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Mires in Latvia

Latvian suot

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Both minerotrophic (fens and transitional mires) and ombrotrophic (raised bogs) mires occur in Latvia. Distribution of mires and diversity of mire vegetation are determined by geology of area, origin of mires and climatic differences between coastal and continental parts of Latvia. Fens started to develop in the early Holocene in the Preboreal 10 000 years BP. Later, during the Atlantic many fens transformed into transitional mires and gradually into raised bogs. Today Latvian mires are represented by all these types and they cover 4.9% of the country. Mires are protected in the North Vidzeme Biosphere Reserve, National Parks (Slītere, Ķemeri and Gauja), Strict Nature Reserves (Teiči, Krustkalni and Grīņi), Nature parks and 140 nature reserves, as well as in protected landscape areas.

Keywords: Mire development, raised bogs, fens

LOCATION AND MIRE DISTRIBUTION

Latvia is situated on the eastern coast of the Baltic Sea (Fig. 1) with its coastline extending for 490 km (Strautnieks 1997). The total area of the country covers 64 635 km^2. Latvia belongs to the boreo-nemoral vegetation zone, characterized by deciduous-coniferous (mixed) forests (Ahti et al. 1968).
Mires cover a total area of 4.9% in Latvia, 70% of which are relatively untouched by human activities.

The climate is influenced by West-Atlantic atmospheric circulation, is comparatively cool and wet and this favours mire development. The predominance of coastal influence in the northwest and the continental character in the southeast of Latvia cause regional climatic differences. In January temperature averages range from –2.6 °C to –6.6 °C. In July the summer temperatures correspondingly ranges from +16.8 °C to +17.6 °C. The average of annual precipitation is 600–650 mm (Kalniņa 1995).

The diversity of mire types is uneven and distribution is determined by the geology of the area, origin of mires, climatic differences between the coastal and continental parts of Latvia.

The degree of paludification in Latvia shows that the main factors promoting this process are relief and the lithological composition of surface deposits, which determine the intensity of surface discharge. Maximum degree of paludification is associated to lowlands and ranges from 0.1% to 40%. Most paludified areas are located in the low-

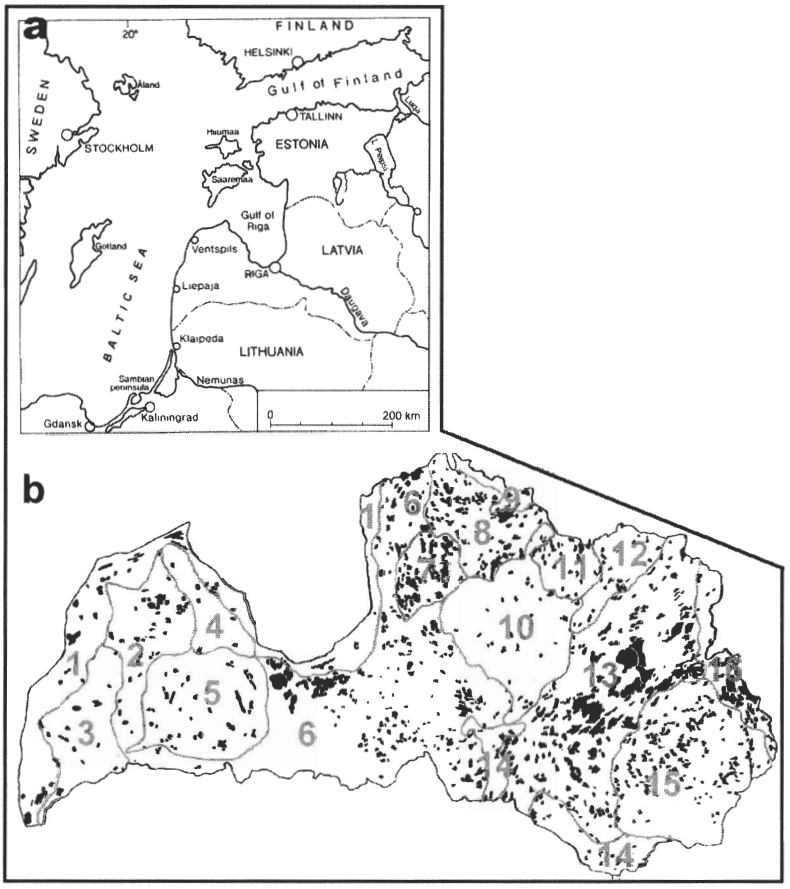

Fig. 1. Location of Latvia (a) and distribution of peatlands in Latvia in nature regions (b). Nature regions after Ramans and Zelčs 1995. 1 — Coastal Lowland; 2 — Kursa Lowland; 3 — West Kursa Highland; 4 — North Kursa Highland; 5 — East Kursa Highland; 6 — Central Latvia Lowland; 7 — Idumeja Highland; 8 — North Vidzeme Lowland; 9 — Sakala Highland; 10 — Vidzeme Highland; 11 — Central Gauja Lowland; 12 — Aluksne Highland; 13 — East Latvia Lowland; 14 — Augszeme Highland; 15 — Latgale Highland; 16 — Mudava Lowland.

Kuva 1. Latvian sijainti (a) ja soiden esiintyminen eri luonnonmaantieteellisillä alueilla (1–16; Ramans and Zelčs 1995) Latviassa (b).

lands with gently undulated relief of the Quaternary tillbeds.

Mires are distributed all over the country but the area covered differs among the nature regions of Latvia (Ramans & Zelčs 1995). The largest raised bogs are found in the East and Central Latvia Lowland districts and North Vidzeme Lowland (Fig. 1). Sizes of peatlands vary from less than 1 ha up to more than 5 000 ha. The 7 largest mires, each covering an area of over 5 000 hectares, are Teiči Mire, Cena Mire, Peikstulnīca-Sala Mire, Seda Mire, Sala Mire, Ķemeri-Smārde Mire and Krievi-Jersika Mire (Nusbaums & Rieksts 1997). The largest peatland in Latvia is Teiči Mire, covering a total area of 19 047 ha.

