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THE PITKASOO BOG – AN ANCYLUS LAGOON FROM SAAREMAA ISLAND, ESTONIA

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Abstract. Two interchanging gyttja–peat sequences were investigated in the basal parts of the Pitkasoo Bog, Saaremaa Island, Estonia. These are interpreted to represent ingressions or ground water rises around 9800 ± 80 BP, depending on water level changes in the Yoldia Sea. An early part of the Ancylus transgression, which occurs earlier than the immigration of *Alnus* to Saaremaa, was also distinguished. The Pitkasoo sequences offer interesting possibilities for the study of the early stages of the Yoldia succession.

Key words: stratigraphy, pollen analysis, ^{14}C AMS-date, Yoldia, Ancylus.

INTRODUCTION

The Baltic Sea history has been intensively investigated in Estonia over the last 40 years (Kessel, 1961, 1988; Haila & Raukas, 1992; Kessel & Raukas, 1967, 1979; Raukas, 1994, 1995). Numerous studies of peat deposits underlying beach ridges, mainly dealing with pollen, molluscs, and radiocarbon dates, appeared during the 1960s and 1970s (Kessel & Raukas, 1967, 1979; Kessel & Punning, 1969). The biphasic transgression of the Yoldia Sea with an amplitude of several metres was suggested but was rejected lately (Lepland et al., 1995; Raukas, 1994, 1995; Saarse et al., 1997). The Pitkasoo Bog was selected for the study because of its position behind an Ancylus beach ridge to get new information on the character and duration of the Yoldia and Ancylus phases on Saaremaa. The results are connected with the development of the Yoldia Sea and the early part of the Ancylus Lake.

The Pitkasoo area has been examined twice; its biostratigraphy and beach formations have been briefly described (Kessel & Raukas, 1967; Saarse & Königsson, 1992; Poska, 1994; Saarse et al., 1994). According to the earlier interpretation, during the second half of the Early Boreal a lagoon was formed behind the Ancylus spit which later on became an isolated lake (Kessel & Raukas, 1967).

During reconnaissance coring in 1991 we found buried organic deposits below Ancylus transgressional silts. This makes Pitkasoo especially attractive among sites providing information about the Baltic Sea history (Saarse et al., 1994; Poska, 1994).

GEOLOGICAL SETTING

Pitkasoo (Käasla) is an ancient Ancylus lagoon, now a small elongated bog on the SE slope of the West Saaremaa Upland, about 20 km west of the town of Kuressaare (Fig. 1). It is 1400 m long and 300 m wide, *c.* 30 ha in area at an elevation of about 25 m a.s.l. The bog has been drained and reclaimed agri-

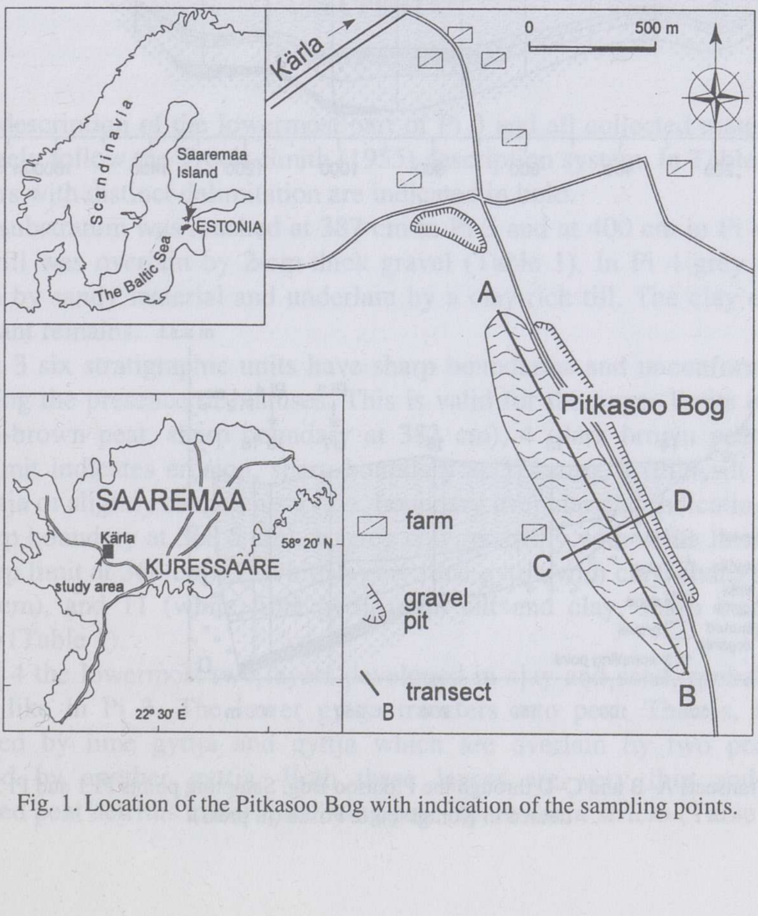

Fig. 1. Location of the Pitkasoo Bog with indication of the sampling points.

culturally. Outflow brooks are absent and water infiltrates through the damming beach ridge and reaches the surface as springs on the eastern slopes of the upland.

The Ancylus spit borders Pitkasoo in the east. Before the Ancylus transgression a glaciofluvial ridge existed in the present place of the Ancylus spit. The structure and texture of the ridge are exposed in a gravel pit in the NW part of the spit: basal glaciofluvial sand and gravel are covered there by *c*. 3-m-thick beach deposits. The top of the spit has been levelled to 30 m a.s.l. The study area lies close to the 32 m isobase corresponding to the highest level of the Yoldia Sea and the 30 m isobase of the Ancylus Lake (Kessel & Raukas, 1979). The initial pre-Ancylus threshold of Pitkasoo at 27.5 m lies about 4.5 m below the Yoldia and 2.5 m below the Ancylus maximum limits.

We made the stratigraphic sections (cores 17, 18, and 19) from the deepest part of the bog (Fig. 2). The buried peaty deposits form a lens behind the Ancylus beach ridge and are covered by clayey deposits which can be followed in almost

