TRANSITION AND CHANGE IN POLLEN DIAGRAMS AND POLLEN-CHARCOAL DIAGRAMS AT AND AROUND THE ATLANTIC/SUBBOREAL BORDER

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ABSTRACT

Three ^{14}C-dated pollen diagram sections which start during Late Atlantic Time are presented and compared with each other. Two of the diagrams are from western Östergötland - the large Dags Mosse bog and the extremely small kettle hole at Nässja - while the third diagram is from Lake Bjärsjöholmssjön in southernmost Scania. In the Nässja diagram not only pollen but also macrofossils (charcoal, seeds) are registered in the lowermost part. In this kettle hole the sedimentation started during the Late Atlantic (charcoal of burnt *Tilia* stems has been found and dated) and accelerated at or above the elm-decline level: charcoal particles of burnt stems of *Betula*, *Corylus*, *Alnus*, *Salix*, Pomoideae, *Tilia* and *Quercus* were deposited during the Early Subboreal. The Scanian early subboreal "index horizons" found in Lake Bjärsjöholmssjön are easy to observe and fix also in the Dags Mosse diagram. These index horizons are synchronous from Scania in the south to Östergötland in the north - and very likely over much larger areas (from Ireland in the west into, not unlikely, western Russia in the east). Thus the vegetational changes between the elm-decline level (5150 BP) and the beginning of the Regeneration (4500 BP) ought to be caused by factors lying beyond man's control. It is also demonstrated that the "sudden" rise of the *Betula* curve in Lake Bjärsjöholmssjön is not a reflection of a "very early landnam" in this area. This "sudden" spread of birch is nothing but an illusion - the sedimentation stopped for some decades above the elm-decline level.

Introduction

Two sections of two new ^{14}C-dated pollen diagrams - one from southernmost Scania (Lake Bjärsjöholmssjön) and one from western Östergötland (the Dags Mosse bog) - are presented and compared with each other (fig 1 and fig 2). The diagram sections cover the period from the latest part of Atlantic Time up to the middle part of Early Subboreal Time (fig 2). The ^{14}C-dates from the Dags Mosse bog presented in figure 2 are correct while all the dates from Lake Bjärsjöholmssjön are about 220 years too old because of the hard-water effect.

The complete diagrams from the Dags Mosse bog and from Lake Bjärsjöholmssjön are presented elsewhere (Göransson 1989, Göransson 1991).

Another diagram - a ^{14}C-dated combined pollen-charcoal-seed diagram from an extremely small kettle hole at Nässja (fig 3) - 20 km north of the Dags Mosse bog - is discussed and compared with the Dags Mosse diagram. The bogs Mabo Mosse and Ageröds Mosse are mentioned in the text and marked on figure 1, but no diagrams from these sites are presented here.

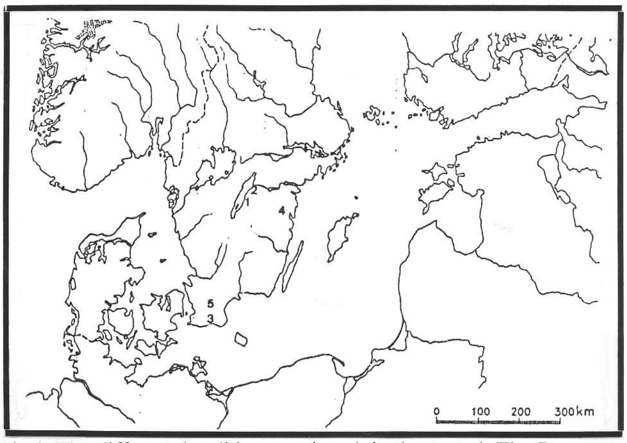

Fig 1. The different localities mentioned in the text. 1. The Dags Mosse bog. 2. The kettle hole at Nässja. 3. Lake Bjärsjöholmssjön. 4. The Mabo Mosse bog. 5. The Ageröds Mosse bog.