Minerotrophic mires (fens and transitional mires) develop in places where ground and river water are rich in nutrients, while ombrotrophic mires (raised bogs) obtain their water and minerals from precipitation. Mires often develop in the vicinity of lakes.

Latvian mires are of considerable biodiversity value as they support a variety of plant communities rich in plant species composition. This rich

diversity of mire types in Latvia is of international conservation significance (Pakalne et al. 1996).

MIRE ORIGIN AND DEVELOPMENT DURING THE HOLOCENE

The oldest mires in Latvia were fens, formed in the lower-lying areas about 10 000 years ago, during the Preboreal. The oldest known mire in Latvia dates from 10 180 ± 140 B.P. (Segliņš 1988). During the Preboreal fens originated also in many small inter-hill depressions in the uplands.

During the Boreal, when climate became warmer and drier, the formation of extensive mires commenced. During the Atlantic period climatic conditions became optimal for mire development and witnessed the most extensive mire formation in Latvia. Rich broad-leaved forests surrounded the mires. During the Atlantic fens gradually transformed into transitional mires and later into raised bogs. At the end of this period *Sphagnum* species were widely distributed and started to dominate in bog vegetation.

In the early stages of mire development *Phragmites* and *Carex* species dominated, e.g. *Phragmites australis*, *Carex dioica*, *C. nigra*, *C. panicea* while trees and shrubs, such as *Betula pubescens*, *Frangula alnus*, *Pinus sylvestris*, *Myrica gale* and *Salix* spp. dominated species-rich fens. When the mire development started, particularly during the Atlantic, many of the currently rare plant species, like *Myrica gale*, *Cladium mariscus*, *Trapa natans*, *Salix myrtilloides* and *Hammarbya paludosa*, were wide spread.

Development of raised bogs was associated with a rapid increase of various *Sphagnum* spp. in the vegetation. During the Sub-boreal *Sphagnum fuscum*, *Scheuchzeria palustris* and *Eriophorum vaginatum* often dominated in bog vegetation, but during the Subatlantic *Sphagnum magellanicum*, *Andromeda polifolia* and *Calluna vulgaris* became more widespread. Microclimate primarily determines vegetation composition in these raised bogs (Kalniņa 1998).

Coastal mires developed during the Boreal and Atlantic in the areas along the coastline of the Baltic Sea and the Gulf of Riga (Lācis & Kalniņa 1998).

Presently existing mire complexes are complicated dynamic systems, growing intensively both in vertical and horizontal directions.

CONTEMPORARY MIRE VEGETATION

Minerotrophic mires

Fens are presently widely distributed in Latvia, wherever waterlogged conditions are maintained at least in part by ground water. They range in a size from extensive fen complexes to small sites only of a few square metres associated with springs.

The Scheuchzerio-Caricetea fuscae communities occupy these fens, like *Caricetum diandrae* and *Caricetum nigrae*. Vegetation can be open or covered with shrubs like *Betula pubescens* and *Salix cinerea* (Pakalne 1998). Sedge species such as *Carex lasiocarpa*, *C. panicea* and *C. diandra* are characteristic for minerotrophic mires. Other associated species are *Menyanthes trifoliata*, *Comarum palustre*, *Eriophorum angustifolium*, *Lysimachia vulgaris*, *Peucedanum palustre* and *Succisa pratensis*. The fen vegetation is typically rich in mosses, e.g *Campylium stellatum*, *Calliergonella cuspidata*, *Fissidens adianthoides*, *Bryum pseudotriquetrum* and *Scorpidium scorpioides* are often present.

Where eutrophic mires have developed over a limestone substrate, calcareous fens occur. Such rich fens are found near Engure Lake and also near other coastal lagoon lakes where the *Schoenetum ferruginei* community was recognised (Pakalne 1994). The *Cladietum marisci* also occurs near the coastal lagoon lakes. The most calcareous parts are extremely rich in species and support a range of plants including *Primula farinosa*, *Parnassia palustris*, *Pinguicula vulgaris*, *Carex hostiana*, *Sesleria caerulea*, *Fissidens adianthoides*, *Bryum pseudotriquetrum*, *Drepanocladus revolvens* and *Scorpidium scorpioides*. Orchids like *Gymnadenia conopsea*, *Dactylorhiza incarnata*, *D. cruenta*, *D. maculata*, *Epipactis palustris*, *Ophrys insectifera*, *Epipactis palustris* and *Liparis loeselii* are well represented in the rich fens.

A further type of species rich mire is the spring fens, where *Carex davalliana* occurs near flushes. The *Cladietum marisci* rarely occurs at these sites.

Communities of the Scheuchzerietalia, like the *Caricetum limosae, Caricetum rostratea* and the *Rhynchosporetum albae,* are common in transitional mires. Species typical of fens and bogs like the sedges *Carex lasiocarpa* and *C. rostrata* occur in these mires. Further species often present on these sites include *Carex chordorrhiza, Eriophorum polystachion, Rhynchospora alba* and *Andromeda polifolia.* In the moss layer *Sphagnum teres, S. warnstorfii, S. fallax* and *S. flexuosum* are amongst the dominants.

Reedswamps and tall-sedge communities, e.g. *Phragmitetum australis* and *Caricetum elatae* often occur near lakes. The dominant species here include *Phragmites australis* associated with *Scirpus lacustris* and *Typha latifolia.*

Rare plant species in Latvia that occur in minerotrophic mires include *Myrica gale, Stellaria crassifolia, Utricularia ochroleuca, Carex heleonastes, Eriophorum gracile, Salix myrtilloides, Hammarbya paludosa* and *mosses* e.g. *Moerckia hibernica, Riccardia multifida, Cinclidium stygium, Bryum neodamense* and *Sphagnum obtusum.*

Ombrotrophic mires

Raised bogs are present all over Latvia. Two regional raised bog types are recognised, namely the western type with *Trichophorum cespitosum* and the eastern type with *Chamaedaphne calyculata.* These bogs can be dome-shaped or of the plateau-type and may be treeless or treed. The central parts of the bogs are often treeless but the margins are treed. The most common microrelief feature of raised bogs is alternations of relatively dry hummocks and ridges with wet hollows and open-water bog pools. Bog pools are mainly large and elongated.