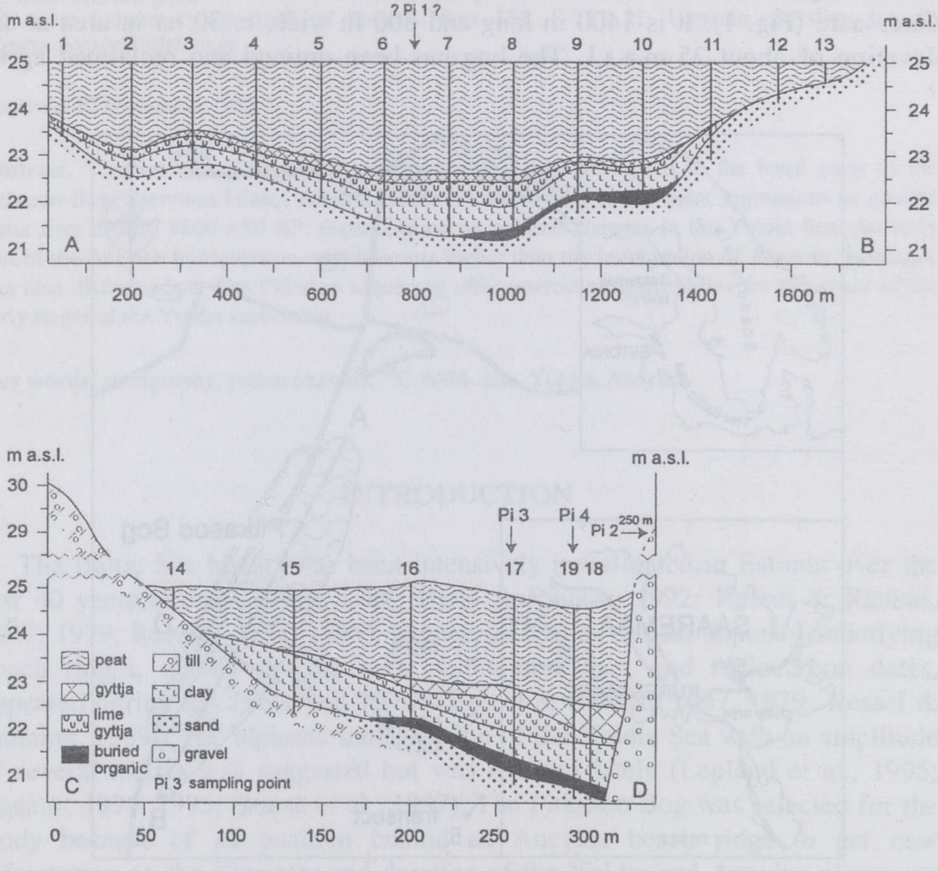

Fig. 2. Transects A–B and C–D through the Pitkasoo Bog. Sampling points Pi 1 and Pi 2 will be treated in Königsson & Poska (in press).

the whole basin. This lowermost part of the section is discussed in the present paper. The main part of the Pitkasoo core will be described in a separate paper (Königsson & Poska, in press).

METHODS

Two transects were cored with a Belarus peat auger (Figs. 1 and 2). Samples from cores 17 (Pitkasoo 3 – Pi 3) and 19 (Pitkasoo 4 – Pi 4) were studied for pollen and diatoms. For Pi 3 and Pi 4 full and combination diagrams have been compiled. One sample of the buried peat was dated by the accelerator mass spectrometry (AMS) techniques in the Tandem Laboratory at Uppsala University. Gyttja and the uppermost peat were dated by A. Liiva at the University of Tartu, using conventional radiocarbon dating techniques. These dates are discussed in another paper (Königsson & Poska, in press). The principles of the reconstruction of the diagrams are presented in Königsson et al., 1998.

MATERIAL

Lithostratigraphy

The description of the lowermost part of Pi 3 and all collected material from Pi 4 largely follow the Troels-Smith (1955) description system. In Tables 1 and 2 the layers with distinct delimitation are indicated in bold.

The substratum was reached at 387 cm in Pi 3 and at 400 cm in Pi 4. In Pi 3 clayey till was overlain by 2-cm-thick gravel (Table 1). In Pi 4 grey clay was overlain by sandy material and underlain by a clay-rich till. The clay contained some plant remains.

In Pi 3 six stratigraphic units have sharp boundaries and unconformities are suggesting the presence of hiatuses. This is valid for the upper limits of units 2 (greyish-brown peat, sharp boundary at 383 cm), 4 (dark brown peat, uneven upper limit indicates erosion, sharp boundary at 374 cm), 5 (thin silt layers in clay gyttja or slightly calcareous gyttja, boundary irregular and indicating erosion (?), sharp boundary at 368.5 cm), 6 (grey clay, possibly with some lime, uneven and sharp limit at 368 cm), 7 (whitish-grey lime gyttja with clay, sharp boundary at 367 cm), and 11 (white lime gyttja with silt and clay, sharp boundary at 355 cm) (Table 1).

In Pi 4 the lowermost two layers developed in clay and sand, probably lying on tills like in Pi 3. The lower gyttja transfers into peat. That is, however, succeeded by lime gyttja and gyttja which are overlain by two peat layers separated by another gyttja. Both these layers are very thin and contain assembled peat detritus rather than being peat layers *sensu stricto* (Table 2).

Table 1

The lithostratigraphy of the Pitkasoo 3 section (core 17)

Unit	Boundaries, cm	Upper limit	Comments
Substratum: clay-containing till (389 cm +) covered by gravel (389–387 cm)			
1	387–385	Gradual, ± 10 mm	Olive-grey, silty to sandy gyttja
2	385–383	Sharp, ± 1 mm	Greyish-brown peat with wood fragments and gyttja particles
3	383–380	Gradual	Dark olive-grey gyttja with some silt
4	380–374	Sharp, ± 1 mm	Dark brown peat with the uneven upper boundary, indicating early erosion
5	374–368.5	Sharp, ± 1 mm	Thin silt layers in clay gyttja or slightly calcareous gyttja. The boundary is uneven, indicating erosion
6	368.5–368	Sharp, ± 1 mm	Grey clay, possibly with some lime. The boundary is uneven (erosion?)
7	368–367	Sharp, ± 1 mm	Whitish-grey lime gyttja with clay
8	367–363	Gradual	Plumbum-grey clay with dark dots
9	363–361.5	Gradual	Plumbum-grey clay without dark dots
10	361.5–360	>1 mm < 10 mm	Plumbum-grey clay with dark dots
11	360–355	Sharp, ± 1 mm	White lime gyttja with silt and clay
12	355–309	± 2 mm	Well-layered clay with lime gyttja in almost cyclotheme structures. Very sharp boundaries between the interchanging layers

Table 2

The lithostratigraphy of the Pitkasoo 4 section (core 19)

Unit	Boundaries, cm	Upper limit	Comments
Substratum: clay-rich till			
1	400–390	> 0 mm	Grey clay with plant remains
2	390–387	>10 mm	Brown sand without visible plant remains
3	387–383	< 10 mm	Blackish-brown gyttja, downwards silty to sandy and with calcareous reaction
4	383–378.5	Sharp, > 1 mm	Blackish-brown, heavily decomposed and compressed peat, possibly peaty gyttja with silt
5	378.5–374.5	Sharp, > 1 mm	Upwards darker, olive-green lime gyttja
6	374.5–373.5	< 1 mm	Gyttja with interacting bands in olive-green and whitish-grey shades
7	373.5–373.2	Sharp, < 1 mm	Grey-brown peat or assembled peat detritus
8	373.2–372.0	Sharp, < 1 mm	White calcareous gyttja
9	372.0–371.5	Sharp, < 1 mm	Grey-brown peat or assembled peat detritus
10	371.5–370.5	Sharp, ± 1mm	Olive-grey calcareous gyttja
11	370.5–368	>1 mm	Dark grey lime gyttja with silt and Characeae bands
12	368–366	Very sharp	Grey, partly calcareous gyttja with silt and Characeae bands
13	366–364	–	Whitish-grey sand and silt

In Pi 4 signs of erosion were recorded in units 4 (blackish-brown, heavily decomposed, very compressed peat, sharp boundary at 378.5 cm), 5 (olive-green lime gyttja with silt and sand particles, very compressed, sharp boundary at 374.5 cm), 7 (grey-brown peat or assembled peat detritus, sharp boundary at 373.2 cm), 8 (white calcareous gyttja, sharp boundary at 372.0 cm), 9 (grey-brown peat or assembled peat detritus, sharp boundary at 371.5 cm), 10 (olive-grey calcareous gyttja, sharp boundary at 370.5 cm), and 12 (grey, partly calcareous gyttja with silt and Characeae bands, very sharp boundary at 366 cm) (Table 2).