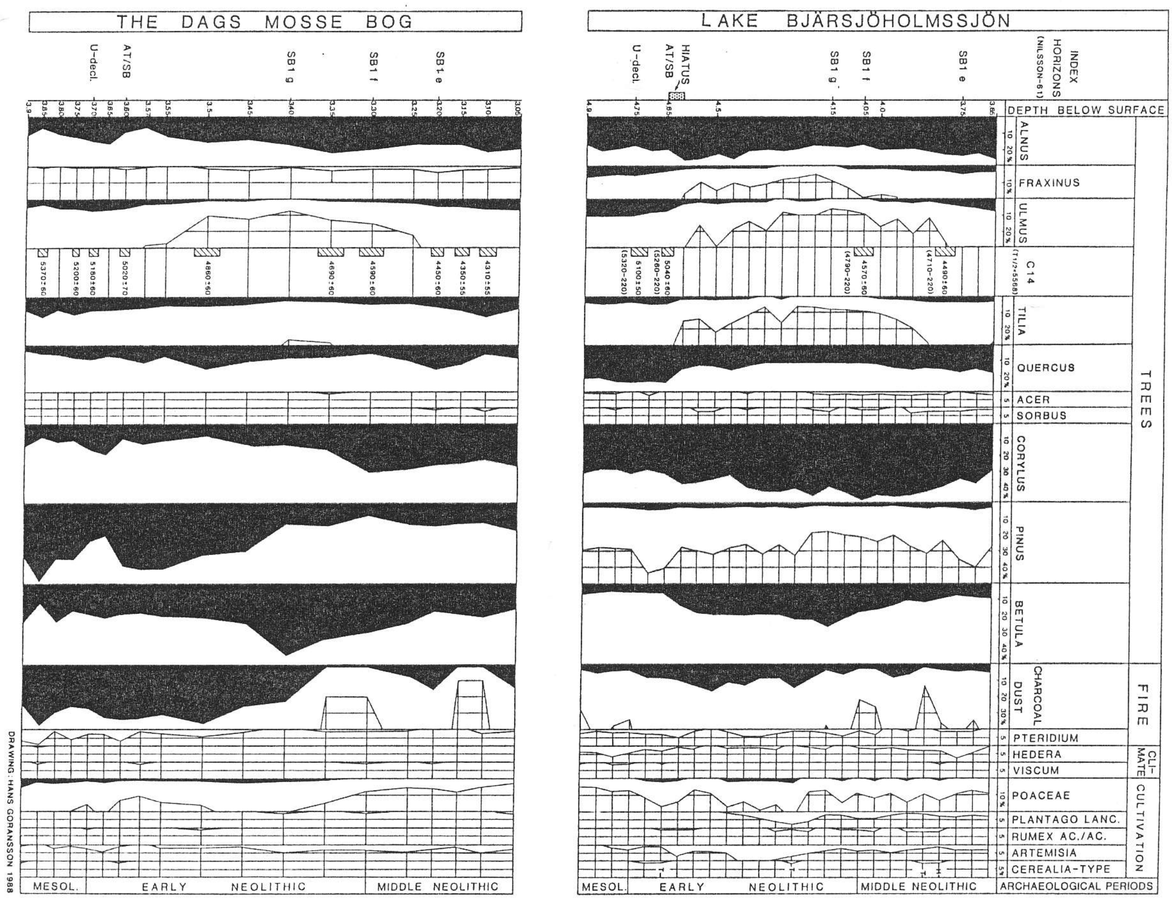

Fig 2. The pollen diagram sections from Lake Bjärsjöholmssjön and the Dags Mosse bog.