Communities of Oxycocco - Sphagnetea are well presented in the raised bogs. The *Sphagnetum magellanici* often occurs on hummocks as well as *Empetro nigri-Sphagnetum fusci.* Vegetation of ombrotrophic mires has a significant cover of dwarf ericoid shrubs with the dominance of *Sphagnum* species in the moss layer - characteristics that distinguish them from the other mire types. *Calluna vulgaris, Oxycoccus palustris, Andromeda polifolia* and *Drosera rotundifolia* are prominant on hummock ridges. In hollows mosses like *Sphagnum cuspidatum* and *S. tenellum* are common while *Scheuchzeria palustris, Rhynchospora alba* and *Drosera anglica* are typical vascular plants in these microhabitats. There may be a zone of *Menyanthes trifoliata,* together with the presence of *Carex limosa,* surrrounding the pools. Therefore, an inflow of nutrient-rich groundwater into the pools can be assumed.

Rare plant species like *Trichophorum cespitosum, Betula nana* and mosses *Calypogeia sphagnicola, Sphagnum lindbergii* and *Odontoschisma sphagni* occur in ombrotrophic mires.

DISTRIBUTION OF VARIOUS MIRE TYPES

According to differences in geological development, vegetation and soil features Latvia is divided into 8 geobotanical districts (Kabucis 1995) (Fig. 2). Differences in mire types, distribution, floristic peculiarities and representation are observed among the geobotanical districts.

The Coastal Lowland district is located along the coast of the Baltic Sea and Gulf of Riga. Here mire vegetation covers quite large areas and includes raised bogs as well as poor and rich fens. Rich fens developed near coastal lagoon lakes like Kaņieris and Engure Lakes (Fig. 3).

There are also a few mire sites in the Coastal Lowland district where *Rhynchospora fusca* grows. One of the localities is near Klāņi Lake that originated 2–3 thousand years ago as a stage of the former Litorina Sea (Tabaka et al. 1981). The rare wetland community with *Eleocharis multicaulis* and *Rhynchospora fusca* occurs at this locality.

Another site with *Rhynchospora fusca* is in the *Rhynchoporetum albae* community occuring in the inter-dune mire near Roja, where *Rhynchospora fusca* grows together with *Myrica gale, Rhynchospora alba, Andromeda polifolia, Drosera anglica, D. rotundifolia, Trichophorum cespitosum, Sphagnum subsecundum, S. rubellum* and *Riccardia multifida* (Pakalne 1998). A third locality with *Rhynchospora fusca* in Latvia is known from the Slītere National Park.

The North Vidzeme geobotanical district is characterized by a high presence of mires and

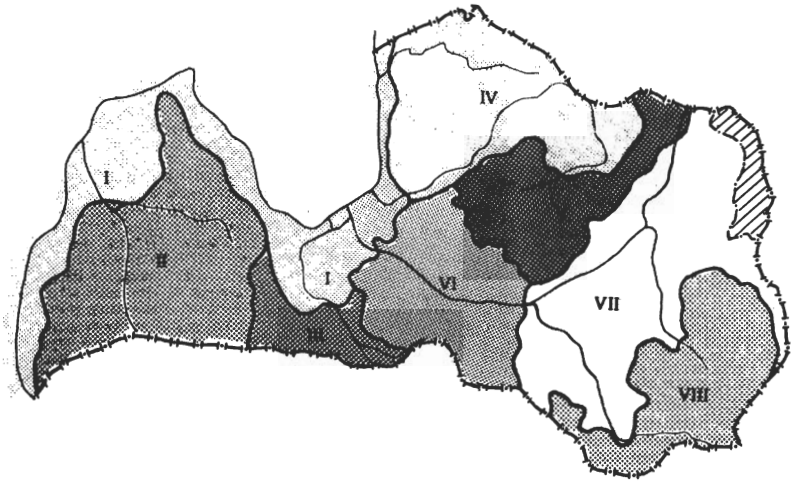

Fig. 2. Geobotanical districts of Latvia (Kabucis 1995). I — Coastal Lowland; II — West Latvia; III — Zemgale; IV — North Vidzeme; V — Central Vidzeme; VI — Central Latvia; VII — East Latvia; VIII — South-East Latvia.

Kuva 2. Latvian kasvimaantieteelliset alueet (Kabucis 1995).

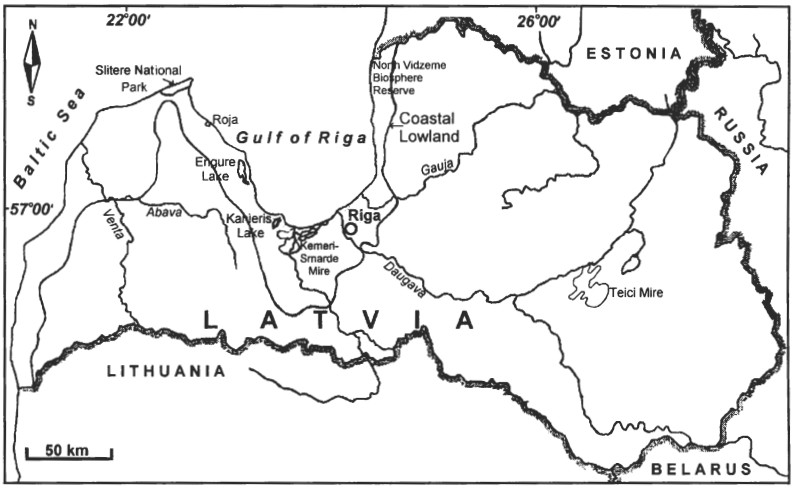

Fig. 3. Distribution of the largest protected nature areas in Latvia.

Kuva 3. Latvian suurimmat luonnonsuojelualueet.

dominance of vast raised bogs. In the western part is the border of distribution of *Chamaedaphne calyculata*. This is also the border between raised bogs of western and eastern types. There are fens with *Betula humilis* but *Betula nana* is restricted to the raised bogs of the northern Latvia.

