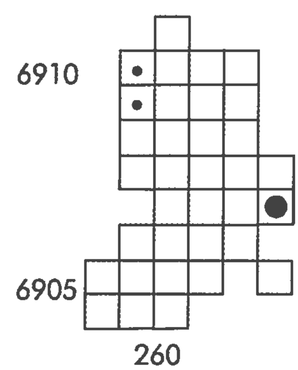
Moneses uniflora



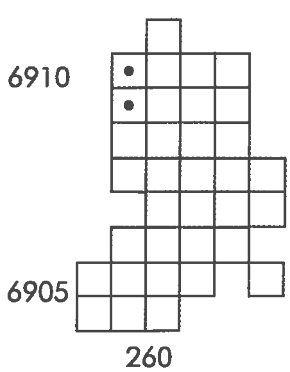
Nymphaea tetragona



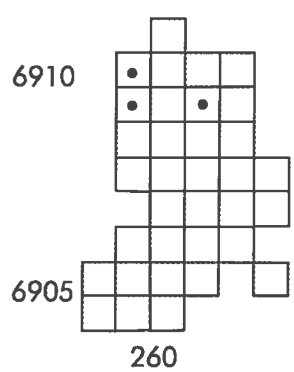
Orthilia secunda



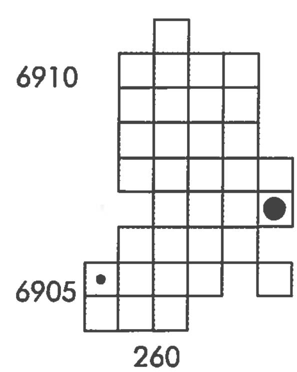
Paris quadrifolia



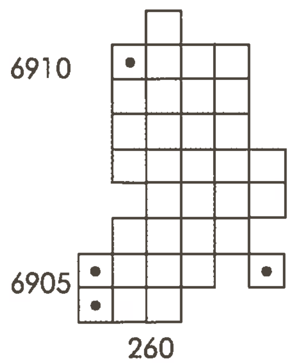
Pedicularis palustris



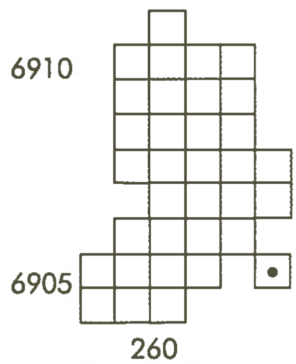
Pedicularis sceptrum- carolinum



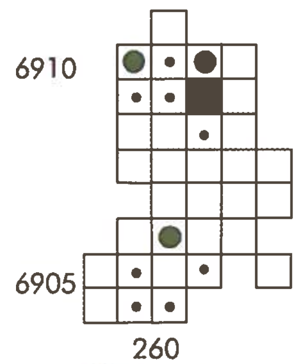
Phalaris arundinacea



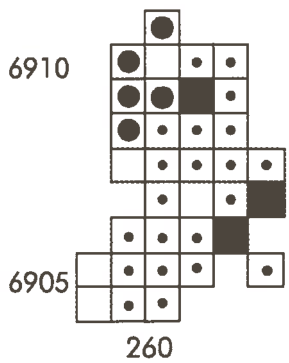
Phleum pratense



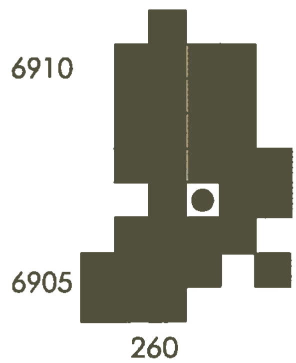
Phlox paniculata



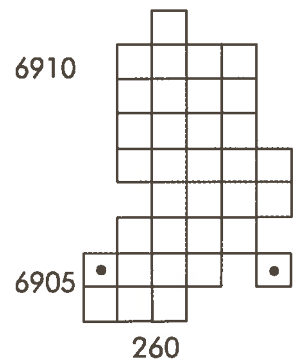
Phragmites australis



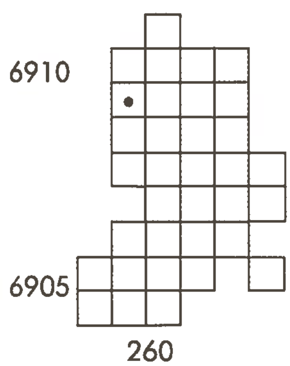
Picea abies



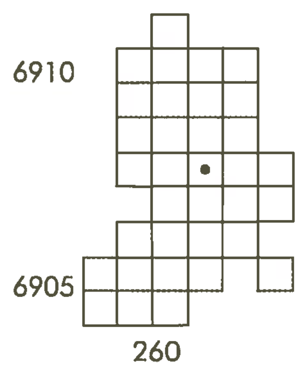
Pinus sylvestris



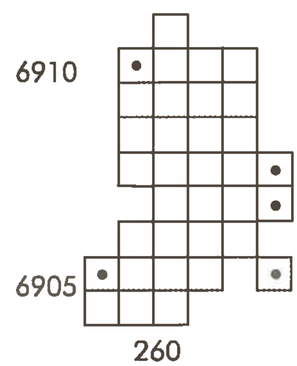
Plantago major



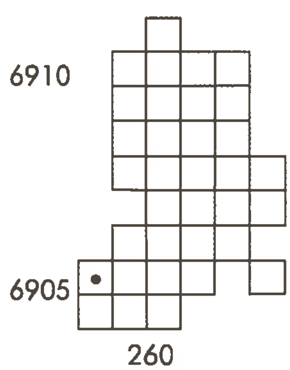
Poa alpigena



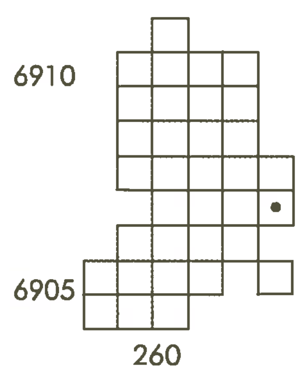
Poa annua



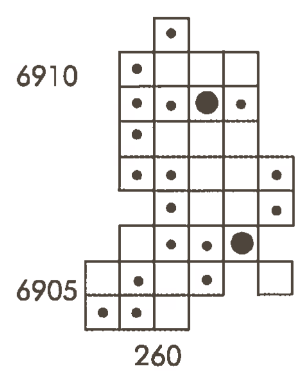
Poa pratensis



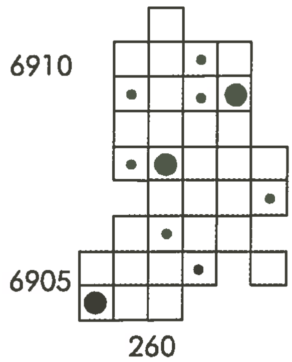
Polygonum aviculare



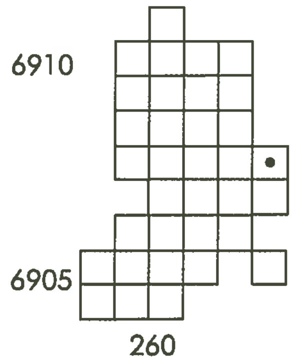
Polygonum viviparum



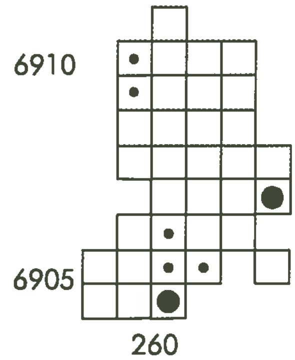
Populus tremula



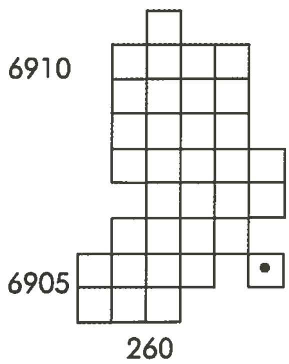
Potentilla erecta



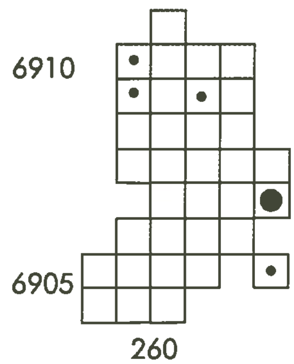
Potentilla fruticosa



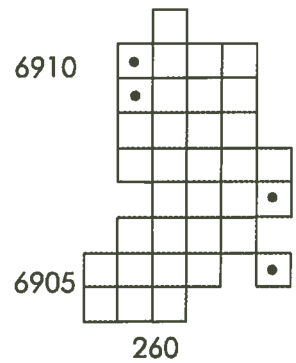
Potentilla palustris



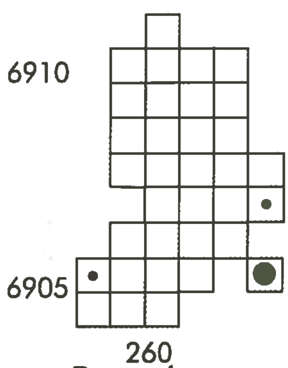
Pyrola chlorantha



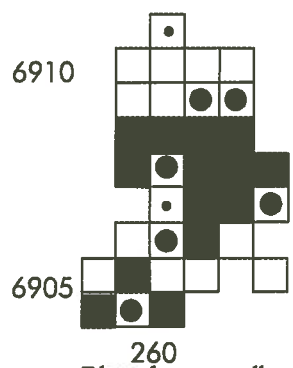
Pyrola minor



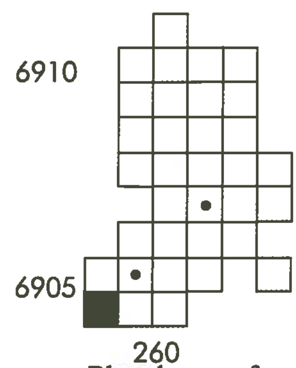
Ranunculus acris



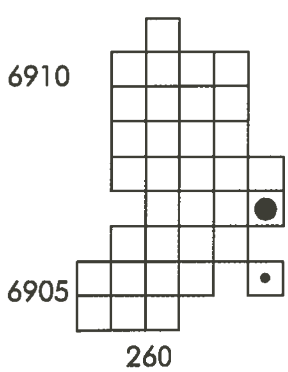
Ranunculus repens