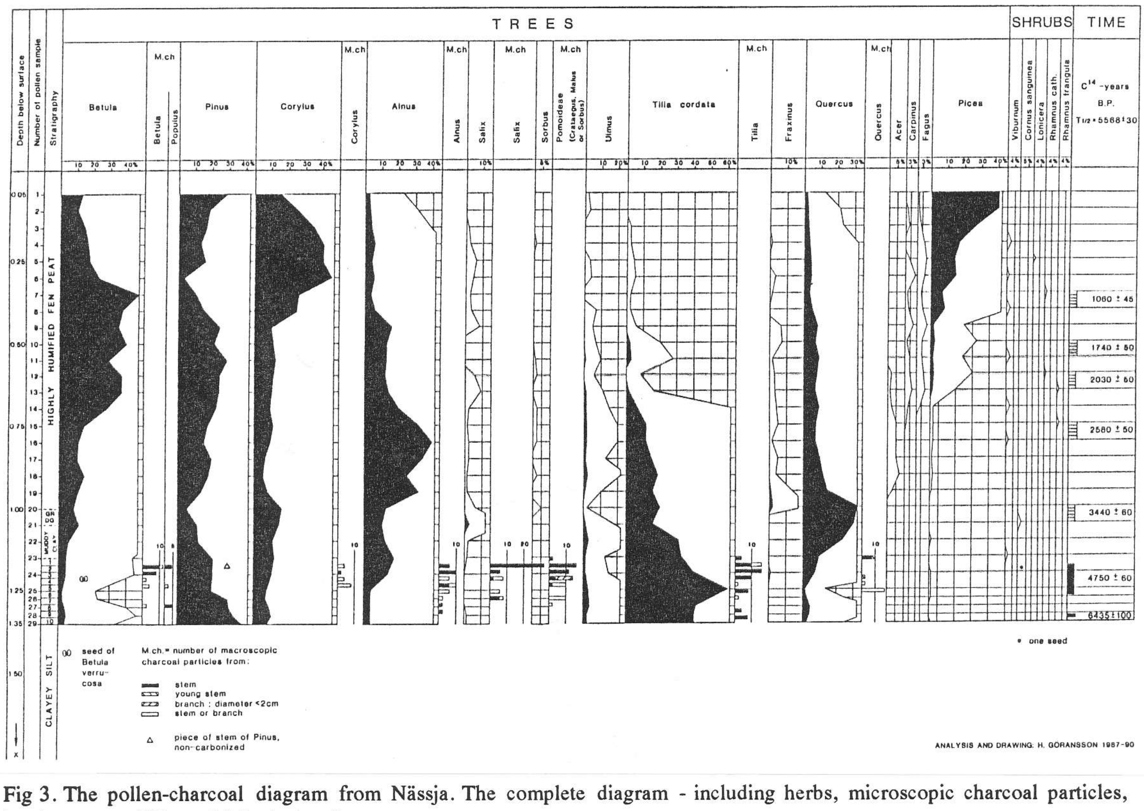

Fig 3. The pollen-charcoal diagram from Nässja. The complete diagram - including herbs, microscopic charcoal particles, beetles etc - will be published elsewhere.

The relation between the three basins

The relation between the three pollen-analysed basins is seen in figure 4. The diameter - D - of the Dags Mosse basin (bog + surrounding fens) is about 5 km (= "large"). The diameter of the Lake Bjärsjöholms-sjön basin is D/10 (="less than medium-sized") and the diameter of the kettle hole at Nässja is D/200 (= "extremely small") (invisible in fig 4).

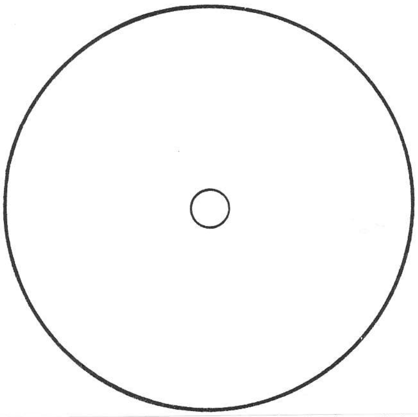

Fig 4. The relation between the basins of the Dags Mosse bog, Lake Bjärsjöholmssjön and the extremely small kettle hole at Nässja.

Lake Bjärsjöholmssjön and the Dags Mosse bog

We begin our study by comparing the diagram sections - from Lake Bjärsjöholmssjön and from the Dags Mosse bog - presented in figure 2. As mentioned, the two sections begin at the latest part of the Atlantic and end in the middle part of the Early Subboreal.