The Central Vidzeme, Zemgale and Central Latvia districts are much poorer in mires than other parts of Latvia. In Central Vidzeme mires cover only small areas. They have been drained and used for agricultural purposes during the latest decades.

In the Central Latvia district, mires are located in river valleys where ombrotrophic mires are very rare and minerotrophic fens dominate the eastern part of this district mainly near lakes. River valley fens are characterised by tall-sedge vegetation and treed mires with a very dense shrub layer occur in this region.

The West Latvia geobotanical district is also not rich in mires. The minerotrophic mires that do occur near lakes and river valleys have been intensively drained. Fens on calcareous soils are similar to those of the Coastal Lowland district, with *Myrica gale, Schoenus ferrugineus, Liparis loeselii* and *Carex hostiana*. In the Stikli Mire complex ombrotrophic mire vegetation dominates, but on margins minerotrophic mire vegetation occurs. A very rare species in Latvia, *Sphagnum lindbergii*, was distinguished in the hollows of a raised bog in this area.

The East Latvia geobotanical district is one of the richest in mires in Latvia. Both ombrotrophic and minerotrophic mires are frequently found. Raised bogs belong to the eastern type with *Chamaedaphne calyculata* in the shrub layer. The largest mire in Latvia — Teiči Mire — is situated in the Lubāna Plain. The raised bogs are mostly covered with pine, more rarely they are of an open type.

In the South-East Latvia geobotanical district, mires are situated between hills near the lakes. These mires have developed as a result of the filling-in of lakes. Ombrotrophic mires do occur in this district, though minerotrophic mire vegetation dominates. Several rare moss species e.g. *Moerckia hibernica, Bryum neodamense* and *Meesia triquetra* occur in these mires.

Latvian mires include some species of the Red Data Book of the Baltic Region (Ingelög 1983).

PEATLAND USE

Peat deposits, including also swamp forest types on peat soil comprise 10.4% of the total land area of Latvia (Snore 1996). Peat is an important natural resource for Latvia reaching 1.5 billion tonnes. Until now about 6% from the peat resources have been utilized (Snore 1999). During previous years and also nowadays, Latvian peatlands have been used for agriculture, forestry, as well as for peat extraction purposes (Snore 1996).

The first efforts to drain wetlands in Latvia took place in the 17th century, however, most were drained from 1960 to 1980. Recently drainage of wetlands practically ceased. In total, 14 571 km^2 of drained wetlands are used for agriculture and 4 000 km^2 support wet forests. Drained peat deposits cover a total area of 1 862 km^2.

The first peat extraction in Latvia was recorded at the beginning of the 18th century. At that time peat was used in agriculture and as a source of fuel. Hereafter there was an increase of peat extraction. Industrial peat extraction in Latvia has already been taking place for many years. In the early 1930's attention was focused on extraction of peat for litter (Lācis 1996). The maximum peat production was reached in 1973 when the total amount of extracted peat was 5.3 million tonnes, of which 2.0 million tonnes was used as a fuel. In 1990 peat production dropped to 2.9 million tonnes of which 0.3 million tonnes was fuel peat.

The peat extraction area covers 0.4% of the country. About 25% of this area is currently utilised. Vast increases of peat mining are not planned. Industrially 536 mires can be used with the total peat resources of 333 million tonnes (Snore 1996). These peat resources do not include mires that are state protected.

In Latvia peat is used as a fuel, in agriculture and for export. In 1997 in total 0.35 million tonnes of peat were burned and 0,15 million tonnes exported, but 0.1 million tonnes used in agriculture. Peat is also used for producing different substrates and modules for plant cultivation. About 9% of Latvia's raised bogs (37 bog areas with the total area of 70 000 ha) are affected by peat cutting activities, 20 000 ha are nearly exhausted. The annual cutting in the recent years was 430 000 to 650 000 tonnes, 65% to 75% of this for fuel and 25% to 35% for agricultural purposes.

MIRE CONSERVATION

A striking feature of Latvian wetlands is the high degree of naturalness with pristine and undamaged mire complexes.

A new list of protected nature areas was accepted by the Latvian Parliament in 1999. Mires are protected in more than 140 protected nature areas, including those of Strict Nature Reserves (Grīņi, Krustkalni, Teiči), National Parks (Gauja, Slītere and Ķemeri), Engure Nature Park, North Vidzeme Biosphere Reserve (Table 1). These sites include raised bogs, fens and mires near lakes.

Three Ramsar sites were designated in Latvia in 1995 — Kaņieris Lake, Engure Lake, Teiči and Pelēčāre Mires covering a total area of 43 200 ha. Main habitat types represented there are relict shallow coastal lakes, coastal marine areas and large raised bogs (Opermanis 1998).

Mires in the Ķemeri National Park

The Ķemeri National Park is rich in mires, with three important raised bogs. Ķemeri-Smārde Mire is the largest one with the total area of 6 192 ha (Galenieks & Krauklis 1995). Zaļais Mire (1 586

ha) (Nusbaums 1998) and Raganu Mire (1 129 ha) (Krauklis 1997) are smaller.

Raised bog vegetation dominates in Raganu Mire. In the northern part fen vegetation appears fed by ground waters rich in nutrients. An interesting feature of this mire is sulphurous springs surrounded by ombrotrophic mire vegetation. *Cladium mariscus* is observed near sulphurous springs growing together with *Phragmites australis, Myrica gale, Schoenus ferrugineus, Primula farinosa, Menyanthes trifoliata, Comarum palustre, Calliergonella cuspidata* and *Scorpidium scorpioides*.

Ķemeri-Smārde Mire

Ķemeri-Smārde Mire began to develop in the Boreal period, with a minerotrophic mire vegetation, about 8000–7000 B.P. The largest part of this mire includes a raised bog and only the northern and western bog margins are transitional mires. The mire is characterised by a hummock-hollow complex and lakes. Ancient dune formations separate the Ķemeri-Smārde Mire from the Gulf of Riga.

Ķemeri-Smārde Mire has developed in the area that was covered by the Baltic Ice Lake (Nikodemus et. al. 1997). After the retreat of the Baltic Ice Lake, fine sand deposits formed the surface of the area. Peat sedimentation started during the Boreal (Fig. 4). Results indicate that highly decomposed wood-*Carex* peat was deposited on the mineral deposits during the Boreal about 8 000 years ago, when sedges, reeds and grasses grew in the mire, but pine forests dominated in vicinity.