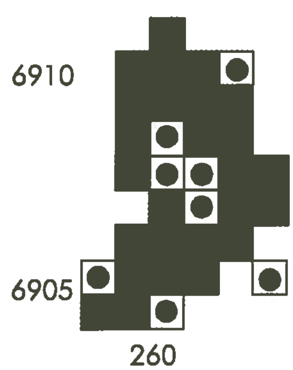
Rhynchospora alba



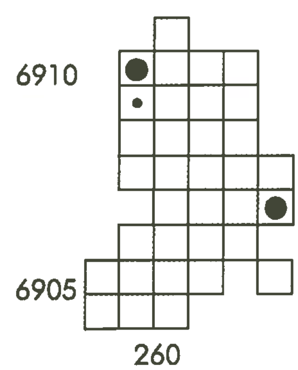
Rhynchospora fusca



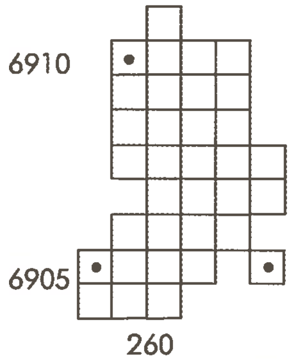
Rubus arcticus



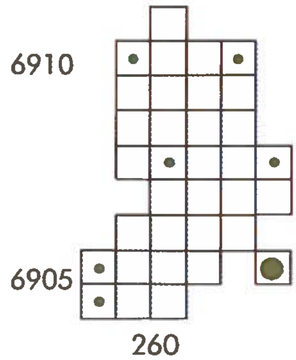
Rubus chamaemorus



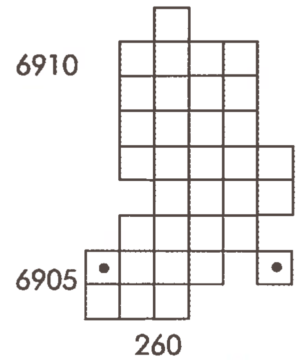
Rubus saxatilis



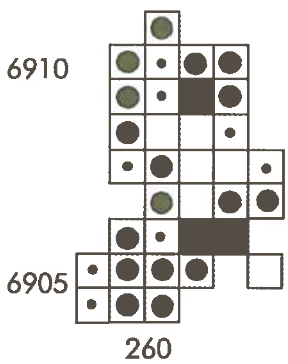
Rumex acetosa subsp. acetosa



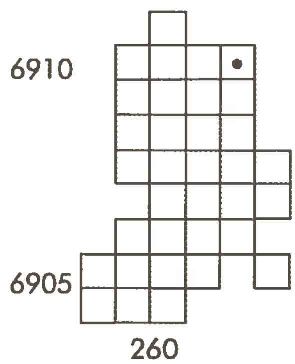
Rumex acetosella



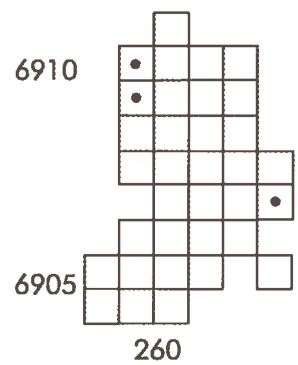
Rumex longifolius



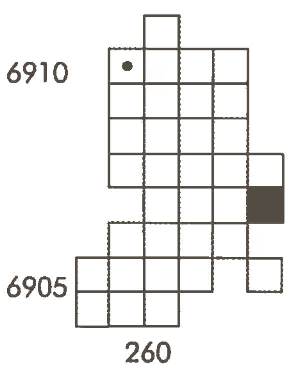
Salix aurita



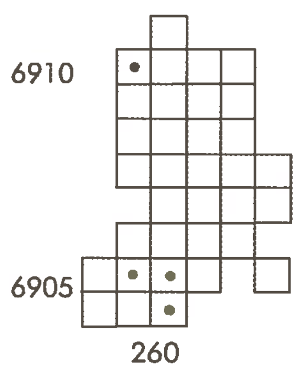
Salix aurita x repens



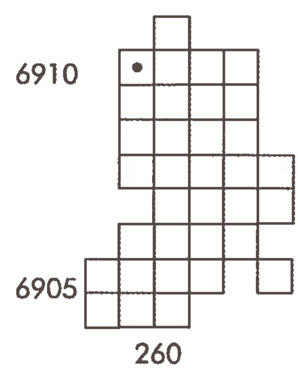
Salix caprea



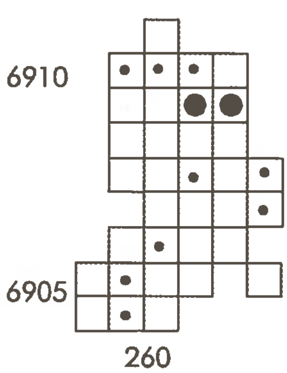
Salix cinerea



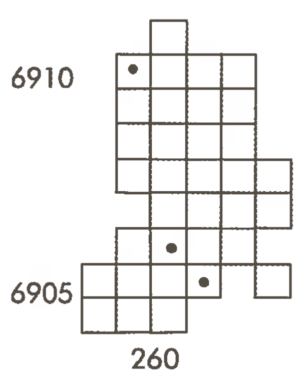
Salix lapponum



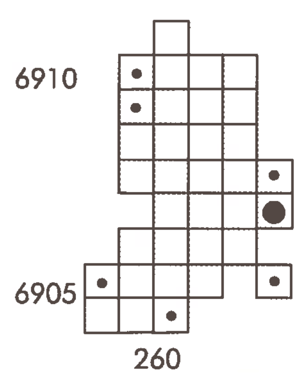
Salix myrsinifolia



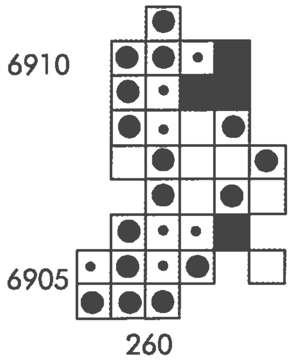
Salix myrtilloides



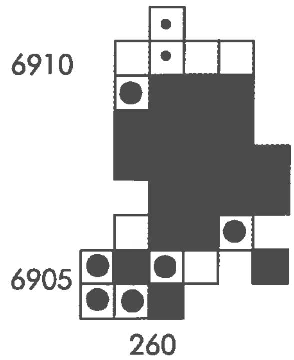
Salix pentandra



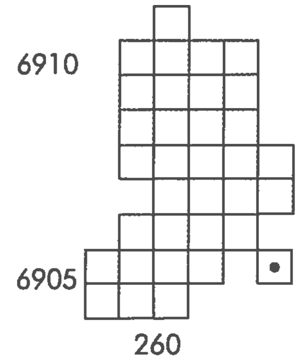
Salix phylicifolia



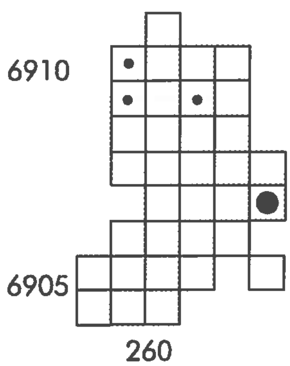
Salix repens



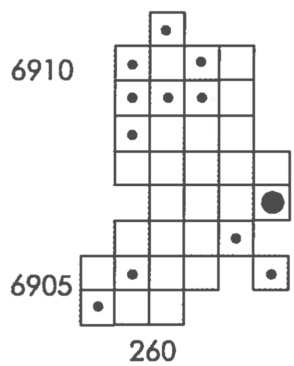
Scheuchzeria palustris



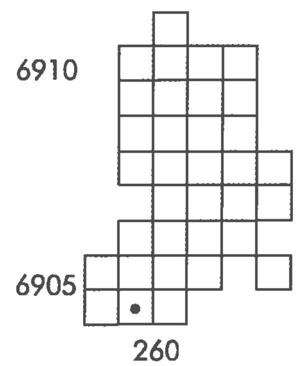
Sedum acre



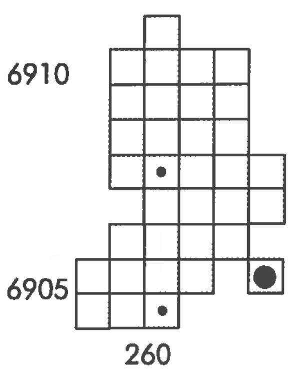
Solidago virgaurea



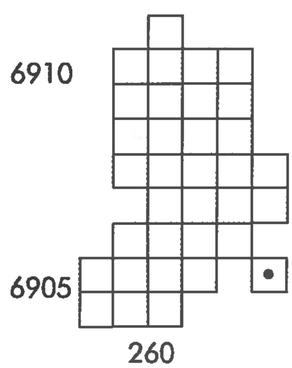
Sorbus aucuparia



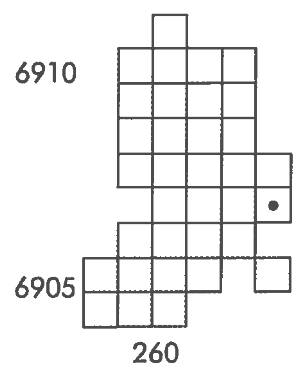
Sparganium hyperboreum



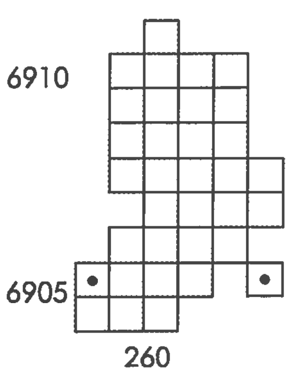
Sparganium minimum



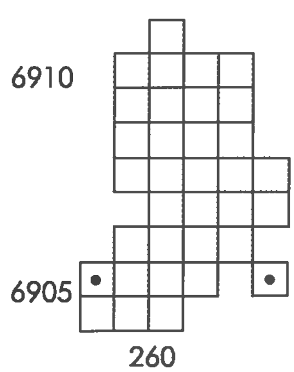
Spergula arvensis



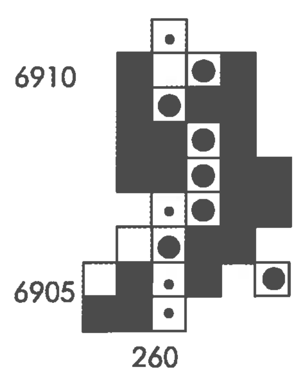
Stellaria graminea



Stellaria media



Taraxacum spp.