BIO- AND CHRONOSTRATIGRAPHY

Pitkasoo 3 (Figs. 3–6)

The lower mineral deposits seems to contain redeposited pollen; *Betula* is high and *Pinus* is low. The charcoal curve frequency is high in the bottom part, possibly due to outwash from the till (Fig. 6). A high *Betula* curve is exchanged for high *Pinus* values in the lowermost gyttja (unit 1) and peat (unit 2). Some other plants show an abundance too, like the members in the dwarf bushes (Fig. 3). Some of the varia minor and varia major pollen show the same trends like Cyperaceae, Gramineae, Polypodiaceae, Asteraceae liguliflorae, and *Equisetum* (Fig. 5). The preceding gyttja (unit 3) has a very impressive *Betula* curve with a subsequent drop in *Pinus*. At the same time a drop in the dwarf bushes occurs together with minima in almost all other curves. *Filipendula* starts continuously. The diversity of nonarboreal (NAP) taxa is high.

Pinus increases again in the peat (unit 4) on the expence of *Betula* which later becomes exchanged for a rapidly dropping *Pinus* (Fig. 3). The dwarf bushes are low and *Artemisia* increases. At the same time there is a succession of *Filipendula–Galium* and Cyperaceae, after which Gramineae and *Betula* increase towards the unit border where *Pediastrum* and *Botryococcus* increase too. A high charcoal curve starts just at the upper unit limit (Fig. 6).

The upper part of the diagram (units 5–12) shows a general growth in the xerophytic plants, but after the expected *Alnus* level they decrease again. The diversity is high but diminishes with the *Alnus* immigration, whilst the curves of *Ulmus* and *Betula* are rising.

Interpretation

The lower gyttja (unit 1) exposes high *Pinus* values and also abundant pollen from the dwarf bushes. Increasing values for Cyperaceae, *Equisetum*, and Gramineae have been interpreted as coming from the pond where gyttja was forming. The lower peat layer (unit 2) shows increasing birch growth but the pine curve is very high initially. Most probably the peat was formed near an open

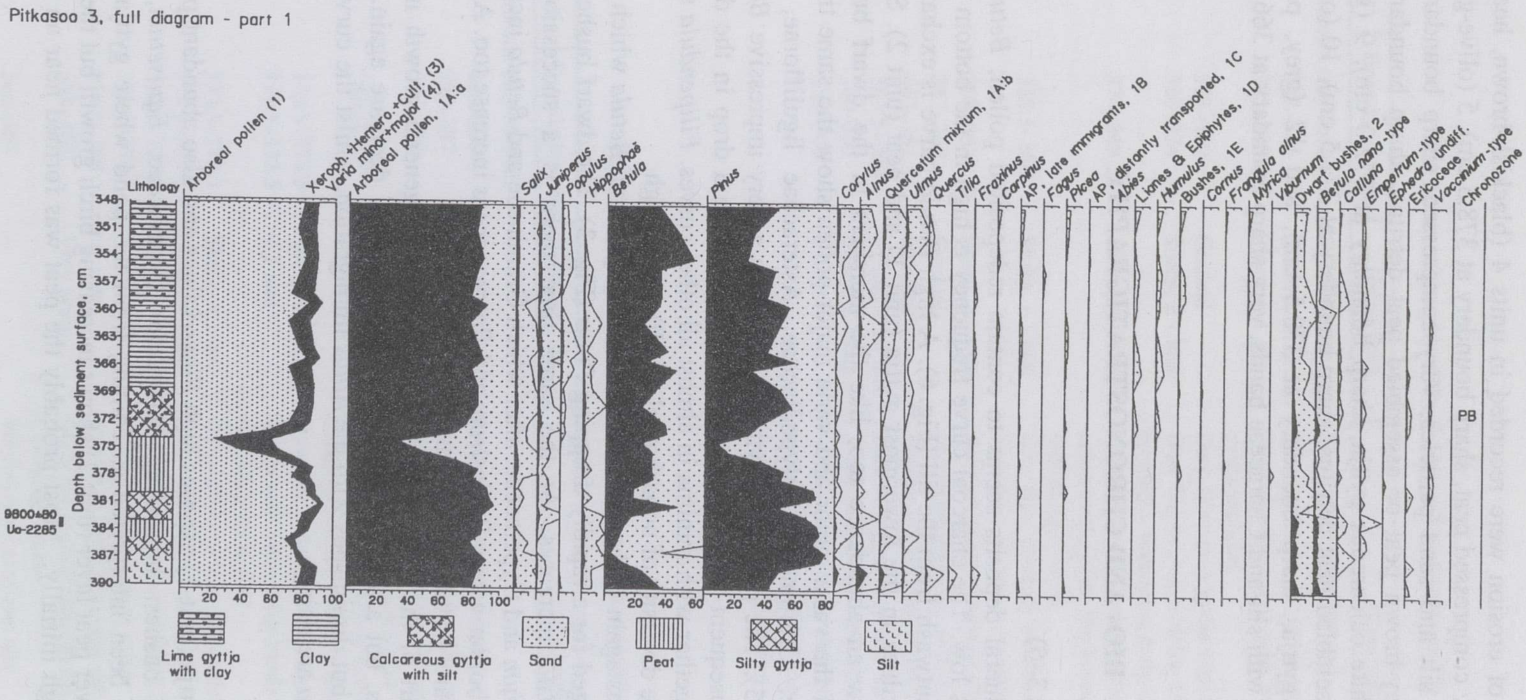

Fig. 3. Full pollen diagram of the Pitkasoo Bog (Pi 3, core 17). Part 1 – arboreal pollen and dwarf bushes.

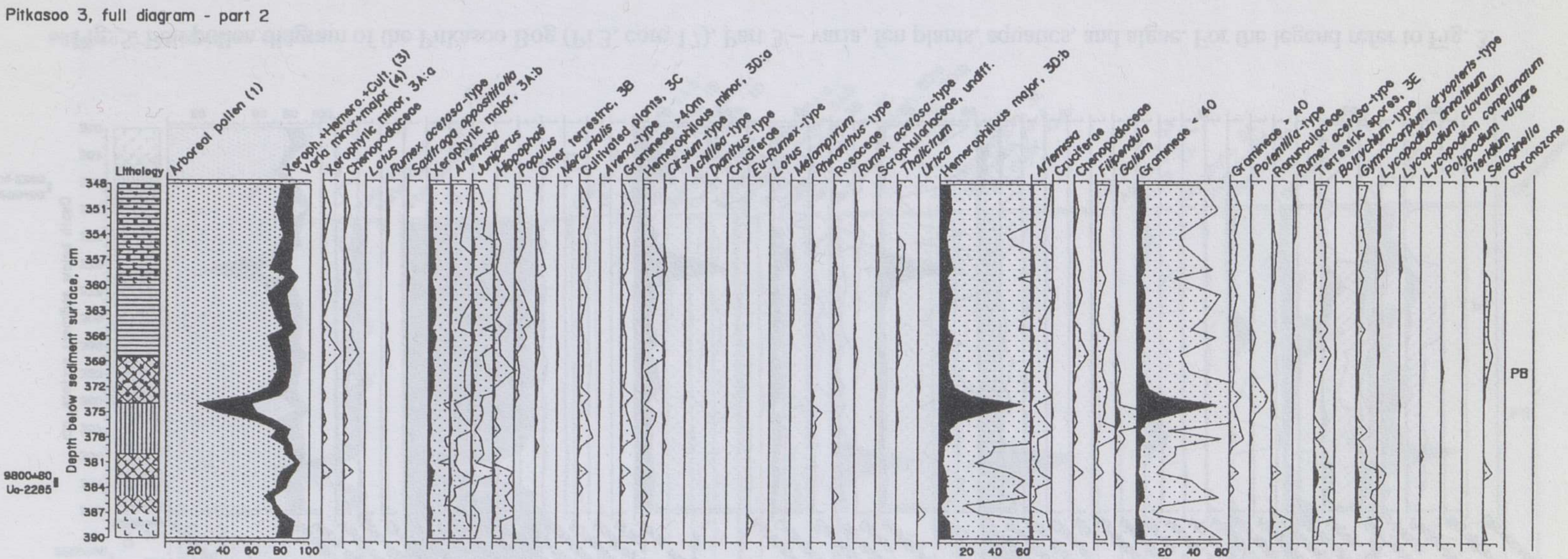

Fig. 4. Full pollen diagram of the Pitkasoo Bog (Pi 3, core 17). Part 2 – terrestrial nonarboreal pollen. For the legend refer to Fig. 3.