Gradually climate became milder and mineral sediments started to paludify in large areas of gently sloping and undulated plain. Fine sand was covered by sedge, wood-sedge, pine and pine - *Sphagnum* peat, degree of decomposition varied from 30–50%.

During the Atlantic time climate became more favourable for mire development and precipitation became more important for vegetation. As a result, mesotrophic plants were replaced by eutrophic ones and *Eriophorum-Sphagnum, Sphagnum angustifolium-Scheuchzeria* peat deposited, degree of decomposition varied from 20 to 40%. During the Subboreal and Subatlantic less intensively decomposed (~20%) *Sphagnum fuscum* and *Sphagnum magellanicum* peat formed.

A pollen diagram (Fig. 4) demonstrates that since the Atlantic period a very rapid increase in *Sphagnum* spores is observed while broad-leaved forest reached a maximum distribution in the surroundings. Pollen, spore and botanical composition of *Sphagnum fuscum* peat formed in the middle of the Atlantic time (about 6000–5000 years BP) testifies that already at that time a raised bog complex in the Ķemeri-Smārde Mire had devel-

Table 1. Protected nature areas in Latvia, focusing on mires.

Taulukko 1. Latvian suojellut luontokohteet, soihin keskittyen.

Category *Luokka*	Total number *Kokonaislukumäärä*	From those including mires *Soita sisältäviä kohteita*
Biosphere Reserve *Biosfäärialueet*	1	1
National parks *Kansallispuistot*	3	3
Strict Nature Reserves *Luonnonpuistot*	4	3
Nature Parks *Luontopuistot*	22	15
Nature Reserves *Luonnonsäästiöt*	211	140
Protected landscape areas *Maisemansuojelualueet*	6	6

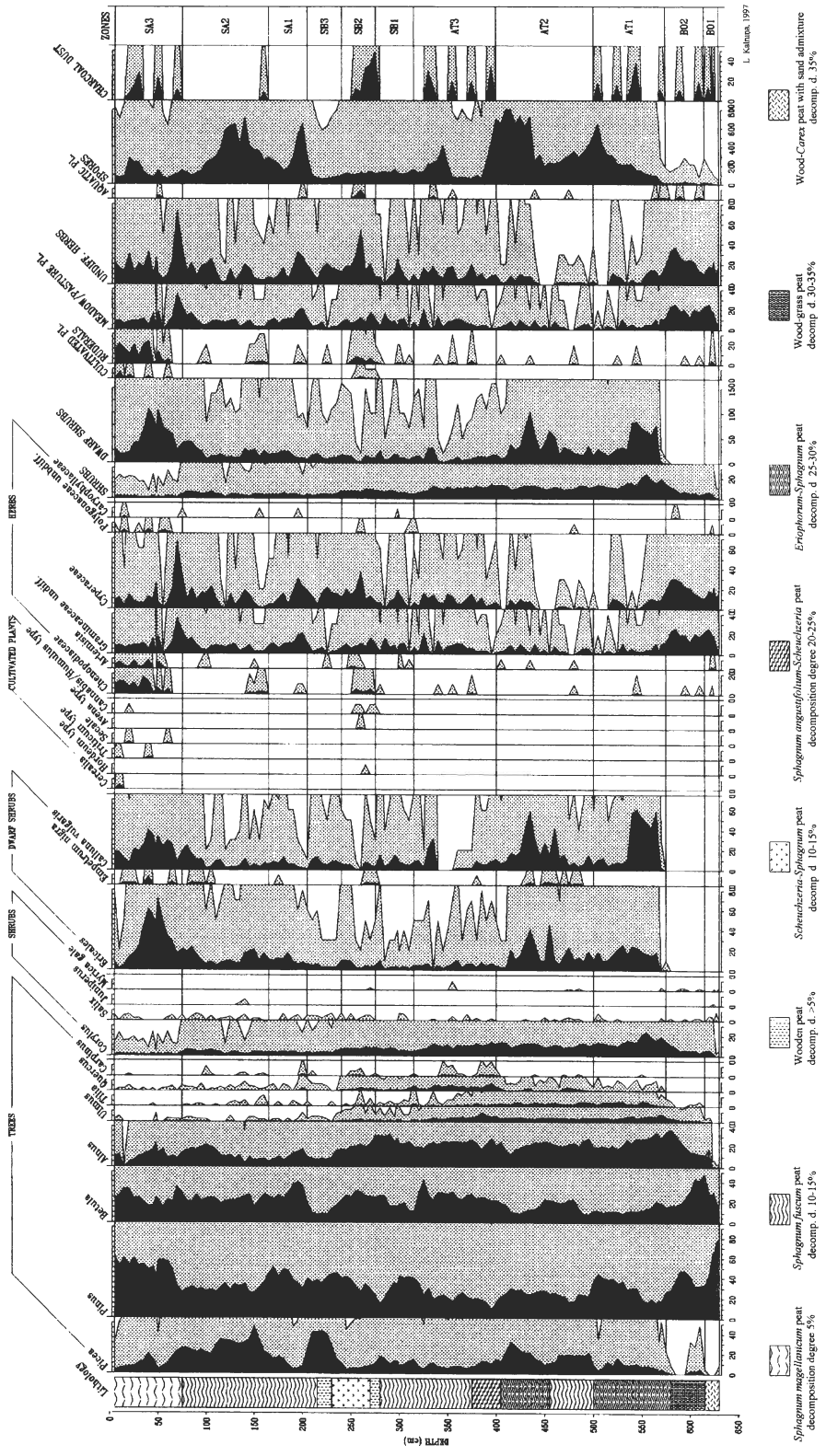

Fig. 4. Pollen diagram from Ķemeri-Smārde Mire.

Kuva 4. Siitepölydiagrammi Ķemeri-Smārde-suosta.

oped that has not changed until present. In the Atlantic the hummock-hollow complex developed.