We first look at the diagram section from Lake Bjärsjöholmssjön. In the left column the elm decline (U-decl.), the atlantic-subboreal border (AT/SB) (after Nilsson 1961*) and the early subboreal index horizons SB1 g, SB1 f and SB1 e are seen. Most of these levels were dated in the Ageröds Mosse bog, 65 km NNW of Lake Bjärsjöholmssjön (Nilsson 1964). The same levels were dated in Lake Bjärsjöholmssjön (Göransson 1991). As mentioned, the dates from the lake are about 220 years too old because of the hard-water effect. By reducing the ^{14}C-values from Lake Bjärsjöholmssjön by 220 years almost correct dates are obtained.

*Nilsson placed the elm-decline horizon in his diagrams at a level where *Ulmus* has already attained low frequency (at AT/SB). The present author and most modern researchers fix the elm decline at the very level where the accelerating fall of the *Ulmus* curve **starts**. A sample with its heavy point 2.5 cm **above** this "modern" elm decline was dated in Lake Bjärsjöholmssjön. The elm decline proper ought to be c 50 years older than the level dated in Lake Bjärsjöholmssjön, that is 5150 BP (5370 - 220 ^{14}C-years).

It is demonstrated - in figure 2 - that the pollen-analytical levels discussed above for Lake Bjärsjöholmssjön are easy to observe and fix also in the Dags Mosse diagram - 300 km(!) north of Lake Bjärsjöholmssjön. The different tree species are, however differently reflected in these two pollen diagrams, that is, the percentage values diverge. Thus, for instance, ash (*Fraxinus*) attains 20 times as high values in Lake Bjärsjöholmssjön as in the Dags Mosse bog. Besides reflecting pedological conditions and different size of the two basins this is a reflection of the two sites being situated in different geographical regions.

The pollen-analytical levels discussed have got the same ^{14}C-dates in the Dags Mosse bog as in the Ageröds Mosse bog. These levels are thus synchronous from Scania in the south to Östergötland in the north. We know that the elm decline starts ca 5150 BP over the whole of Northwest Europe. It seems as if the early subboreal pollen-analytical levels discussed here are synchronous over very large areas.

The horizon SB1 g - dated to 4750 BP in the Mabo Mosse bog (fig 1) - which is characterized by the very *Ulmus* minimum after the elm decline is found also in western Russia and eastern Latvia. While in south Scandinavia birch (*Betula*) has a maximum at this level, spruce (*Picea*) has a maximum at this horizon in this part of Eastern Europe (Levkovskaja pers.comm.). No "landnam" could cause these changes in this part of Europe. A climatic "disturbance" of some kind very likely lies behind the changes between the elm decline and the Regeneration Phase (see below) and the forests are affected over hundreds of thousands of km^2. That is why the early subboreal pollen-analytical levels are synchronous and easy to observe in pollen diagrams from different regions.

The "early-landnam" illusion

Iversen suggested a very "early landnam" in southern Scania, Zealand and Ireland (Iversen 1973:87). He observed an "earlier" rise of the *Betula* curve in these areas than in other areas. This "too early" - or abrupt - rise of the *Betula* curve is observed in Lake Bjärsjöholmssjön. The sedimentation obviously **stopped** above the elm decline in Lake Bjärsjöholmssjön during several decades (Nilsson 1935, Nilsson 1961, Göransson in print). The vegetational changes around the lake can thus not be registered in the pollen diagram at the very beginning of the Early Subboreal. We get a false picture of an early and abrupt expansion of *Betula* at this site because of this hiatus. I have obtained the same false picture in Ballygawley Lough, Co. Sligo, Ireland, because of a hiatus immediately above the elm decline (Göransson 1984;165). In Lake Bysjön, 25 km to the NNW of Lake Bjärsjöholmssjön, a very marked lake-level lowering above the elm decline has been recorded (Digerfeldt 1988;173).