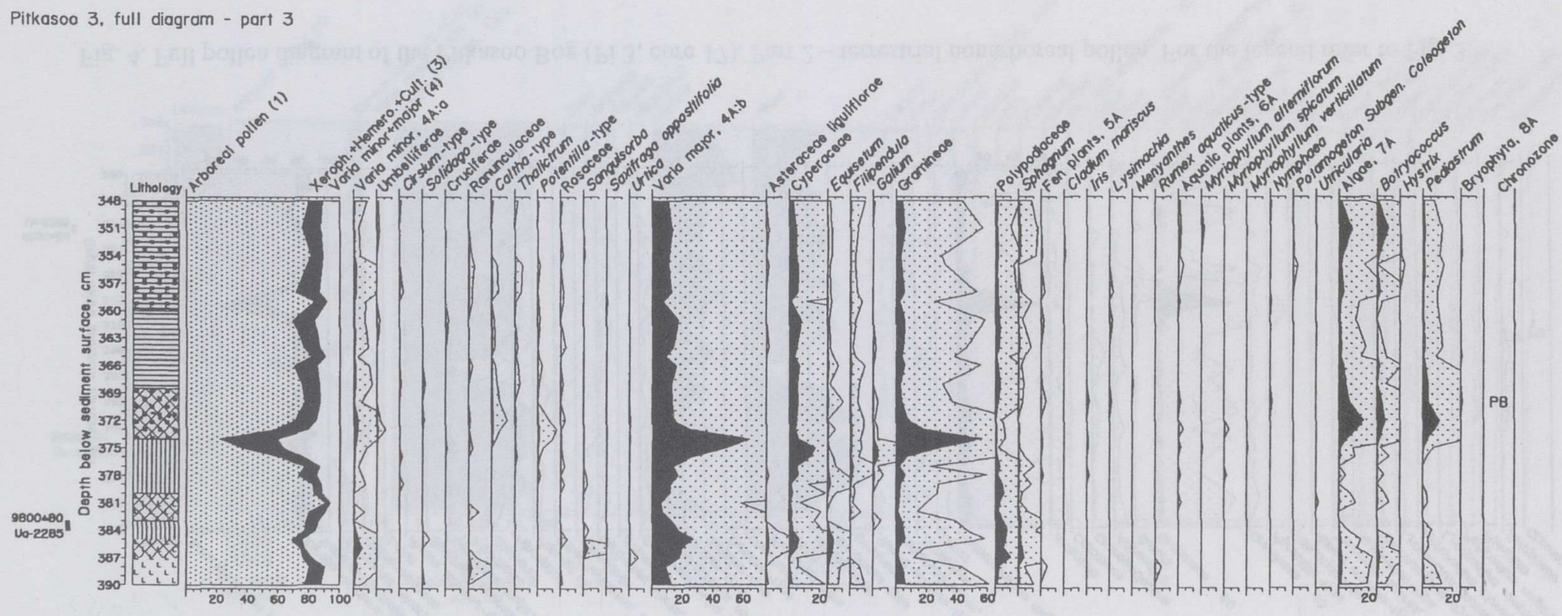

Fig. 5. Full pollen diagram of the Pitkasoo Bog (Pi 3, core 17). Part 3 – varia, fen plants, aquatics, and algae. For the legend refer to Fig. 3.

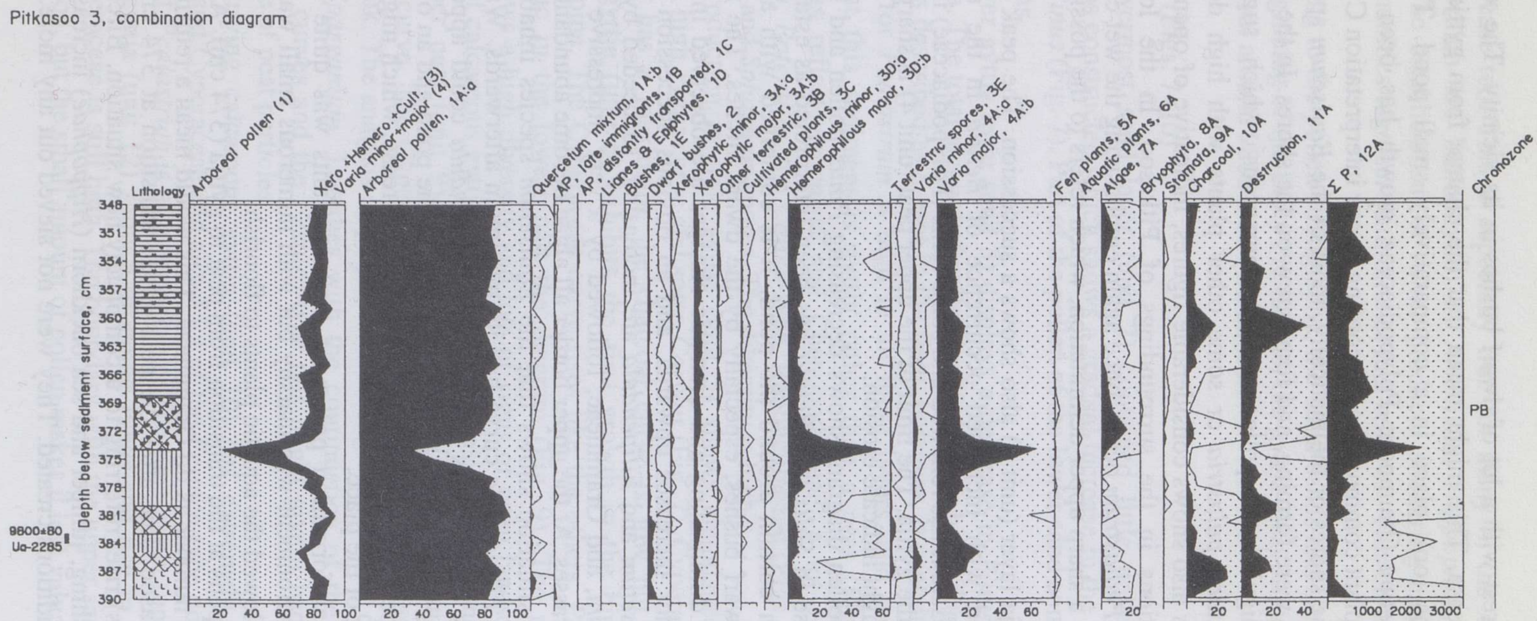

Fig. 6. Combination diagram of the Pitkasoo Bog (Pi 3, core 17). For the legend refer to Fig. 3.

pine-dominated forest with a lot of dwarf bushes in its vicinity. The xerophytic major curves increase. This might mean that the change from gyttja to peat-forming conditions took place in a comparatively small pond. The initial Cyperaceae–*Equisetum*–Gramineae–Polypodiaceae growth has been a natural succession of wet plant communities. According to our interpretation Cyperaceae was growing on the shores or thelmatically, most of the *Equisetum* spores grew in the water, reeds were forming, and ferns grew on the shores. In the beginning also Asteraceae liguliflorae pollen is quite numerous, which suggests the presence of *Taraxaca palustria* or some other plants with high demand of wetness. *Juniperus* also shows considerable figures, indicative of open and light demanding conditions in the surroundings of Pitkasoo. In the lower peat *Botryococcus* and *Pediastrum* occur, once again emphasizing the wet conditions. The peat layer has a sharp upper delimitation, which refers to the possibility of a hiatus.