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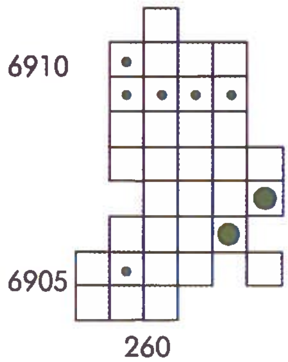

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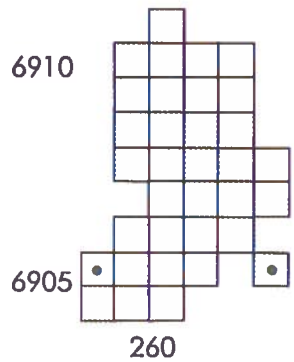

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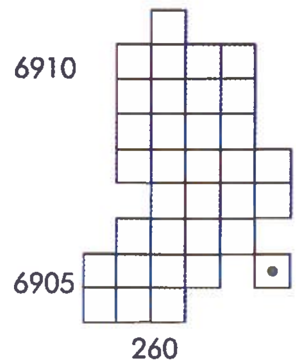

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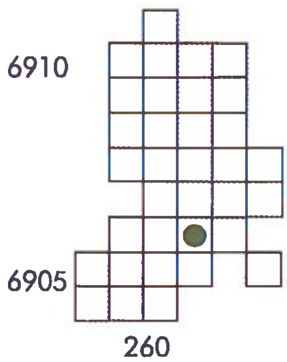
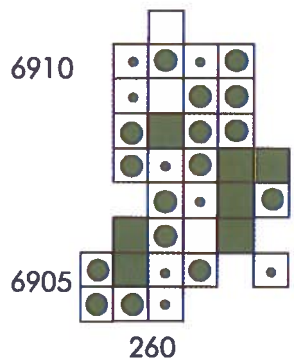
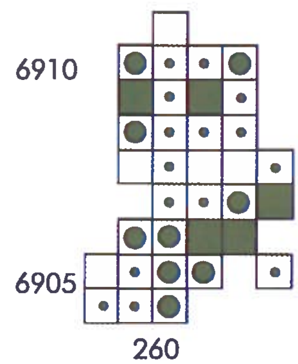


Utricularia intermedia



Vaccinium microcarpum



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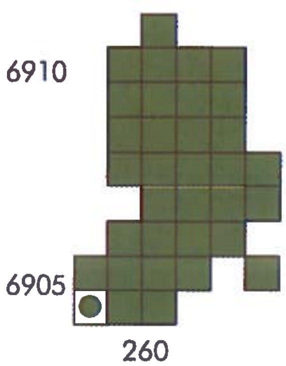

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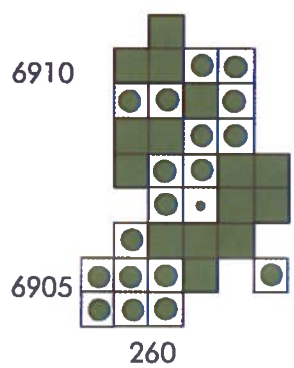
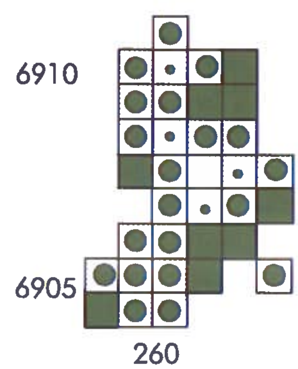
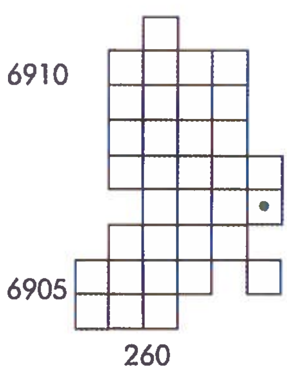


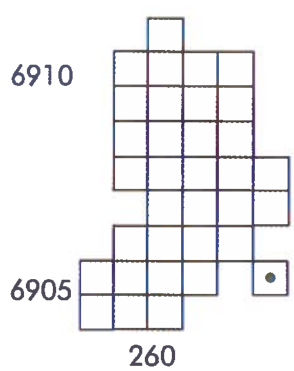
Vaccinium uliginosum



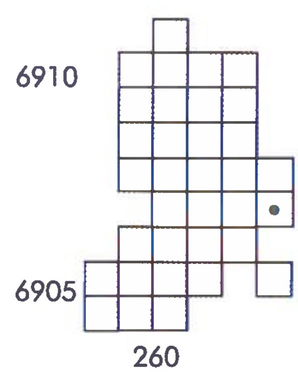
Vaccinium vitis-idaea



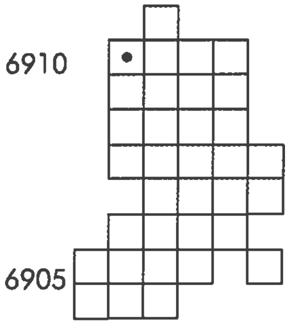
Veronica chamaedrys



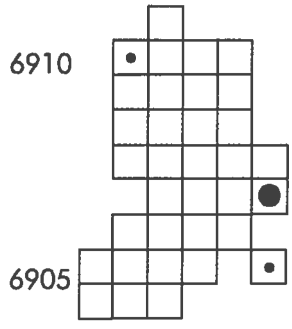
Vicia cracca



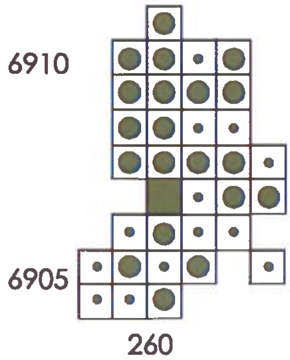
Viola canina subsp. montana



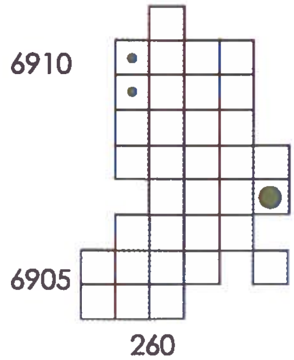
Viola epipsila



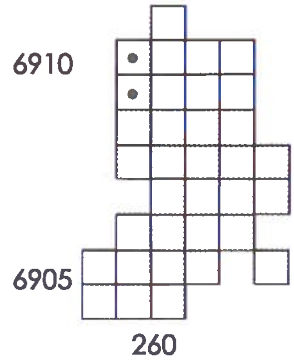
Viola palustris



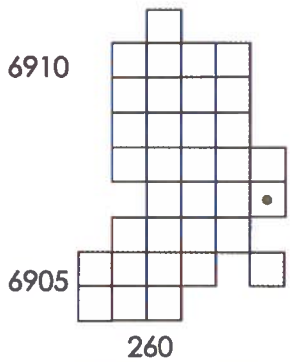
Aulacomnium palustre



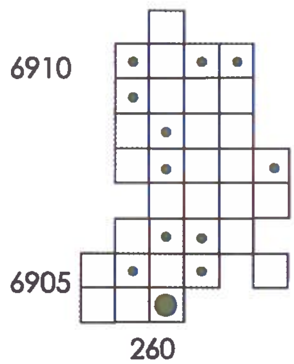
Brachythecium rivulare



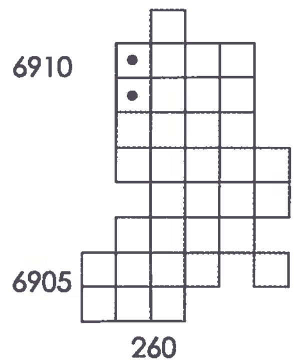
Bryum weigelii



Calliergon cordifolium



Calliergon stramineum



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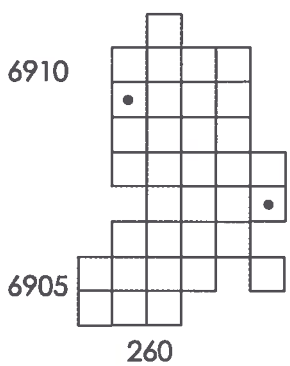
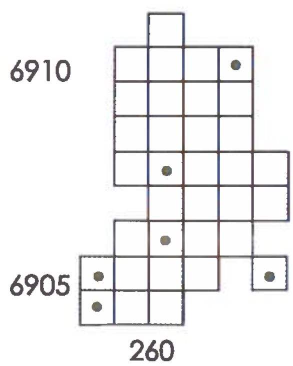
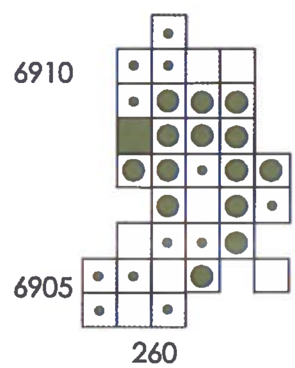