The beginning of the Regeneration Phase

At SB1 f *Corylus* has a maximum, *Betula* is declining and the regeneration of *Ulmus*, *Fraxinus* and *Tilia* begins. Nilsson dated this level to 4510±80 BP in the Ageröds Mosse bog. As there are 500 ^{14}C-years between AT/SB and SB1 f (and 650 ^{14}C-years between the *Ulmus* decline and SB1 f!) Nilsson realized that Iversen's landnam model was untenable - a "landnam phase" cannot last 500-600 years (Nilsson 1964:39). It is most interesting to observe that SB1 f - the beginning of the Regeneration Phase - has got the very same ^{14}C-dates in the Mabo Mosse bog (4520±60 BP) and the Dags Mosse bog (4590±60 BP) as in the Ageröds Mosse bog.

At SB1 e - dated to 4450 BP in the Dags Mosse bog - the forest regeneration has accelerated. It is highly interesting to observe that the Alvastra Pile Dwelling was built at the time which exactly corresponds to SB1 e (Göransson 1987). The passage grave at Omberg was also built at this time (Janzon 1984) as were the passage graves in the Falbygden area. Many of the passage graves in Scania, for instance - at Hagestad (Strömberg 1988;66) and along the Lödde-Kävlinge river (Hårdh 1982) ought to have been built at this time.

The passage tombs were thus constructed when the forests had begun to regenerate - more than 650 ^{14}C-years after the initial fall of the elm curve. The pollen spectra at SB1 e - "passage grave time" - reflect cultivation in managed forests, in coppice woods according to my model (Göransson 1987). It is thus no wonder that pollen of *Triticum* and *Hordeum* have been found at precisely this level in Lake Bjärsjöholmssjön. (Nilsson wrongly placed "Ganggräberzeit" at SB1 c, which is dated to 4000 BP).

The curve of microscopic charcoal particles

In many pollen diagrams the curve of microscopic charcoal particles has high values during the Late Atlantic. Not seldom the curve of bracken (*Pteridium*) more or less coincides with that of charcoal dust. Bracken is favoured by forest fires. It is suggested that the hunter-gatherer cleared the forest by burning the forest ground (dry twigs, bushes and girdled trees) (Göransson 1987;45 ff). It is also assumed that such clearance fires continued during the Early Neolithic. The charcoal-dust curve thus does not reflect any slash-and-burn cultivation during that time - the "damaged" forests were cleared by burning.

The curve of microscopic charcoal particles most often has high values up to immediately below SB1 g. (The fires from the elm-decline level up to SB1 g are, consequently, a continuation of the Mesolithic clearance fires). Then the curve falls and has low values before it rises at SB1 e. The rise of the charcoal-dust curve at SB1 e probably discloses clearance fires in felled coppice-wood areas during "passage-grave time".

Burning of the forest ground and of girdled trees was thus practised by the hunter-gatherer as well as by the neolithic forest farmer. "Above" the elm decline also trees killed by disease(?) - and of other natural agencies - may have been burnt. This has nothing to do with any landnam.

Extremely small basins compared with other basins

In basins which are not extremely small the fossils deriving from vegetation on high ground are airborne **microfossils** (pollen, spores and microscopic charcoal particles). From bare soil (arable land, overgrazed pastures, etc) microscopic mineral particles are brought by winds to *Sphagnum* bogs and are incorporated in the peat (see, for instance, Vuorela 1983, Göransson 1989).

My investigations of extremely small basins in western Östergötland demonstrate that **macrofossils** from high ground are found in the sediments of such kettle holes. This is easy to understand: macrofossils from high ground must be more concentrated in extremely small basins than in other basins where the macrofossils are "diluted". The crowns of the trees and the twigs of the shrubs extended over the kettle hole and the fruits and seeds were trapped in the hole. Not only pollen of *Picea* is found but also spruce-cones, not only pollen of *Corylus* is found but also hazel nuts, not only pollen of *Cornus sanguinea* is found but also fruits of this shrub etc. Also seeds of herbs which have grown in the immediate vicinity of the extremely small basin are found in the sediments.

Above all - microscopic charcoal particles "turn into" macroscopic charcoal pieces in the extremely small basin. Such pieces can be determined to genus level. It also seems as if microscopic airborne mineral particles "turn into" stones(!) - at least if the ground slopes to the kettle hole. Also beetles and snails are trapped in the kettle hole.