The upper gyttja layer (unit 3) also shows a succession. The peak in growth may be correlated with increased occurrence of *Betula* in the area. The succession of *Equisetum* has renewed and some ferns (Polypodiaceae) increase in the upper parts of the gyttja. The limit of the upper peat (unit 4) is sharp and very irregular, which might indicate erosion.

Upwards the pollen diagram shows decreasing *Pinus* pollen and increasing *Betula*. Coeval rise in *Salix* and *Betula* has been interpreted as establishment of a willow–birch curtain around the pond. It is combined with a decrease in the curve by dwarf bushes, especially by the dwarf birches. The xerotherm vegetation is also diminishing and dramatic changes are observed in the varia curves. Varia minor increases upwards, and an obvious succession occurs in varia major: *Equisetum* and *Filipendula* are increasing, succeeded by a rise in Cyperaceae, *Galium*, and Gramineae, followed by a very impressive growth in the spontaneous grasses. At the upper border all algae become abundant.

The described situation shows that the *Equisetum* species inhabited drier areas and that the *Filipendula* curve had its maximum afterwards. Water-living *Equisetum* species became less frequent and *Filipendula* could appear in the marshy zones. This gives evidence of a drying up of the pond and an overgrowth of it. Then the Cyperaceae and the *Galium* species increase, which might refer to a continued drying of the place.

During the peat formation pollen of aquatic plants was quite abundant. Obviously, the environment was marshy but with numerous small water bodies included, which allowed the aquatic plants to flourish.

Something happens at the transition from peat to gyttja (374 cm). Algae show a great increase in number as do Gramineae. This would mean a return of wetter conditions to Pitkasoo. Just after the peat–gyttja transition at 374 cm, birches (and dwarf birches) rise, referring to a completely new situation. Birches, all of them, were flourishing, juniper and sea buckhorn (*Hippophaë*) increased due to the more open conditions created. They were not sieved out any more. All other curves increase too. This is especially true for many of the xerophytic curves (most of which are heliophytic) as *Artemisia*, *Hippophaë*, *Juniperus*, and *Populus*. The establishment of *Alnus* produces sheltering and sieving through plant communities together with birches and willows. This changed the situation again.

According to the pollen stratigraphy, the basal sands and silts were formed at the very beginning of the Early Pre-Boreal, the gyttja–peat sequences also during the Pre-Boreal around 9800 ± 80 (Ua-2285).

Pitkasoo 4 (Figs. 7–10)

The lowermost sand layer (unit 2) contained little pollen. Anyway, the diagram was constructed which shows a gradual increase in the *Betula* curve and very high *Pinus* (Fig. 7). Part of the pollen of the lower sand contains redeposited pollen grains.

The lower gyttja layer (unit 3) displays a decrease in *Pinus* pollen and high birch pollen. The total amount of pollen in this layer is high. The lower peat layer (unit 4) was described as a peat in the field, however, it contains a lot of gyttja. The curve for *Pediastrum* is high in all those layers, and one may therefore suggest that this sediment is gyttja rather than a peat (Fig. 9). The close surroundings reflect *Artemisia* and Chenopodiaceae, a lot of dwarf bushes, *Filipendula*, *Potentilla*, the *Caltha*-type, Ranunculaceae (Figs. 8, 9), and some *Selaginella* and *Sphagnum* spores. The diversity is high.

The introduction to lime gyttja (unit 5) shows abundance of pollen too, especially a high *Pinus* curve and some *Corylus* (Fig. 7). Cyperaceae is common. *Pediastrum* has a maximum, the charcoal curve is low but increasing. The overlying gyttja (unit 6) exhibits the first growth in the birch curve and a decline of pine. The Cyperaceae curve rises like the others. *Pinus* stomata are characteristic in the lowest part the diagram (Fig. 9). The next peaty layer (unit 7) shows a high diversity and lots of signs of open landscape. The pollen frequency of calcareous gyttja (unit 8) also emphasizes open conditions.

The upper peat (unit 9) has an impressive *Betula* and an extremely high Gramineae curve. The Cyperaceae and *Pediastrum* are abundant and there is a charcoal peak. The analysis displayed a rather high and further developing curve of *Typha–Sparganium*. Together with the continuation of the Gramineae and Cyperaceae curves and the *Festuca*-type this might give a background for the assemblance of peat particles.

The overlying calcareous gyttja (unit 10) has extremely well developed Gramineae and Cyperaceae and also a lot of the *Festuca*-type pollen (Figs. 8, 9). The share of *Pediastrum* is also remarkable. The lime gyttja (unit 11) and upper calcareous gyttja (unit 12) show a dropping *Pinus* and rise in almost all other curves. Cyperaceae is still high. The boundary with the upper sand contains a lot of information, but the small amount of pollen makes it less valuable.

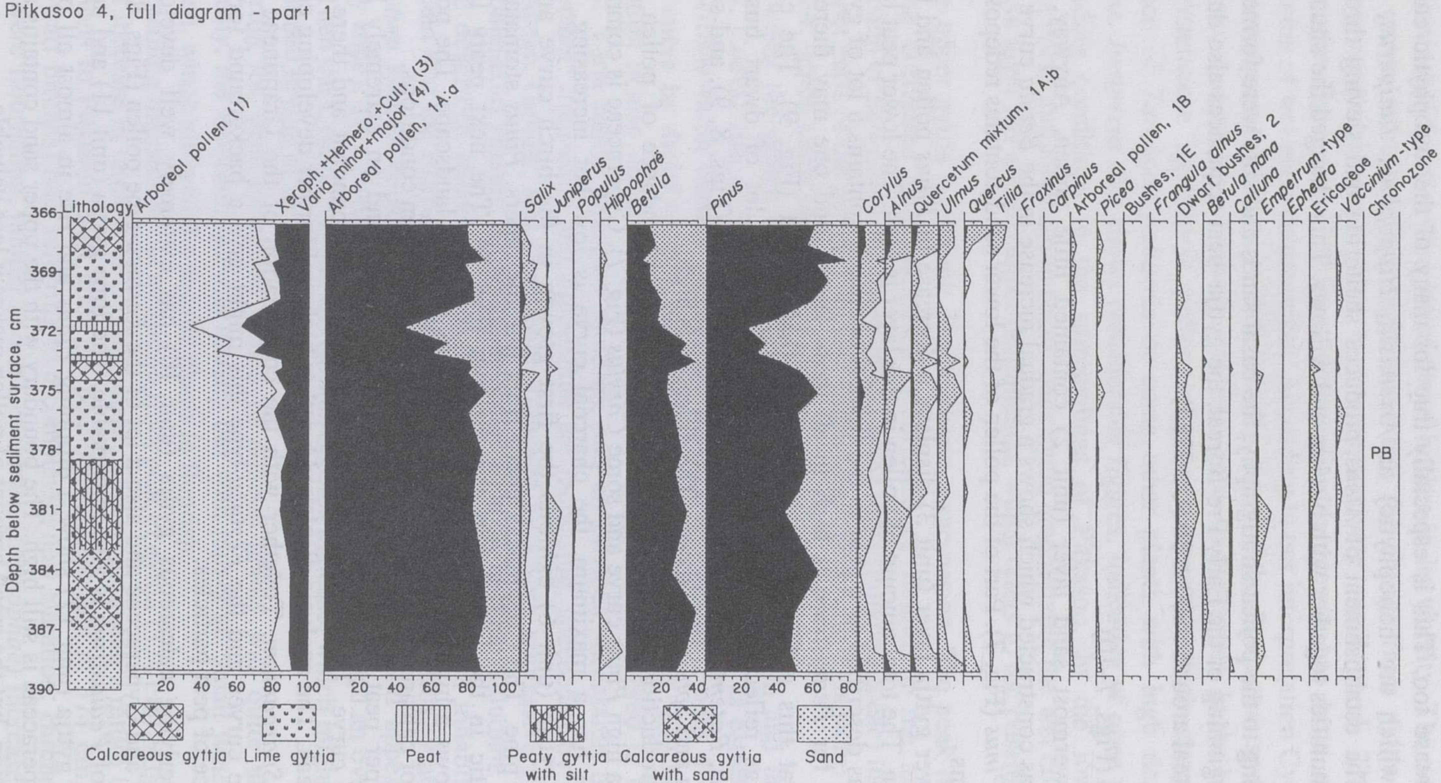

Fig. 7. Full pollen diagram of the Pitkasoo Bog (Pi 4, core 19). Part 1 – arboreal pollen and dwarf bushes.