Due to the humid and warm climate the raised bog grew rapidly during the Atlantic period, when the thickest peat layers (2.5–3.0 m) were formed. A second very intensive period of peat formation was the Subatlantic (since 2500 years BP), when *Sphagnum fuscum* and later *Spagnum magellanicum* peat formation (~2 m) took place under humid and cool climatic conditions.

Slītere National Park

The Slītere National Park is located in the far northwestern part of Latvia and it stretches along the coast of the Baltic Sea. All main types of forests and mires found in Latvia are represented here (Seile & Rēriha 1983). The area of Slītere National Park can be considered as a unique museum of the Baltic Sea stages. A peculiarity of the area is a complex of ancient dunes with inter-dune mires that were formed during the Post-Litorina period of the last 4 000 years, across the Litorina Sea (the Baltic Sea development stage from 8 300–4 000 years ago) and the Ancylus Lake (9 000–8 300 years ago) offshore formations.

Most peculiar is the zone of Litorina Sea beach accumulation, represented by two series of alternating long narrow walls (beach barrier with cover of eolian deposits) and narrow depressions between ridges (usually occupied by mires). This forms the inter-dune mire complex.

Mire vegetation is located between the coastal formations of the Litorina Sea parallel to the Baltic Sea coastline. Inter-dune mires include poor and rich fen vegetation. In the fens most common communities include *Carex lasiocarpa* associated with *Trichophorum alpinum, Menyanthes trifoliata, Carex limosa, C. chordorrhiza, C. rostrata, Rhynchosphora alba, Scheuchzeria palustris, Comarum palustre, Peucedanum palustre, Utricularia intermedia, Drosera anglica* and *Oxycoccus palustris*. In the moss layer *Calliergonella cuspidata, Scorpidium scorpioides, Calliergon giganteum, Campylium stellatum, Fissidens adianthoides* and *Bryum pseudotriquetrum* are common.

The rare species *Lycopodiella inundata, Hammarbya paludosa, Saxifraga hirculus Juncus stygius, Dactylorhiza incarnata, Liparis loeselii, Eriophorum gracile, Carex heleonastes* and *Moerckia hibernica* occur in the inter-dune mires.

The inter-dune mire complex borders with Baži Mire. It is a raised bog of a coastal type with a total area of 1 880 ha. The largest ridge is up to 15 km long and crosses the Baži Mire. Mires and even small lakes are located between the ridges.

North Vidzeme Biosphere Reserve

The area of the North Vidzeme Biosphere Reserve comprises 4 744 km^2 (Urtāns 1988). Kodu-Kapzeme Mire is the largest in the reserve with the total area of 1 925 ha. It includes diverse mire vegetation, but raised bog vegetation dominates. It is of great importance for breeding and migratory birds. Rare plant species grow there, e.g. the atlantic *Trichophorum cespitosum* and the arctic *Betula nana*. The northern part of the mire is about 1 km from Estonian mire reserve Nigula and together with Olla and Nigula Mire can be regarded as a perspective Ramsar site (Opermanis 1998).

Madiešēni Mire with the area of 1 881 ha (Krauklis 1995) is located in the North Vidzeme Biosphere Reserve in the vicinity of the Augstroze Lielezers and Daugulu Mazezers Lakes. This mire is formed as extensive paludified depression between an injective glaciotectonic landform known as "dauguls" at Augstroze interlobate High. Pollen analyses estimate the Atlantic age of gyttja, but formation of mire started at the end of the Atlantic period and raised bog conditions appeared during the Subboreal period. It is a raised bog of a concentric type. The mire includes open-water bog pools and lakes. Minerotrophic fen vegetation occurs on the mire margins. Several minerogenic islands covered by vast forest are present in the mire.

Ramsar sites in Latvia

Kaņieris Lake

Kaņieris Lake is located at the southwestern coast of the Gulf of Riga, in the Coastal Lowland. It is the largest lake in the Ķemeri National Park, com-

prising 1 130 ha (Opermanis 1998). According to the geomorphologic features Kaïieris Lake belongs to a coastal lagoon lake type. Sulphurous springs, rich fens and swamps occur near the lake. In the northern part of the lake very dense *Phragmites australis* stands occur, but in the western and southern parts they are separated by water. The eastern part is mainly open water.

The surroundings of Kaņieris Lake include vegetation with *Cladium mariscus* and rich fen vegetation with *Schoenus ferrugineus*. *Caricetum lasiocarpae* is common near Kaņieris Lake. Rare plant species, *Myrica gale, Dactylorhiza incarnata, Liparis loeselii, Epipactis palustris* and *Schoenus ferrugineus* characterize the rich fens near the lake.

Engure Lake

Engure Lake covering 3 500 ha (Opermanis 1998) is located in the western part of Latvia, in the Coastal Lowland district. It is the largest relict lake in the coastal area and has remained there since the Litorina Sea time. During the first and the second regressions, a 20 km long sandy buried split with dunes separated a wide inlet from the open sea.

Engure Lake is characterized by reed swamp vegetation filling-in the lake. The rare species *Cladium mariscus* occurs on the margins. Communities with *Carex lasiocarpa* and *Schoenus ferrugineus*, are typical for the area.

Teiči and Pelēčāre Mires

Teiči and Pelēčāre Mires are located in the East Latvia district (Fig. 3). The mires are a part of the Teiči Nature Reserve. Raised bog vegetation is most common, fens occur fragmentarily, mainly near lakes and on mire margins. The area is recognized as an IUCN Management Category I: a protected area managed mainly for science or wilderness protection (Bergmanis 1996).

Teiči Mire is a typical raised bog of eastern type. Its origin has begun already in the Preboreal and had passed the minerotrophic phase of mire development to reach the ombrotrophic phase of a raised bog (Lācis & Kalniņa 1998). During the Atlantic period, raised bogs had already developed in the large mire complexes, but during the Subatlantic they also developed in the smaller ones. Teiči Mire has developed both as a result of lake terrestrisation and soil paludification (Bambe 1993).