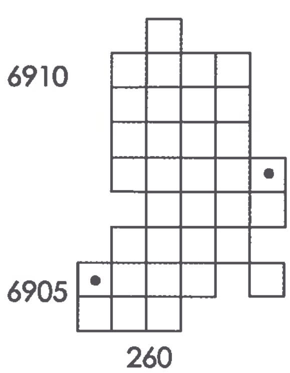
Campylium protensum



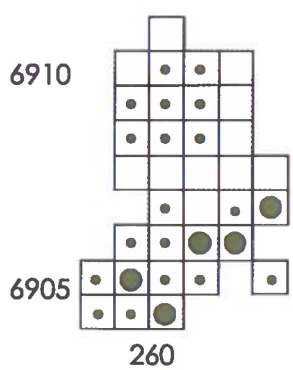
Ceratodon purpureus



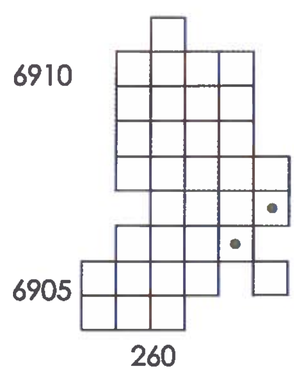
Dicranum bergeri



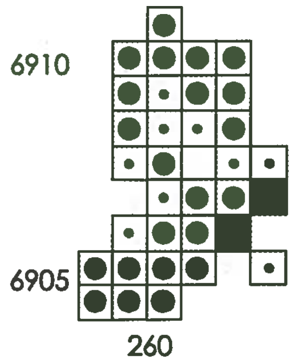
Dicranella cerviculata



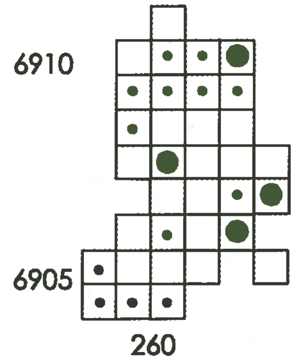
Dicranum fuscescens



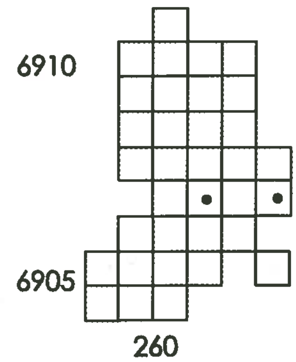
Dicranum majus



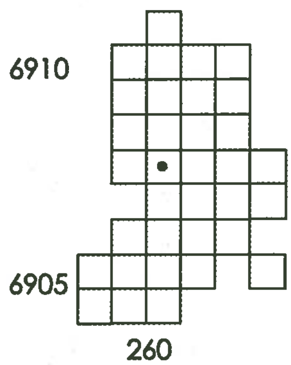
Dicranum polysetum



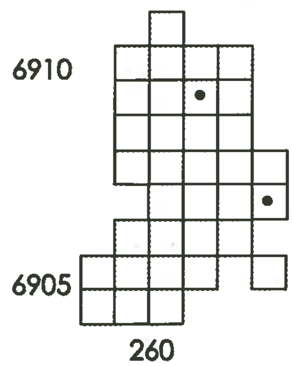
Dicranum scoparium



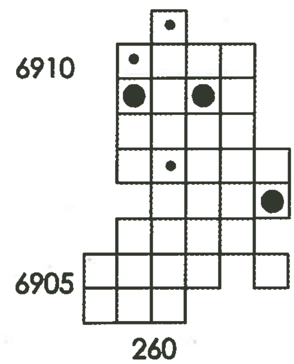
Fontinalis antipyretica



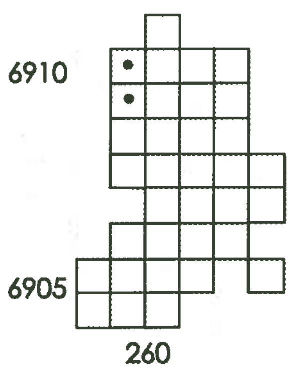
Funaria hygrometrica



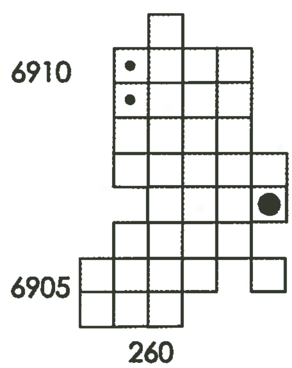
Helodium blandowii



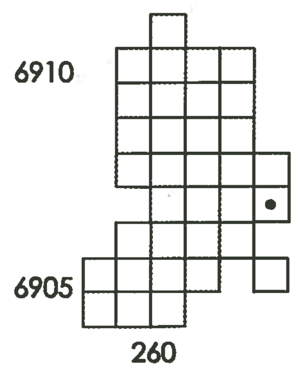
Hylocomium splendes



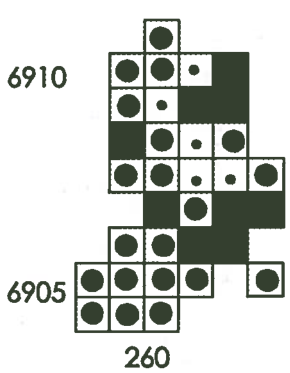
Paludella squarrosa



Plagiomnium ellipticum



Plagiothecium denticulatum



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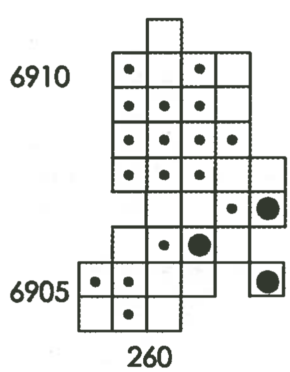
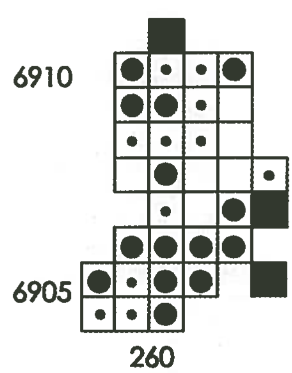
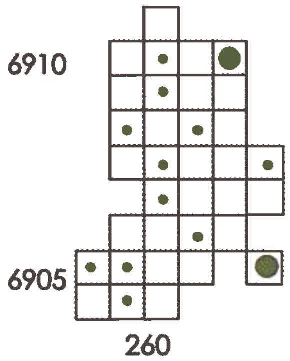


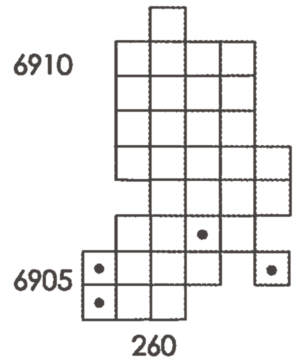
Pohlia nutans



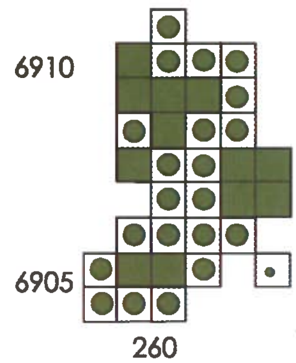
Polytrichum commune



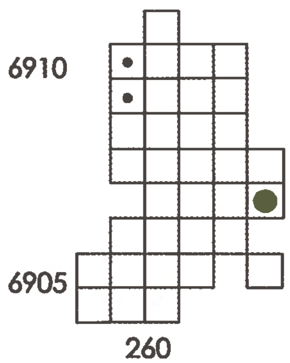
Polytrichum juniperinum



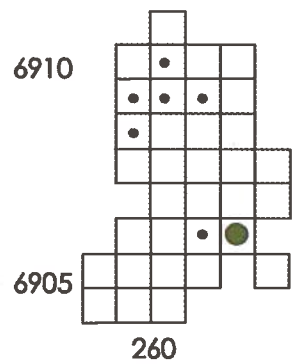
Polytrichum piliferum



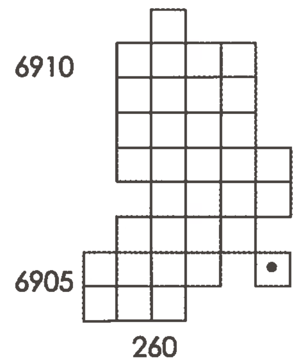
Polytrichum strictum



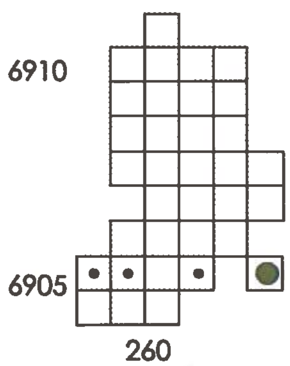
Pseudobryum cinclidioides



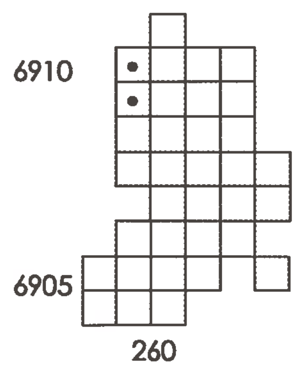
Ptilium crista-castrensis



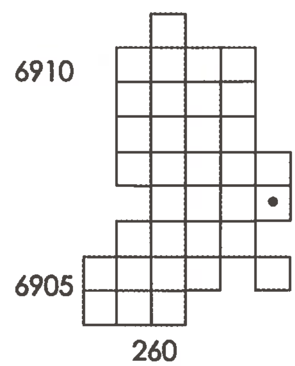
Racomitrium fasciculare



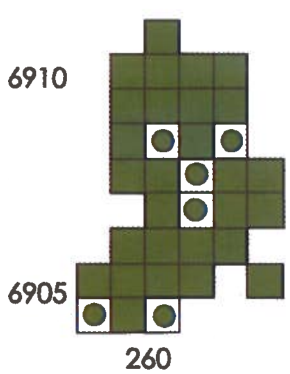
Racomitrium microcarpon



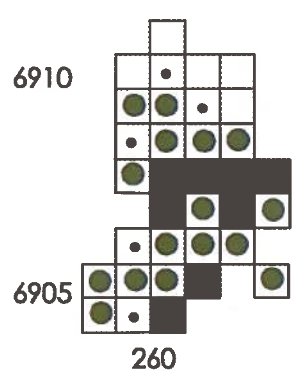
Rhizomnium punctatum



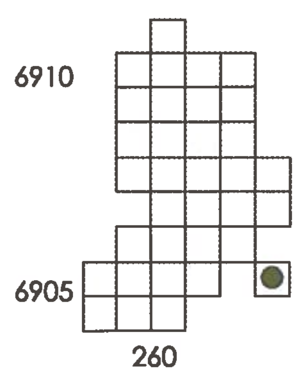
Rhytidiadelphus triquetrus



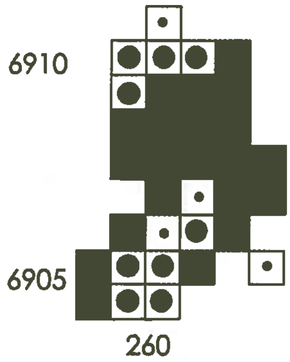
Sphagnum angustifolium



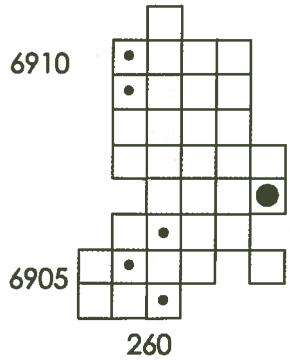
Sphagnum annulatum
var. porosum



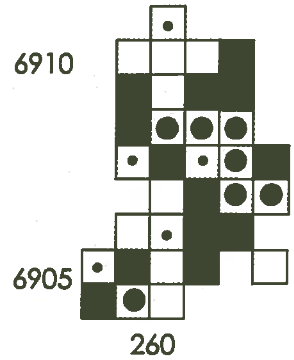
Sphagnum auriculatum
var. inundatum



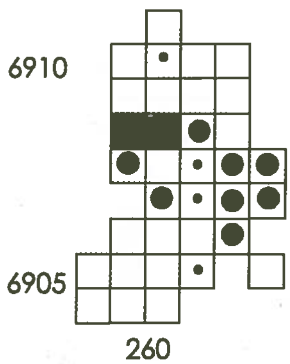
Sphagnum balticum



Sphagnum centrale



Sphagnum compactum



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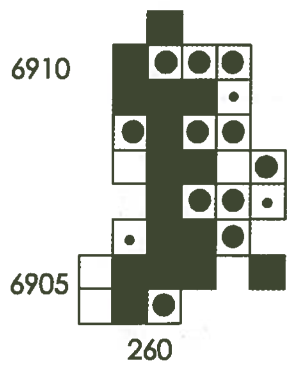
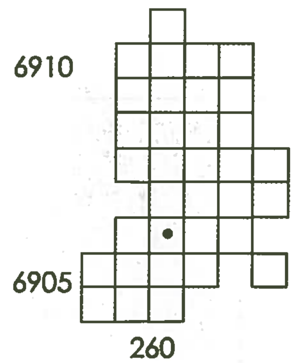
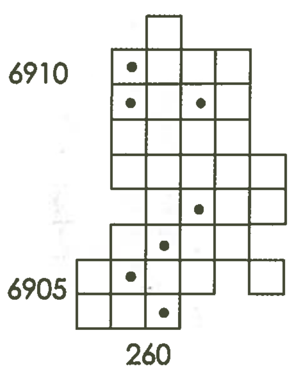