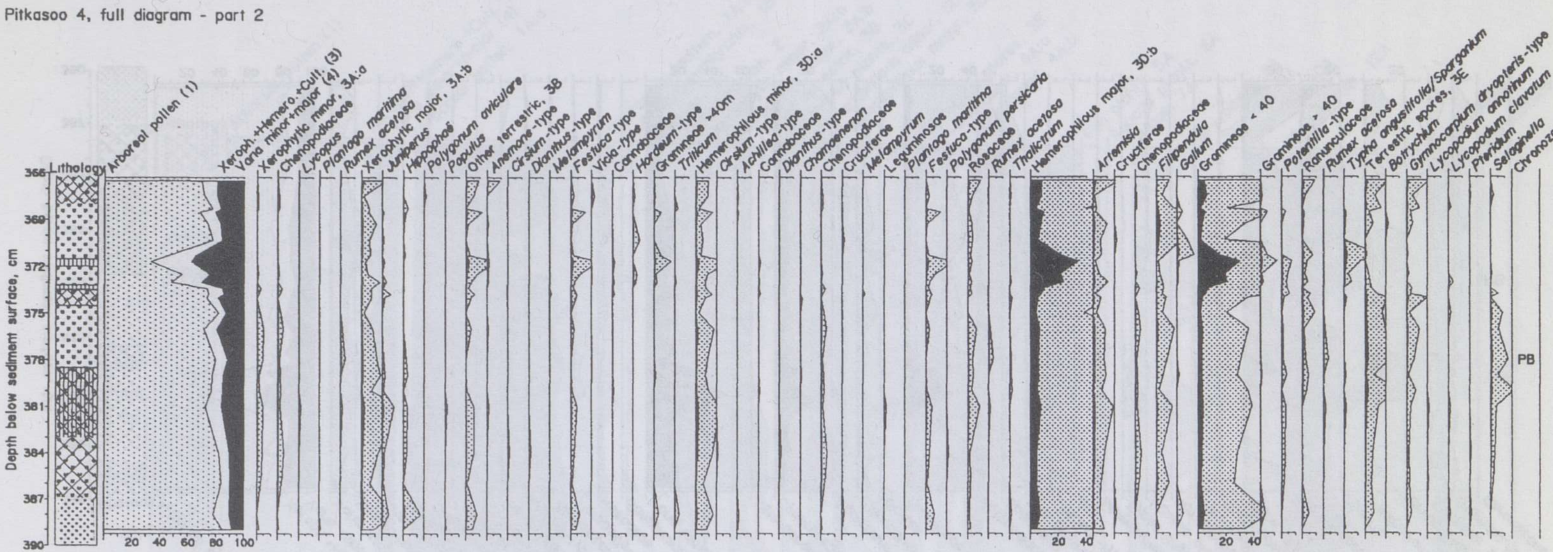

Fig. 8. Full pollen diagram of the Pitkasoo Bog (Pi 4, core 19). Part 2 – terrestrial nonarboreal pollen. For the legend refer to Fig. 7.

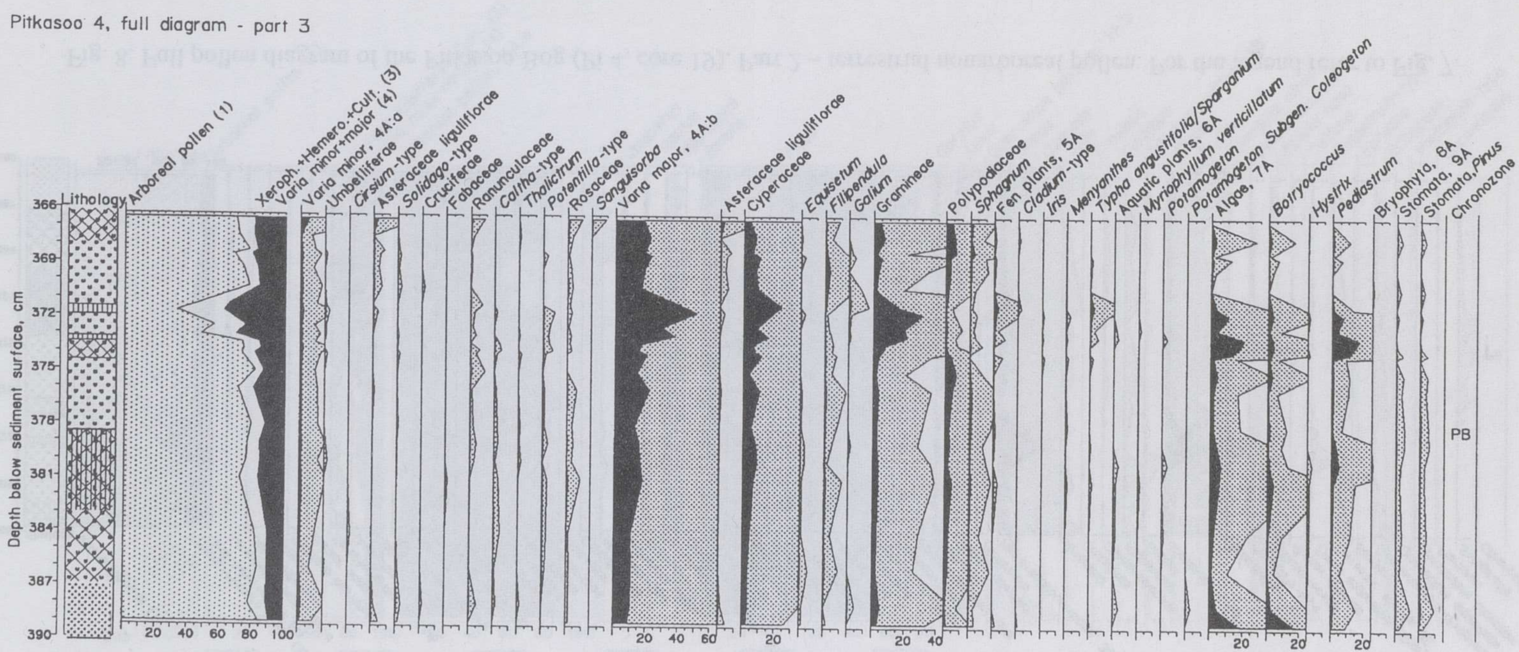

Fig. 9. Full pollen diagram of the Pitkasoo Bog (Pi 4, core 19). Part 3 – varia, fen plants, aquatics, and algae. For the legend refer to Fig. 7.