During the final stage of Late Glacial, dead ice blocks covered the area of Teiči Mire. After complete melting, about 12 000 years ago, the glacier and its melting waters had left an undulating relief in the area with well distinguished hollows and ridges (Lācis & Kalniņa 1998). The position of different events is regarded as rough estimations using pollen data. The diagram obtained from spore-pollen data (Lācis & Kalniņa 1997, 1998) reveals that sand and clay in the mire bottom have accumulated during the older Dryas (DR2) period under arid and cold subarctic climatic conditions (Fig. 5, 6). Dominance of *Betula nana* and *Artemisia* pollen, *Bryales* spores as well as presence of *Ephedra* and *Selaginella* are noticed.

About 10 300 years ago at the beginning of the Preboreal, climate became milder and in the bottomland sites around lakes and in other depressions fen peat and gyttja started to accumulate in narrow zones. It is formed by plant remnants that have been growing under excess humidity. *Hypnum*, *Carex*-Graminea, *Carex*-Graminea-*Hypnum*, more seldom wood- *Carex*-Graminea and wood peat cover the mineral bottom of the depressions, the absolute elevation of which ranges within 95–103 m a.s.l. In the surrounding area a very scanty woodland dominated.

About 9 000 years ago when the Boreal climate became warmer and less humid, the groundwater level lowered (Lācis & Kalniņa 1998). The mire vegetation was fed more by rainwaters. The eutrophic plant species were gradually replaced by mesotrophic ones. *Hypnum* moss was replaced by *Sphagnum* species, *Eriophorum vaginatum* appeared. In the woody stands pine became important, then alder and some broad-leaved trees appeared on the mire margins. The mire rose vertically and water streamed away to its edges promoting a horizontal widening of the bog and palufied the lowest sites (100–104 m a.s.l.). Lake terrestrialization started on silty gyttja. Transitional peat was formed by well-decomposed (36%) grass-*Sphagnum* peat, where *Sphagnum*

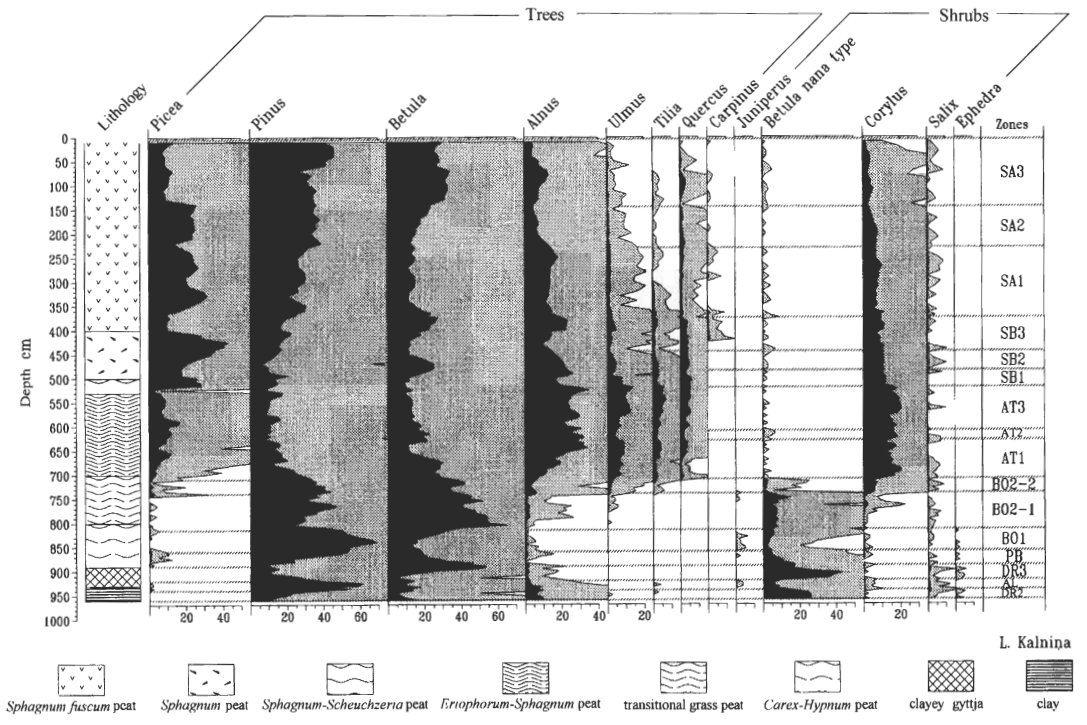

Fig. 5. Pollen diagram of trees and shrubs from Teiči Mire.

Kuva 5. Siitepölydiagrammi Teiči-suosta (puut ja pensaat).

angustifolium, *S. fuscum* and *S. subsecundum* comprise 35–80%. According to the pollen data, the upper limit of Boreal is marked in pollen diagram by a sharp raise of *Alnus* and *Ulmus* pollen curves that demonstrates significant changes in regional vegetation.

About 7 400 years ago the climate changed and warm and humid Atlantic climatic conditions commenced. In the central areas of the mire where 2–3 metres thick layer of peat had accumulated ombrotrophic vegetation developed.

During the Atlantic time a 1–2 m thick layer of *Eriophorum-Sphagnum* peat accumulated, where *Sphagnum* residues comprised 55–70% in the peat. Pollen data indicates more favourable climatic conditions for upsurge of broad-leaved trees in the region. Although, during the Atlantic, particularly during its second part, the raised bog conditions and microclimate in the mire had already formed and regional climate and vegetation changes did not effect the mire vegetation. Such feature allows to explain also the maintenance of *Betula nana* through the Atlantic climatic optimum until the present time.

The Subboreal set in before 4 800 years ago, when climate became slightly cooler and in the surroundings of the mire spruce forests became dominant. During this period *Sphagnum* and *Eriophorum* basically formed bog vegetation that produced *Sphagnum magellanicum* peat. In this period an intensive accumulation of peat occurred all over the mire.