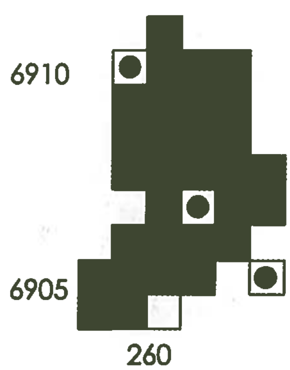
Sphagnum fallax



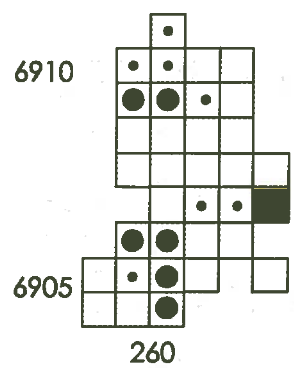
Sphagnum fimbriatum



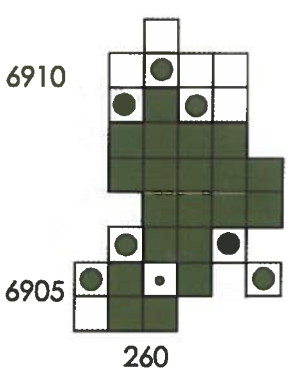
Sphagnum flexuosum



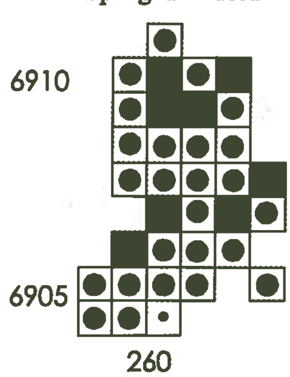
Sphagnum fuscum



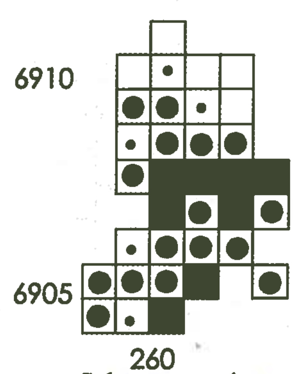
Sphagnum girgensohnii



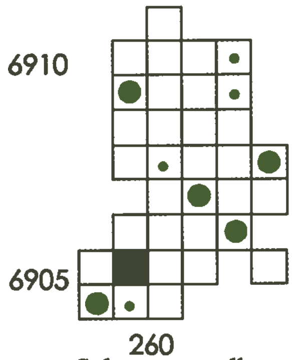
Sphagnum lindbergii



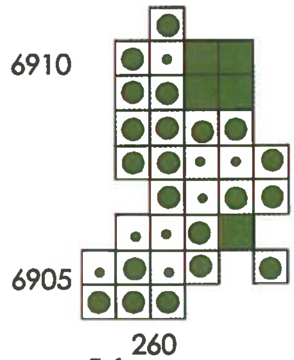
Sphagnum magellanicum



Sphagnum majus



Sphagnum molle



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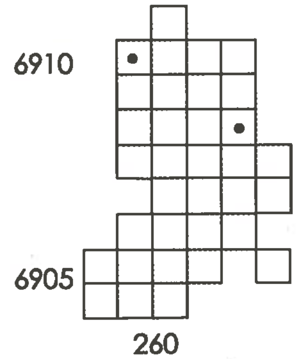

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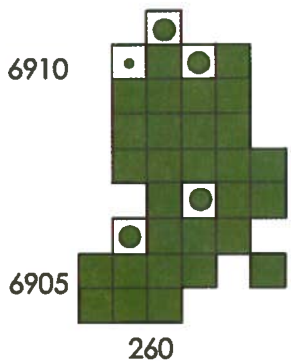

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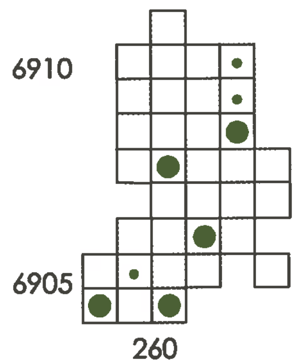

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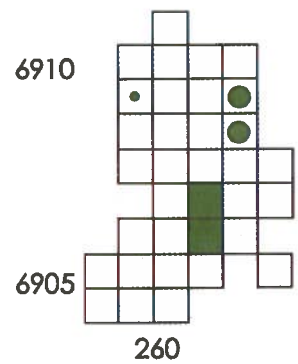
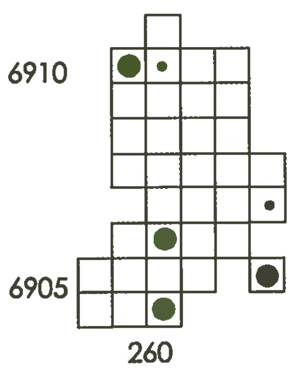


Sphagnum pulchrum



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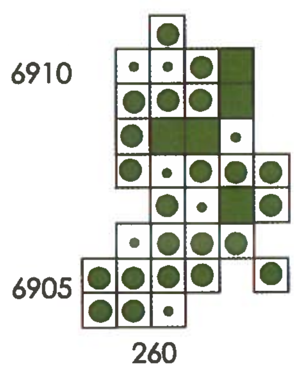
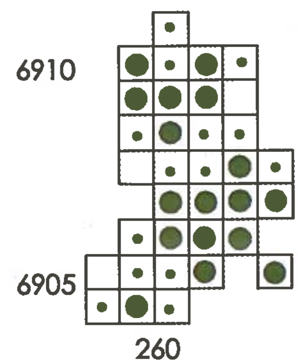
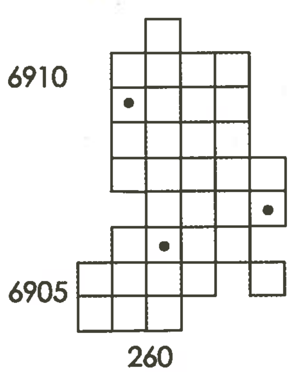


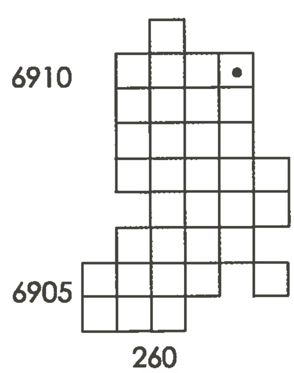
Sphagnum rubellum



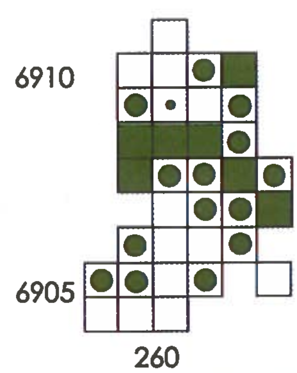
Sphagnum russowii



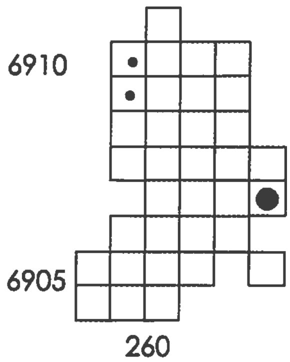
Sphagnum squarrosum



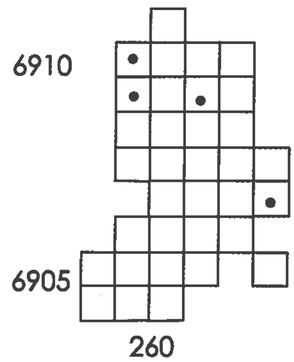
Sphagnum subsecundum



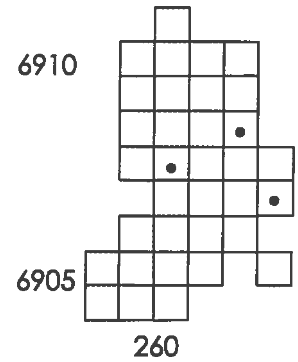
Sphagnum tenellum



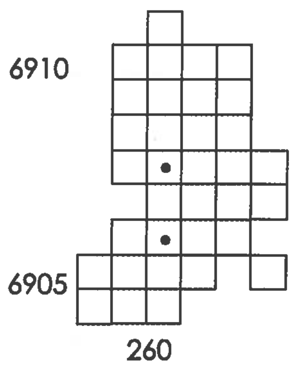
Sphagnum teres



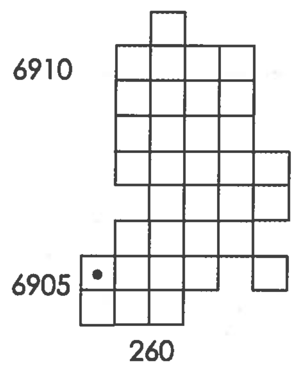
Sphagnum warnstorfii



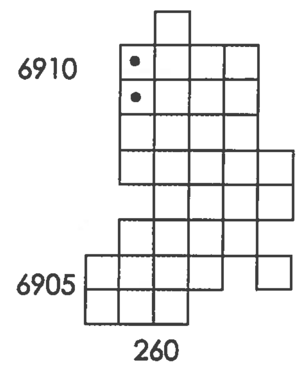
Splachnum ampullaceum



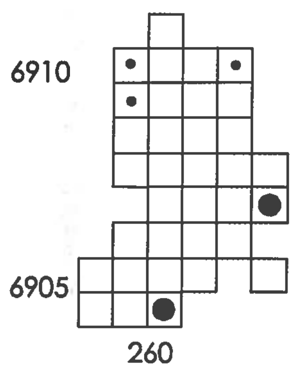
Splachnum luteum



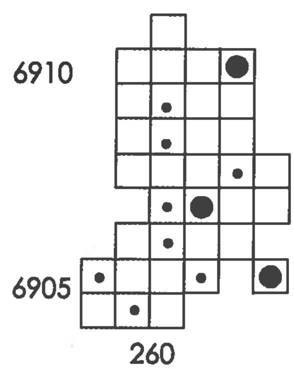
Tetraphis pellucida



Tomentypnum nitens



Warnstorfia exannulata



Warnstorfia fluitans

Appendix 3. Vegetation descriptions of sample plots using Karelian mire research methods along the transects I and II. For the location of the plots see Figs. 3, 11 and 12.