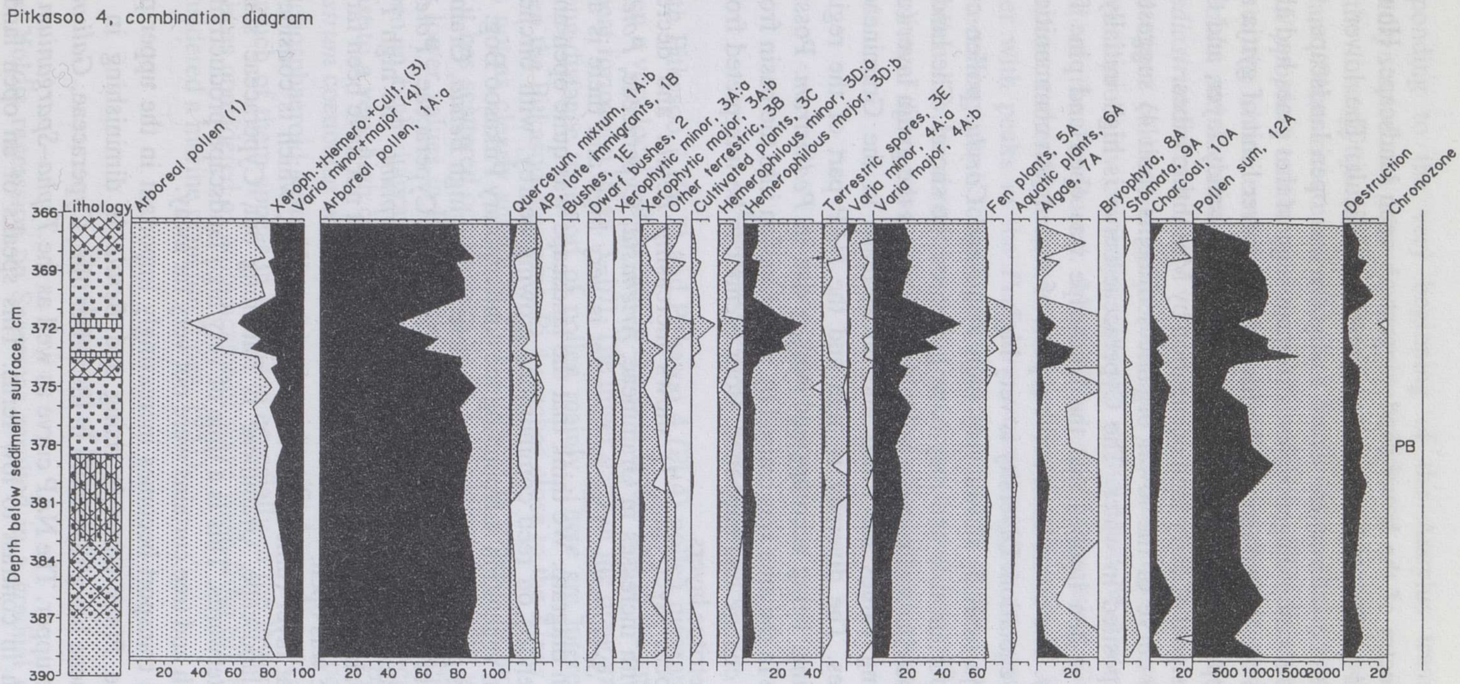

Fig. 10. Combination diagram of the Pitkasoo Bog (Pi 4, core 19). For the legend refer to Fig. 7.

Interpretation

The pollen spectra of the lower sand suggest an open landscape. However, much redeposited pollen makes the interpretation difficult. The lower gyttja (unit 3) comprises the information about a slightly less open landscape, which can be seen in the relation diagram. *Pinus* stomata suggest that pines had already started to grow in the West Saaremaa Upland. At the lower limit of gyttja a high charcoal curve appears which may be connected with a sandy layer, and thus is not necessarily a signal of early land occupation by Mesolithic tribes.

A *Pediastrum* curve of the lower organic sediments (unit 4) suggests that the layer was deposited in water. The Cyperaceae curve is high initially. The increasing *Pinus* pollen implies that the landscape was open and pine forests were not far away. The dwarf bush curve reports of some heath communities still important in the vegetation. Diversity is very high.

The lime gyttja (unit 5) shows very high *Pinus* and *Corylus* pollen curves. Ferns had an important role and may have grown on the shores. The landscape was still open. The charcoal curve is quite high. Upwards the gyttja layer (unit 6) exposes decreasing values for *Pinus* and an increase in the Gramineae and Cyperaceae curves. The diversity is high and the NAP part of the registered pollen is increasing, being accompanied with a rise in *Pediastrum*. Possibly a ground water rise in the area was caused by an ingression into the basin from the sea or a climatic change had happened. Both events can be interpreted from the assembled peat detritus layers.

The middle peat layer (unit 7) shows increasing *Betula* and decreasing *Pinus* together with increases in Gramineae, *Artemisia*, Cyperaceae, *Potentilla*, *Ranunculus*, and *Selaginella*. The *Pediastrum* is very high and there is a NAP rise in the relation diagram. We think that the landscape was quite open and that peaty layers depended on reed communities growing nearby, with birches and willows as curtain vegetation surrounding the contemporary Pitkasoo Bog.

The calcareous gyttja layer (unit 8) is characterized by high *Betula*, Gramineae, and *Artemisia* curves which appeared together with Cyperaceae, *Potentilla*, *Ranunculus*, Rosaceae, the *Festuca*-type, and *Gymnocarpium*. The high *Typha–Sparganium* probably gives the hint that the shores might not have been far away and the landscape was open.

The upper peat layer (unit 9) shows a high diversity, which is considered to reflect an open landscape. Gramineae is flattening out, Cyperaceae starts its maximum just afterwards. This is a time of very high landscape productivity, the reeds and the bush and tree curtains were not very far away.

Long-distance transport becomes increasingly important in the upper part of the diagram. The *Pinus* curve is rising and *Betula* is diminishing in gyttja (unit 10). Gramineae has a maximum in the lower unit, Cyperaceae, *Galium*, and *Filipendula* in the upper. The NAP curve as well as the *Typha–Sparganium* curve is extremely high in contrast to low ferns. This speaks of an open landscape corresponding to the very beginning of the Ancylus transgression which assumedly started as a ground water rise at Pitkasoo.

In the lime gyttja (unit 11) long-distance and regional pollen transport is important. *Pinus* rises even more and *Betula* drops throughout the gyttja unit. Some *Hippophaë* exhibit a rise, as does willow. The diversity is low, which refers to the shore environment and includes *Artemisia* (initially), *Galium*, *Filipendula*, and Asteraceae liguliflorae. Polypodiaceae, *Gymnocarpium dryopteris*, and *Pediastrum* increase.

The upper calcareous gyttja (unit 12) indicates high *Pinus* and low *Alnus*. This level probably coincides with the introduction of *Alnus* to Saaremaa at the end of the Pre-Boreal. Much *Hippophaë*, increasing Gramineae, stable Cyperaceae, rather high Asteraceae liguliflorae, and a lot of *Sphagnum* spores together with peaks in the *Pediastrum* curve suggest an open landscape (the mire) receiving much long-distance transported and regional pollen. Only very few pollen has been registered in the topmost sand (unit 13). This gives an impression of the ingressive landscape and the final Ancylus transgression.