About 3 000 years ago the climate became cooler and more humid. During this Subatlantic time *Sphagnum fuscum* peat developed, occupying the upper part of peat. *Sphagnum fuscum* constitutes 45–90% of the residue of peat. The other part of peat consists of *Sphagnum angustifolium* and *S. magellanicum* remnants and *Eriophorum*. *Sphagnum fuscum* peat occupies a layer of 3–6 m. During the Subatlantic period bogs became dynamic systems, growing rapidly in both vertical and horizontal directions, exerting considerable effect on dynamics of the landscapes with 3–

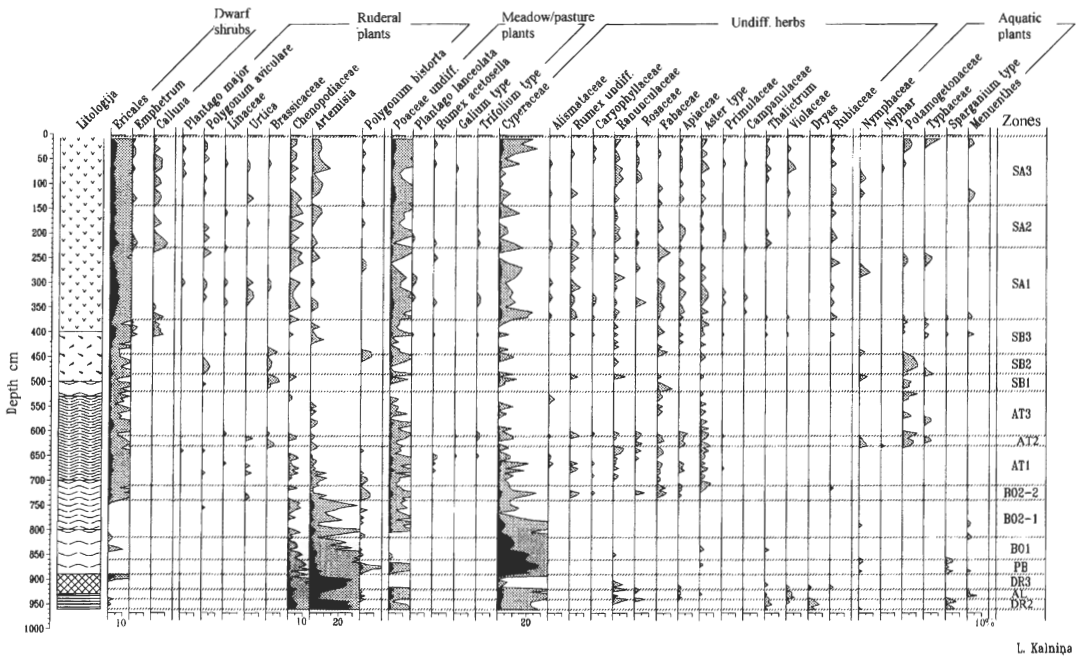

Fig. 6. Pollen diagram of dwarf shrubs and herbs from Teiči Mire.

Kuva 6. Siitepölydiagrammi Teiči-suosta (varvut ja ruohot).

6 m high cupola-lake formations in central part of some bogs.

During the Subatlantic period smaller mires joined together and some lakes became terrestrialised. Filling-in of the lakes was facilitated by their disposition close to the bog's edge, and they received waters rich in mineral substances. In those areas transitional *Sphagnum angustifolium* peat covers the gyttja.

The most typical mire communities are representative of the Oxycocco-Sphagnetea and Scheuchzerio-Caricetea fuscae.

Rare plant species in Latvia occur in Teiči Mire. *Betula nana* grows near the bog lakes and pools. *Salix myrtilloides* occurs in transitional mires. *Nymphaea alba* and *N. candida* are associated with lakes. *Utricularia ochroleuca, Carex heleonastes, Eriophorum gracile, Liparis loeselii, Hammarbya paludosa, Carex aquatilis, Sphagnum subnitens, Helodium blandowii, Cinclidium stygium* and *Scapania irrigua* grow in fens and transitional mires. *Corallorhiza trifida, Eriophorum gracile, Drepanocladus vernicosus* and *Preissia quadrata* occur in fens. *Dactylorhiza incarnata* and *D. maculata* grow in fens and in some transitional mires. *Sphagnum molle, Pohlia sphagnicola, Calypogeia sphagnicola* and *Sphagnum papillosum* occur in raised bogs and transitional mires.

Teiči Mire is especially rich in wetland bird species: both quantitatively and qualitatively. It is a highly significant area for birds, not only in Latvia but also in Europe. Great numbers of bird species breed there. For some bird species Teiči Mire is one of the most important nesting sites in Latvia. There are species that breed only in the raised bogs in the Eastern Baltic, like *Gavia arctica, Pluviatilis apricaria, Tringa glareola, Tringa nebularia, Numenius phaeopus, Lanius excubitor* and others, such as, *Grus grus, Falco columbarius, Limosa limosa, Tringa totanus*. High numbers of *Tetrao tetrix* and *Tetrao urogallus* breed there, while some individuals of *Lagopus lagopus* survive in the mire. Surrounding forests are the habitat for rare raptors like *Aquila chrysaetos, Aquila pomarina, Strix uraliensis,*

Aegolius funereus, Glaucidium passerinum, as well as for woodpeckers.

Most of the rare and important bird species breed at the bog pools. Dominant species there are *Anthus pratensis, Alauda arvensis, Anthus trivialis, Saxicola rubetra* and *Fringilla coelebs.*

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TIIVISTELMÄ

Latvian suot

Latviassa esiintyy sekä minerotrofisia sara- eli aapasoita, että ombrotrofisia keidassoita. Eri suotyyppien alueellinen esiintyminen riippuu alueen geologiasta, suon alkuperästä sekä ilmastollisista eroista Latvian rannikon ja sisämaan välillä. Sarasuot alkoivat kehittyä Holoseenin aikana preboreaalisella kaudella 10 000 vuotta sitten. Atlantisella kaudella alkoi soiden kehittyminen kohti ombrotrofiaa. Nykyään suot peittävät 4,9% Latvian pinta-alasta. Latviassa on suojeltuja soita Pohjois-Vidzemen biosfäärialueella, kansallispuistoissa (Slītere, Ķemeri ja Gauja), tiukasti suojelluissa luonnonpuistoissa (Teiči, Krustkalni ja Grīņi), useissa eri luontopuistoissa sekä luonnonsäästiö- ja maisemansuojelualueilla.

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