Nutrient status																		
Number of description	1		2			3		4	5		6	7		8			9	
Elements of microrelief	⌒	-	⌒	-	⌒	⌣	⌣	~~	⌒	-	~~	~~	⌒	⌣	⌣	⌒	-	⌣
% of element	80	20	30	70	80	5	15	100	20	80	100	100	20	70	10	15	50	35
Pinus sylvestris	2		1		2			1	1		1		1					
	3m		1-3m		3-4m			1-2m	1-1,5m									
Betula pubescens								1	1									
Salix aurita					1													
Salix phylicifolia																		
Andromeda polifolia	1	1	1	2	1	1	1	1	1		1	1	2	1				
Betula nana	1	1	1	1	1	1	1	2	1	1	1	1	1	1				
Calluna vulgaris	3	2	3	1	3	2	2	2	3	1	2	1	1			3		
Empetrum hermaphroditum					1													
Empetrum nigrum	1		1					1	1				2					
Ledum palustre	1				1													
Vaccinium microcarpum	1	1	1	1					1				1					
V. oxycoccos		1	1	1				1			1	1	1	1				
Salix repens					1	1	1	1	1									
V. vitis-idaea	1				1				1									
V. uliginosum	1				1				1		1							
Sheuchzeria palustris														1	2			2
Eriophorum angustifolium						1		1										
E. vaginatum	2	2	2	1	1	1	1	2		2	3	2	2	2	1		2	2
Trichophorum cespitosum		2	2	1	1	2	2	2	1	3				1				
Rynchospora alba																		
Carex canescens																		
C. echinata						1	1	1	1	1								
C. globularis					1													
C. lasiocarpa						1	1	1	1	1	1	1						
C. limosa												1		1	1			
C. magellanica												1						
C. nigra												1						
C. pauciflora	1	1	1	1		1	1	1	1		1	1	1	1				
C. rostrata												1						
Molinia caerulea				1				2	1									
Drosera anglica																		
D. rotundifolia	1	1	1	1		1	1	1				1	1	1				
Menyanthes trifoliata																		
Potentilla erecta						1		1										
Rubus chamaemorus	1	1	1	1					1		1		1			3		
Utricularia intermedia																		
Calliergon stramineum																		
Drepanocladus fluitans																		

Nutrient status																		
Number of description	1		2		3			4	5		6	7	8			9		
Elements of microrelief	⌒	-	⌒	-	⌒	‿	‿	~~	⌒	-	~~	~~	⌒	‿	‿	⌒	-	‿
% of element	80	20	30	70	80	5	15	100	20	80	100	100	20	70	10	15	50	35
Aulacomnium palustre											1	1						
Dicranum bergerii									1									
Dicranum sp	1							1					1					
Pleurozium schreberi	+								1									
Pohlia nutans																		
Polytrichum commune																		
Polytrichum strictum	1	1					+	1			1	1	1					
Sphagnum angustifolium	2	2	1	+			1	+			2		2					
S. balticum		4		4						4		3		5	3			
S. compactum				1		3	4	3	1	5	1							
S. cuspidatum																		
S. fallax								2										
S. fimbriatum									2				5					
S. fuscum	4	2	5		2	+										5		
S. lindbergii																		
S. magellanicum			+	1								+		1				
S. majus											1	1		+	5			
S. molle						+	1	2										
S. nemoreum	2		+		4			3	4									
S. papillosum				4		4	4			1	5	5		4	1		4	4
S. pulchrum																		3
S. rubellum	1	4	2	2		2				1			1	+	1			
S. russowii				1														
S. tenellum							1	2										
Cephalozia sp				1														
Hepaticae sp																		
Mylia anomala	1		1															
Cetraria ericetorum																		
Cetraria islandica									1									
Cladina alpestris					2													
C. arbuscula	1		1		2				2									
C. fimbriata																		
C. mitis					1													
C. squamosa																		
C. stygia	1		1		2				2									
Cladonia coccifera																		
C. cornuta																		
C. deformis					1													
C. gracilis					1													
C. subfarina																		
C. subfurcata																		
C. sulfurina					1													
C. uncialis																		
Cladina sp 1									1									
sp 2									1									
Algae																		

Nutrient status																		
Number of description	10		11				17			16				15			14	
Elements of microrelief	⌒	◡	⌒	◡	◡	●	⌒	◡	◡	⊓	-	◡	◡	⌒	-	◡	⌒	◡	◡
% of element	30	70	30	5	5	60	25	70	5	10	70	10	10	10	85	5	5	60	35
Pinus sylvestris			1				1			1				1			1		
			1,5m				2m							2-3m					
Betula pubescens																			
Salix aurita																			
Salix phylicifolia																			
Andromeda polifolia	2		1	2	1		2	1	1	2	1		1	1	1		2	1	1
Betula nana	1		1				1	1		1				2	1		1		1
Calluna vulgaris			2				2			1				2			1		
Empetrum hermaphroditum																			
Empetrum nigrum	1		2				2			2				2			2		
Ledum palustre			1				1			1				1			1		
Vaccinium microcarpum			1				1			1				1			1		
V. oxycoccos	1			1			1	1	1	1	1			1	1		1	1	1
Salix repens																			
V. vitis-idaea																			
V. uliginosum										1				1					
Sheuchzeria palustris	1	1		1	2				2		1	1	2		1	1		2	1
Eriophorum angustifolium		1																	
E. vaginatum	1		1	3			1	2	1	2	2			2	2	1	1	2	2
Trichophorum cespitosum			1	1			1	2		1	2		1	1	2				
Rynchospora alba	1	2		1	1				1		1		1		1	1		1	
Carex canescens																			
C. echinata																			
C. globularis																			
C. lasiocarpa																			
C. limosa	1	2									1	1	1						
C. magellanica																			
C. nigra																			
C. pauciflora	1									1	1								
C. rostrata	2	2																	
Molinia caerulea																			
Drosera anglica		1	1	1	1			1	1		1	1	1		1			1	1
D. rotundifolia	1		1				1	1	1	1	1			1	1		1	1	1
Menyanthes trifoliata		2																	
Potentilla erecta																			
Rubus chamaemorus			2				2	1		2	1			2	1		2		1
Utricularia intermedia												1							
Calliergon stramineum	1																		
Drepanocladus fluitans																			

Nutrient status																			
Number of description	10		11				17			16				15			14		
Elements of microrelief	⌒	‿	⌒	‿	‿	●	⌒	‿	‿	m	-	‿	‿	⌒	-	‿	⌒	‿	‿
% of element	30	70	30	5	5	60	25	70	5	10	70	10	10	10	85	5	5	60	35
Aulacomnium palustre										1									
Dicranum bergerii																			
Dicranum sp			1				1	1		1									
Pleurozium schreberi			1				1			1				2			2		
Pohlia nutans										1									
Polytrichum commune																			
Polytrichum strictum	1		1				1			1				1			1		
Sphagnum angustifolium										1				1					
S. balticum				5				5	3		3				3				
S. compactum		1						+				+						1	1
S. cuspidatum																			
S. fallax																			
S. fimbriatum																			
S. fuscum			4				3			2				4			4		
S. lindbergii				2	5						1		4		1	1		1	1
S. magellanicum	+									4				2	1		1		
S. majus									4		1	+	5		1	5		5	3
S. molle																			
S. nemoreum								2						1			2		
S. papillosum	5							3			5	+	+		5			3	5
S. pulchrum	3	4										+							
S. rubellum	+		1					1											
S. russowii																			
S. tenellum				1															
Cephalozia sp								1	2									1	
Hepaticae sp				1								1							
Mylia anomala							1												
Cetraria ericetorum																			
Cetraria islandica																			
Cladina alpestris																			
C. arbuscula			3				2												
C. fimbriata							1												
C. mitis										1				1					
C. squamosa																			
C. stygia			3				3			1				1			1		
Cladonia coccifera																			
C. cornuta																			
C. deformis																			
C. gracilis							1												
C. subfarina							1												
C. subfurcata			1																
C. sulfurina																			
C. uncialis																			
Cladina sp1																			
sp 2																			
Algae									1										

Nutrient status																		
Number of description	13		12		20		21		22					23				
Elements of microrelief	⌒	-	⌒	-	⌒	-	⌒	-	⌒	⌣	⌣	⌣	⌣	⌒	⌒	⌣	⌣	◗
% of element	10	90	60	40	20	80	20	80	30	15	10	20	15	30	15	15	10	30
Pinus sylvestris	1		2	1	1		1		1					1				
	2m		2-2,5m		2m				2-3m					2-3m				
Betula pubescens					1													
Salix aurita					1													
Salix phylicifolia																		
Andromeda polifolia	1	1	1	1			1	1	1	2	1	1		1	2	+	1	+
Betula nana	2	1	1	1	1	1	1	1	1		1			+				
Calluna vulgaris	2	1	2	1	2	1			2	1	1			3	+		+	
Empetrum hermaphroditum																		
Empetrum nigrum	1		2		2	1	2	1	2					3	+			
Ledum palustre	1						1		1					+				
Vaccinium microcarpum	1		1				1		1	1	1			+				
V. oxycoccos	1	1		1	1	1	1	1	1	1	1	1		+	1		+	
Salix repens																		
V. vitis-idaea					1													
V. uliginosum	2		1	1	1	1			1					+				
Sheuchzeria palustris								1		1		2	1		+	2	1	+
Eriophorum angustifolium						1												
E. vaginatum	2	3	2	2	2	3	2	3	1	2	1			1	3	+	+	
Trichophorum cespitosum	1	1	1	2											+	+	+	
Rynchospora alba										1	1	2	1		+	2	1	
Carex canescens						1												
C. echinata																		
C. globularis																		
C. lasiocarpa		1				1									+	+	+	+
C. limosa												1						
C. magellanica					1	1	1	1										
C. nigra					1	1												
C. pauciflora	1	2	1	1														
C. rostrata						1		1										
Molinia caerulea			1															
Drosera anglica		1		1						1	1	1				+	+	
D. rotundifolia	1	1	1	1			1	1	1	1	1			1	+			
Menyanthes trifoliata																		
Potentilla erecta																		
Rubus chamaemorus			2	1			2	1	2		1			2	+			
Utricularia intermedia																		
Calliergon stramineum																		
Drepanocladus fluitans						1												