DISCUSSION

Comparison of pollen diagrams

Both Pitkasoo 3 (Pi 3) and Pitkasoo 4 (Pi 4) pollen diagrams show changes between a very local pollen rain in the peat layers and in the small ponds before each peat formation (Figs. 3–10). The upper parts of the diagrams reveal regional and long-distance transport of pollen mainly. There are interesting differences between the Pitkasoo diagrams. Pi 4 reaches close to the *Alnus* immigration, but this is not as clearly shown in Pi 3. *Corylus* is present in most parts of Pi 4, while it has scattered occurrences in Pi 3. *Juniperus* has high values in Pi 3 but shows lower values in Pi 4. Almost continuous high frequencies of *Hippophaë* are seen in both diagrams. Some few *Betula nana* occurrences found in Pi 4 contrast to a very high curve in Pi 3. The lower peat layer in Pi 3 has almost no *Pediastrum* coenobiae whilst much *Pediastrum* occurs in the peat layers in Pi 4. Hystrichosphaeroid cysts (*Hystrix*) were identified in one analysis in Pi 3 while quite much of them appear in Pi 4, and especially in the lower parts. *Hystrix* is sometimes considered as an indicator of wave wash from till, but might as well be considered a marine plankton (Fries, 1951).

Development of landscape

The Yoldia regression on Saaremaa resulted in a gradual drop in sea level between the glaciofluvial ridge and the slope of the upland. First the lagoon, then an isolated lake was formed, which due to gradual water level lowering turned into a small pond. Under clayey deposits peat and gyttja accumulated twice and there are evidences of limnic conditions later on. The organic layer is underlain by sand and gravel which rest directly on the washed till. A lower peat at 385 cm is dated to 9800 ± 80 BP (Ua-2285). The originally marine plankton *Hystrix* (Hystrichosphaeroid cysts) was identified and several shore plants appear. Possibly two ground water rises occurred before the lake became overgrown by thelmatic fen vegetation. The upper peat limit at 21.5–22.5 m roughly estimates the lowest Yoldia level here. As the Yoldia maximum shore displacement is at 32 m, this yields a magnitude of the Yoldia regression of some 10–11 m.

The earliest part of the Ancylus transgressional sediments were identified as clay overlain by a peat–gyttja bed. Contemporaneously with the clay deposition, a huge spit, 3 km in length and 100–150 m wide was formed east of Pitkasoo. It is one of the most representative Ancylus transgression formations on Saaremaa Island (Kessel & Raukas, 1967). Spit texture and structure show that the Pre-Ancylus glaciofluvial ridge occurring in the core of the spit was covered by beach deposits with a mollusc fauna, containing *Limnaea peregra*, *Ancylus fluviatilis*, *Pisidium*, and *Bithynia* (Kessel & Raukas, 1967). This spit closed the connection between the lagoon and the Ancylus Lake and dammed up the lake in the Pitkasoo basin with a threshold elevation of about 27.5–28.0 m. The lake was larger and lasted longer than the previous one. First lime gyttja, then gyttja was deposited, both rich in macroremains, indicating that the lake was filling up with sediments.

The Ancylus transgression started about 9600–9500 BP, which is in good accordance with the records obtained from the other parts of Estonia (Heinsalu & Veski, 1991; Saarse et al., 1990, 1997) and also from the neighbouring countries (Berglund, 1964; Königsson, 1968; Eronen, 1976; Eronen & Haila, 1982; Svensson, 1989, 1991; Björck, 1995; etc.).

Judging by the elevation of the Yoldia Sea minimum and the Ancylus Lake maximum water level, sea level rose about 8 m during the Ancylus transgression and reached 30 m a.s.l. The duration of the Ancylus transgression is not exactly dated as the isolation contact lies between clay and lime gyttja. However, according to regional pollen stratigraphy (Saarse et al., 1990, 1994; Saarse & Königsson, 1992), the *Betula* PAZ is dated to 9500–9000 BP (Raukas et al., 1995). So, the lime gyttja presumably started to accumulate around 9000 BP. A similar date has been derived from the Järvesoo Bog sequence (Saarse, 1994). Järvesoo is also an ancient Ancylus lagoon, located 2 km southwest of Pitkasoo and having a similar development. The radiocarbon date of 8800 ± 80 BP (TA-782) from lacustrine lime near the isolation contact at Järvesoo defines the age of the isolation during the Ancylus regression. By that time the Ancylus transgression was over and its level had decreased to the Järvesoo threshold at 27.5 m a.s.l.

CONCLUSIONS

1. The Pitkasoo Bog is a transgressional basin with the following sediment lithofacies:

(a) peat and peaty gyttja lacking diatoms (Heinsalu, pers. comm.), formed during the regressional phase of the Yoldia Sea;

(b) Ancylus transgressional spit deposits with typical Ancylus molluscs (Kessel & Raukas, 1967);

(c) transgressional Ancylus lagoonal clay which is rather thick and widespread.

The bedding conditions of these deposits estimate the magnitude of the Yoldia regression as 10–11 m or more and the Ancylus transgression to *c*. 8 m in the vicinity of Pitkasoo.

2. The lower parts of both Pitkasoo pollen diagrams (covering the Yoldia regressional phase) show changes between a very local pollen rain in the buried peat and gyttja layer, because a very small water body was left at Pitkasoo. The upper parts of the diagrams (covering the Ancylus transgressional phase) show regional and long-distantly transported pollen as Pitkasoo became part of a large lake.

3. Pitkasoo was isolated at two times from the Baltic Sea according to the lithostratigraphic records: first during the Yoldia regression at about 9800 BP, and for a second time during the Ancylus transgression before the *Alnus* immigration to Saaremaa.

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PITKASOO – ANTSÜLUSJÄRVEST ERALDUNUD LAGUUN SAAREMAAL

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Pitkasoost leiti hiljuti savikate setete alla mattunud turba- ja järvemudakihid, mille teke algas Joldiamere regressioonil, umbes 9800 aastat tagasi. Need sisaldasid valdavalt väga lokaalset õietolmu, mistõttu ka õietolmuspektrite varieeruvus oli küllaltki suur. Lasuvad savikad setted on kuhjunud Antsülusjärve transgressiooni käigus. Neis sisalduv õietolm on nii regionaalne kui ka kaugsissekandest pärinev. Stratigraafilisele materjalile tuginedes oletatakse, et Pitkasoo isoleerus Läänemerest esmalt Joldiamere regressiooni ajal ja lõplikult Antsülusjärve transgressiooni ajal maakoore neotektoonilise kerke tulemusel. Turba ja järvemuda vaheldumine näitab, et Joldiamere regressiooni ajal tekkinud väikeses järves veetase muutus. Põhjuseks võisid olla kas sademetehulga mõningane suurenemine ja sellega seoses ka põjaveetaseme tõus või siis muutused meretasemes.

БОЛОТО ПИТКАСОО – АНЦИЛОВАЯ ЛАГУНА НА ОСТРОВЕ СААРЕМАА, ЭСТОНИЯ

Ларс-Кёниг КЁНИГССОН, Лейли СААРСЕ и Гёран ПОССНЕРТ

В болоте Питкасоо найдены погребенные под глинистыми отложениями торф и сапропель, формирование которых началось одновременно с регрессией Иольдиевого моря, примерно 9800 лет т. н. В органогенных отложениях преобладают пыльца и споры местных растений. Накопление покрывающих органогенные отложения глин происходило во время трансгрессии Анцилового озера. Эти отложения содержат пыльцу не только регионального характера, но и привнесенную извне. Стратиграфический материал подтверждает вывод о том, что изоляция Питкасоо от Балтийского моря началась в ходе регрессии Иольдиевого моря и завершилась во время трансгрессии Анцилового озера, произошедшей в результате поднятия земной коры. Чередование сапропеля и торфа в отделившемся от моря озере указывает на изменение в нем уровня воды в раннем пребореале. Причина кроется либо в увеличении осадков, а значит, и в повышении уровня грунтовых вод, либо в изменении уровня моря.