Nutrient status																			
Number of description	13		12		20		21		22					23					
Elements of microrelief	⌒	-	⌒	-	⌒	-	⌒	-	⌒	⌣	⌣	⌣	⌣	⌒	⌒	⌣	⌣	●	
% of element	10	90	60	40	20	80	20	80	30	15	10	20	15	30	15	15	10	30	
Aulacomnium palustre	1																		
Dicranum bergerii														+					
Dicranum sp	1		1																
Pleurozium schreberi	1		1						+					1					
Pohlia nutans																			
Polytrichum commune					1				1										
Polytrichum strictum	1		1		1	1	1							1					
Sphagnum angustifolium	+				3	5	1							+	+				
S. balticum				4				5		5	3	2			5	+	+		
S. compactum		3	1	2						+	+				+		+		
S. cuspidatum																		+	
S. fallax																			
S. fimbriatum						+													
S. fuscum	4		4				5		3					3	+				
S. lindbergii						1		3		+		+	+				+	+	
S. magellanicum	+				2	+	1	+	1	+						+			
S. majus		2										5	2			5	+	+	
S. molle		1																	
S. nemoreum	2								1					2	+				
S. papillosum		5						1		1	+	+			+	+	+		
S. pulchrum																			
S. rubellum			2	3			3	+	1	+	+								
S. russowii					4	+													
S. tenellum				2						2	5				+				
Cephalozia sp									1	1	+	2	4		1	2	2		
Hepaticae sp																			
Mylia anomala									1	1	+			1					
Cetraria ericetorum														+					
Cetraria islandica			1						1										
Cladina alpestris			1						1										
C. arbuscula			2						3					2					
C. fimbriata																			
C. mitis																			
C. squamosa									1		+								
C. stygia	2		2						3					3					
Cladonia coccifera														+					
C. cornuta														+					
C. deformis																			
C. gracilis														+					
C. subfarina																			
C. subfurcata														+					
C. sulfurina																			
C. uncialis														+					
Cladina sp 1	1																		
sp 2																			
Algae																			

Nutrient status												
Number of description	24		25			26			27			
Elements of microrelief	⌒	⌣	⌒	-	⌣	⌒	-	⌣	⌒	-	⌣	●
% of element	20	80	15	70	15	10	40	50	20	30	10	40
Pinus sylvestris	1		1						1			
	3m								2-3m			
Betula pubescens												
Salix aurita												
Salix phylicifolia												
Andromeda polifolia	1	1	1	1		2	2	1	1	2	+	+
Betula nana	2		1			1	1		1	+		
Calluna vulgaris	2		2						3	+		
Empetrum hermaphroditum												
Empetrum nigrum	3		3			2			3	+		
Ledum palustre	1		1						+			
Vaccinium microcarpum	1	1	1						+			
V. oxycoccos	1	1	1	1		1	1			+		
Salix repens												
V. vitis-idaea												
V. uliginosum	1		1			1			+			
Sheuchzeria palustris		1			2			1		+	2	+
Eriophorum angustifolium												
E. vaginatum	2	2	2	3	1	1	3	2	+	2	+	
Trichophorum cespitosum	1	1							+	+		
Rynchospora alba		1										
										1	1	
Carex canescens												
C. echinata												
C. globularis												
C. lasiocarpa												
C. limosa		1						2		+	+	+
C. magellanica												
C. nigra												
C. pauciflora												
C. rostrata								1				
Molinia caerulea												
Drosera anglica		1						1		+	1	
D. rotundifolia	1	1	1	1		1	1		+	+		
Menyanthes trifoliata												
Potentilla erecta												
Rubus chamaemorus	2		2	1		2	1		3	+		
Utricularia intermedia												
Calliergon stramineum												
Drepanocladus fluitans												

Nutrient status													
Number of description	24		25			26			27				
Elements of microrelief	⌒	⌣	⌒	-	⌣	⌒	-	⌣	⌒	-	⌣	●
% of element	20	80	15	70	15	10	40	50	20	30	10	40
Aulacomnium palustre												
Dicranum bergerii	+								1			
Dicranum sp												
Pleurozium schreberi	2											
Pohlia nutans												
Polytrichum commune									1			
Polytrichum strictum	+					1						
Sphagnum angustifolium	1					+	+					
S. balticum		2		4	1		4	+		5	1	
S. compactum		+								1		
S. cuspidatum												
S. fallax												
S. fimbriatum												
S. fuscum	4		5						3	+		
S. lindbergii		4		1	1					+	2	+
S. magellanicum			+	1		5	+		+	+		
S. majus		3		2	5			5		+	5	+
S. molle												
S. nemoreum	2		+	+					2	+		
S. papillosum	1	1	1	5	+	+	5	+		+	+	
S. pulchrum												
S. rubellum	+	+	1	1					+	1		
S. russowii												
S. tenellum										1		
Cephalozia sp		1							+	+		
Hepaticae sp												
Mylia anomala	1	+	1	1					1	+		
Cetraria ericetorum												
Cetraria islandica			1						+			
Cladina alpestris									3			
C. arbuscula	1		1						3			
C. fimbriata												
C. mitis												
C. squamosa										+		
C. stygia	2		1						3			
Cladonia coccifera									+			
C. cornuta									+			
C. deformis												
C. gracilis									+			
C. subfarina												
C. subfurcata									+			
C. sulfurina												
C. uncialis									+			
Cladina sp1												
sp 2												
Algae												

Documentation page

Publisher	Finnish Environment Institute	Date November 2001
Author(s)	Raimo Heikkilä, Oleg Kuznetsov, Tapio Lindholm, Kaisu Aapala, Vladimir Antipin, Tamara Djatshkova and Pavel Shevelin	
Title of publication	Complexes, vegetation, flora and dynamics of Kauhaneva mire system, western Finland	
Parts of publication/ other project publications	The publication is available in the internet: http://www.vyh.fi/eng/orginfo/publica/electro/fe489/fe489.htm	
Abstract	Structural diversity is characteristic to mires. Therefore it is important to understand the mire as a whole and the relations of its parts to the whole and with each other. The occurrence of mire complexes, their relations and the location of site types in mire complexes, flora in relation to site types and complexes as well as the developmetn history of Kauhaneva mire system were studied. The Kauhaneva mire system (2484 hectares) is a mosaic of several mire complexes. First time in mire research the concrete boundaries of different complexes were defined. Three concentric bogs, six eccentric bogs, one Sphagnum fuscum bog and four southern aapamires were described in the system. According to Finnish mire site type classification, 45 site types were found. They were compared with sites described according to Karelian classification along two transects across the mire. Altogether 173 vascular plant species, including 109 true mire plants, and 71 bryophytes, including 29 *Sphagna*, were found in the mire and its margins. The development of the mire system started with primary paludification immediately after the retreat of Ancylus Lake about 9000 years B.P. In the beginning minerotrophic sedge communities dominated, but the vegetation rapidly changed into more poor communities, turning widely into ombrotrophy. A large proportion of the present minerotrophic communities seems to be in transition to ombrotrophy. The work is a part of Finnish-Russian cooperation in nature conservation. The common aim has been to compare mires, mire conservation and their concepts in Finland and the Karelian Republic.	
Keywords	Mire system, mire complex, biodiversity, vegetation development, boreal zone, mire conservation	
Publication series and number	The Finnish Environment 489	
Theme of publication	Nature and natural resources	
Project name and number, if any	Ministry of the Environment	
Financier/ commissioner		
Project organization		
	ISSN 1238-7312	ISBN 952-11-0916-5, 952-11-1072-4 (PDF)
	No. of pages 97	Language English
	Restrictions Public	Price 96 FIM (16.15 €)
For sale at/ distributor	Edita Plc, P.O.Box 800, FIN-00043 Edita, Finland tel. +358 20 450 05, telefax +358 20 450 2380, e-mail: asiakaspalvelu@edita.fi www-server: http://www.edita.fi/netmarket	
Financier of publication	Finnish Environment Institute P.O.Box 140, FIN-00251 Helsinki, Finland	
Printing place and year	Vammalan Kirjapaino Oy, Vammala 2001, Finland	

Kuvailulehti

Julkaisija	Suomen ympäristökeskus Julkaisuaika: Marraskuu 2001
Tekijä(t)	Raimo Heikkilä, Oleg Kuznetsov,Tapio Lindholm, Kaisu Aapala, Vladimir Antipin, Tamara Djatshkova ja Pavel Shevelin
Julkaisun nimi	Kauhanevan suoalueen suoyhdistymät, kasvillisuus, kasvisto ja kehityshistoria
Julkaisun osat/ muut saman projektin tuottamat julkaisut	Julkaisu on saatavana myös internetissä: http://www.vyh.fi/eng/orginfo/publica/electro/fe489/fe489.htm
Tiivistelmä	Suoluonnolle on ominaista niiden rakenteen monimuotoisuus, joten soiden tutkimuksessa on tärkeää huomioida kokonaisuus ja osien suhde siihen. Kauhanevan suoalueella otettiin tarkasteltavaksi suoyhdistymien esiintyminen, niiden suhde toisiinsa ja kasviyhdyskuntien sijoittuminen suoyhdistymiin sekä kasviston suhde kasviyhdyskuntiin ja suoyhdistymiin. Edelleen otettiin tutkittavaksi suon kehittyminen nykytilaansa. Kauhanevan suosysteemi (2484 ha) on useiden suoyhdistymien muodostama mosaiikki. Ensimmäistä kertaa suotutkimuksessa määriteltiin konkreettisesti yhdistymien rajat. Suolta kuvattiin kolme kilpikeidassuota, kuusi viettokeidassuota, yksi rahkakeidassuo ja neljä Pohjanmaan vyöhykkeen sara-aapasuota. Suomalaisen kasvillisuusluokituksen mukaan suolta löytyi 45 suotyyppiä. Näitä verrattiin kahdelta linjalta kuvattuihin karjalaisen luokitusjärjestelmän mukaisiin kasvillisuustyyppeihin. Suolta ja sen reunoilta löytyi 173 putkilokasvilajia, joista 109 on varsinaisia suokasveja. Lehtisammalia löytyi 71 lajia, joista 29 rahkasammalia. Suon kehitys on alkanut primäärisenä soistumisena välittömästi maan paljastuttua Ancylus-järvestä n. 9000 vuotta sitten. Aluksi vallitsivat saraiset minerotrofiset kasviyhdyskunnat, mutta kasvillisuus kehittyi nopeasti karummaksi ja laajalti myös ombrotrofiseksi. Minerotrofisten kasviyhdyskuntien kehittyminen ombrotrofisiksi näyttää jatkuvan edelleen. Työ on osa suomalais-venäläistä luonnonsuojeluyhteistyötä. Tavoitteena on ollut verrata suoluontoa, sen suojelua ja niihin liittyvää käsitteistöä Suomessa ja Karjalan tasavallassa.
Asiasanat	suosysteemi, suoyhdistymä, monimuotoisuus, dynamiikka, boreaalinen vyöhyke, soidensuojelu
Julkaisusarjan nimi ja numero	Suomen Ympäristö 489
Julkaisun teema	Luonto ja luonnonvarat
Projektihankkeen nimi ja projektinumero	
Rahoittaja/ toimeksiantaja	Ympäristöministeriö
Projektiryhmään kuuluvat organisaatiot	
	ISSN: 1238-7312 ISBN: 952-11-0916-5 (nid.), 952-11-1072-4 (PDF)
	Sivuja: 97 Kieli: Englanti
	Luottamuksellisuus: Julkinen Hinta: 96 mk (16,15 €)
Julkaisun myynti/ jakaja	Edita Oyj, Asiakaspalvelu, PL 800, 00043 Edita puh. 020 450 05, telefax 020 450 2380 sähköpostiosoite: asiakaspalvelu@edita.fi www-palvelin: http://www.edita.fi/netmarket
Julkaisun kustantaja	Suomen ympäristökeskus PL 140,00251 Helsinki
Painopaikka ja -aika	Vammalan Kirjapaino Oy, Vammala 2001

Presentationsblad

Utgivare	Finlands miljöcentral — Datum: November 2001
Författare	Raimo Heikkilä, Oleg Kuznetsov,Tapio Lindholm, Kaisu Aapala, Vladimir Antipin, Tamara Djatshkova och Pavel Shevelin
Publikationens titel	Myrmarksområdet Kauhaneva myrkomplexen, vegetationen, floran och utvecklingshistorian
Publikationens delar/ andra publikationer inom samma projekt	Publikationen finns tillgänglig på internet: http://www.vyh.fi/eng/orginfo/publica/electro/fe489/fe489.htm
Sammandrag	Eftersom myrmarksnaturen karakteriseras av mångformighet på flera nivåer, måste man inom myrmarksforskningen beakta både helheten, delarna samt delarnas förhållanden till helheten. Inom naturskyddsområdet Kauhaneva undersöktes myrkomplexens inbördes relationer, vegetationssamhällenas läge i förhållande till myrkomplexen och relationerna mellan floran och vegetationssamhällena och myrkomplexen. Dessutom undersöktes myrens utvecklingshistoria från början fram till idag. Myrsystemet Kauhaneva (2484 ha) innefattar en mosaik av flera olika myrtyper. För första gången avgränsades och markerades gränserna mellan de olika myrkomplextyperna. Inom området beskrevs tre kocentrixka högmossar, sex excentriska hogmossar, en *Sphagnum fuscum* -högmosse och fyra aapamyrar inom Österbottens zon. Inom området påträffades 45 olika myrtyper enligt den finska vegetationsklassifikationen. Utifrån mätningar från två bandprofiler inom området gjordes en jämförelse av den finska och karelska myrtypklassifikationen. Inom myren och dess randområden påträffades sammanlagt 173 kärlväxtarter. Utav dessa var 109 egentliga myrmarksväxter. Det påträffades även 71 bladmossor. Utav dessa 29 var vitmossor. Myren har bildats genom primär försumpning. Processen påbörjades när fastmarken frigjordes, efter Ancylussjöns tillbakadragande, ca 9000 år sedan. I början dominerades vegetationen av starr och andra minerotrofa vegetationssamhällen, men vegetationens blev snabbt allt mer karg och ombrotrofisk. Denna utveckling av växtsamhällen tycks fortsätta alltjämt. Undersökningen utfördes inom ett finsk-ryskt samarbetsprojekt inom naturskyddet. Målsättningen med projektet var att jämföra myrmarksnaturen, skyddet av myrar och myrmarksbegreppen i Finland och Karelska republiken.
Nyckelord	myrsystem, myrkomplex, biodiversitet, dynamik, boreal zon, skydd av myrar
Publikationsserie och nummer	Suomen Ympäristö 489
Publikationens tema	Natur och naturtillgångar
Projektets namn och nummer	
Finansiär/ uppdragsgivare	Miljöministeriet
Organisationer i projektgruppen	
	ISSN 1238-7312 — ISBN 952-11-0916-5, 952-11-1072-4 (PDF)
	Sidantal 97 — Språk Engelska
	Offentlighet Offentlig — Pris 96 mk (16,15 €)
Beställningar/ distribution	Edita Oyj, Kundservice, PB 800, FIN-00043 Edita, Finland tel. +358 20 450 05, telefax +358 20 450 2380 e-mail: asiakaspalvelu@edita.fi www-server: http://www.edita.fi/netmarket
Förläggare	Finlands miljöcentral P.O.Box 140, FIN-00251 Helsingfors, Finland
Tryckeri/ tryckningsort och -år	Vammalan Kirjapaino Oy, Vammala 2001

ЛИСТ ОПИСАНИЯ ПУБЛИКАЦИИ

Издатель	Центр окружающей среды Финляндии	*Дата публикации* Ноябрь 2001
Авторы	Раймо Хейккиля, Олег Кузнецов, Тапио Линдхольм, Кайсу Аапала, Владимир Антипин, Тамара Дьячкова & Павел Шевелин	
Название публикации	Болотная система Кауханева: болотные массивы, растительность, флора и динамика	

Резюме

Большое структурное разнообразие весьма характерно для болот. Поэтому очень важно изучение болота как единой (целой) структуры, так и отдельных его частей (составляющих) и их взаимосвязь и взаимодействие как друг с другом, так и с болотом в целом.

Изучалось распределение болотных массивов, их взаимодействие и составляющие их болотные участки (фации), флористический состав болотных участков и массивов в неразрывной связи с историей формирования болотной системы Кауханева.

Болотная система Кауханева (2 484 га) представляет собой мозаичное сочетание нескольких болотных массивов. В первую очередь были определены точные границы болотных массивов. Три концентрических грядово-озерковых, 6 эксцентрических грядово-мочажинных и одно кустарничково-сфагновое болото представляют омбротрофные массивы системы, а 4 описанных массива относятся к южному варианту аапа типа. Согласно финской классификации типов болотных участков, 45 из них было обнаружено. Они сравнивались с фациями, которые выделяются в классификации болотных участков Карелии, вдоль 2 трансект, пересекающих всю систему. 179 сосудистых растений, включая 109 истинно болотных видов, и 71 вид мхов, из которых 29 сфагновых мхов, было описано на болоте и его окрайках. Развитие болотной системы началось с первичного заболачивания сразу же после регрессии Ацилового Озера около 9 000 лет назад. На первых этапах формирования системы доминировали осоковые минеротрофные сообщества, которые быстро сменились более бедными омбротрофными ценозами. Большинство современных минеротрофных сообществ находится на переходном к омбротрофной стадии этапе.

Данная работа выполнена в рамках договора о сотрудничестве в области охраны природы. Основная цель – это сравнение болот и путей их сохранения в Финляндии и Республики Карелия.

Ключевые слова	Болотная система, болотный массив, биоразнообразие, развитие растительности, бореальная зона, охрана болот	
Наименование и номер серии	The Finnish Environment 489	
Теема публикации	Природа и природные ресурсы	
Финансирование	Министерство окружающей среды	
	ISSN 1238-7312	*ISBN* 952-11-0916-5, 952-11-1072-4 (PDF)
	Количество страниц 97	*Язык* Английский
	Конфиденциальность Публичная	*Цена* 96 FIM (16,15 €)
Распределитель	Центр окружающей среды Финляндии Lentiirantie 342, FIN-88900 Kuhmo, Suomi/Финляндия	
Издатель	Центр окружающей среды Финляндии PL 140, FIN-00251 Helsinki, Suomi/Финляндия	
Место печати/ типография и дата	Vammalan Kirjapaino Oy, Vammala 2001, Finland	

The Finnish Environment

NATURE AND
NATURAL RESOURCES

Complexes, vegetation, flora and dynamics of Kauhaneva mire system, western Finland

The aim of this study has been a comprehensive ecological analysis of a large protected mire to understand the fuctioning and state of the ecosystem. This helps the assessment of the importance of the mire as a part of the network of mire reserves in Finland and internationally. In Kauhaneva there is an exceptionally high diversity on mire complex, mire site type and plant species levels. During 9000 years the mire has developed from minerotrophic fens into a diverse system of bogs and aapamires.

Kauhaneva mire system, covering more than 2500 hectares, has mainly been protected as a part of Kauhaneva-Pohjankangas national park since the year 1982. However, the sustainability of the ecosystem is threatened by several factors: All the marginal parts of the mire are not included in the national park, and there are ditches excavated to improve timber growth, covering ca. 300 hectares of the mire margins. In some 20% of the margins, the ditches prevent the waters from adjacent mineral soil to flow to the mire along their natural courses. In the mineral soils surrounding the mire there are extensive clearcuts without any buffer zone against the protected mire. On the northeastern margin of the mire there is a groundwater pumping station, which has decreased groundwater seepage in the mire from the year 1993.

This publication is directed to international scientific community and nature conservation authorities and people involved in environmental education.

The publication is available in the Internet:
http://www.vyh.fi/eng/orginfo/publica/electro/fe489/fe489.htm

ISBN 952-11-0916-5
ISBN 952-11-1072-4 (PDF)
ISSN 1238-7312

Edita Publishing Ltd.
P.O.Box 800, FIN-00043 EDITA, Finland
Phone +358 20 450 00
Mail orders:
Phone +358 20 450 05, fax +358 20 450 2380
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Annankatu 44, phone +358 20 450 2566

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