The kettle hole at Nässja

The "extremely small" kettle hole (dead-ice hole at Nässja, 20 km north of the Dags Mosse bog), is only 29 x 14 metres. In this kettle hole which is situated at the base of a glaciofluvial eskar clayey silt was deposited during Yoldia Time.

After Yoldia Time no sedimentation took place in the kettle hole for thousands of years. Forests surrounded the kettle hole during Boreal Time and Early Atlantic Time. The kettle hole was nothing else than a dry hollow in the forest. The forest was, however, here and there transformed by man.

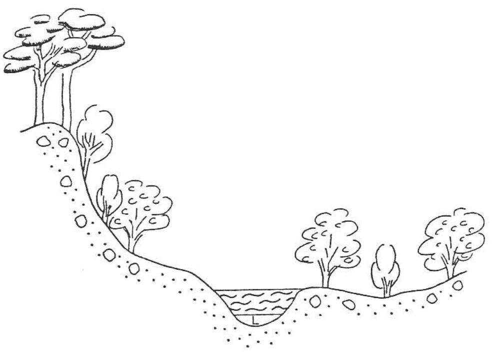

Fig 5. The Nässja kettle hole of today.

Forest-ground fires were common in western Östergötland during the whole of the Atlantic - from 7000 BP up to the elm decline - according to the complete Dags Mosse diagram (Göransson 1989:385). Especially around 6400 BP fires are strongly reflected in the Dags Mosse diagram. It is suggested that the hunter-gatherer transformed the forest - in patches - by girdling and burning (cf discussion above). This assumption seems to be confirmed by the investigations in the kettle hole at Nässja.

Pollen diagrams from extremely small basins give very local diagrams which always deviate from pollen diagrams from medium-sized and large basins. It is, nonetheless, possible to observe an *Ulmus-Tilia* decline in the pollen diagram from Nässja (samples nos. 27-25). Often *Tilia* declines later than *Ulmus* (see, for instance, Göransson 1987:figs 37-38). The very undermost part of the pollen diagram from Nässja thus belongs to Late Atlantic Time. A trench was dug through a part of the kettle hole at Nässja. Above the clayey Yoldia silt a 20 cm thick layer of a muddy clay, rich in macroscopic charcoal particles, had been deposited. A part 42 x 20 cm and 16 cm deep was dug up and cut into 10 slices (fig 7).

Macroscopic charcoal particles, seeds, fruits and beetle remains were collected after sieving. The macroscopic charcoal particles were determined to genus (by T. Bartholin) and drawn into the pollen diagram (M ch = macroscopic charcoal particles). No big hearth-charcoals were found - only small particles (1-10 mm) (of those only the largest could be determined). The beetles are being examined by G. Lemdahl (Göransson and Lemdahl in prep).

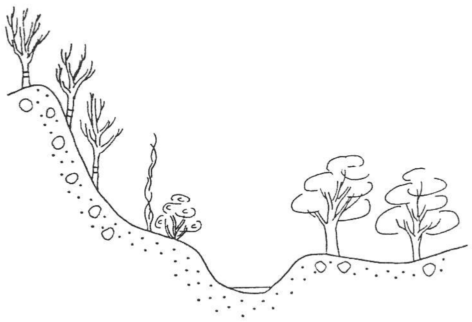

Fig 6. The kettle hole at Nässja during Late Atlantic Time.

The undermost part of the clay is rich in silt (layer 10). An accelerator dating of a macroscopic charcoal particle - from a stem(!) of *Tilia* - found in that layer gave the ^{14}C age of 6435 ± 100 BP. As mentioned above, forest fires were common around the Dags Mosse bog during that time. The sedimentation thus started very slowly again in the kettle hole during Late Atlantic Time (Late Mesolithic Time).

1
2
3
4
5
6
7
8
9
10

Fig 7. The late atlantic-early subboreal clay in the kettle hole.

Suddenly - probably immediately above the elm-decline level (which starts at 1.30 m = pollen sample no 27) - the sedimentation rate increases and muddy clay, rich in charcoal, is deposited. Charcoal particles from stems of *Betula* (most probably *B. verrucosa* according to the seed analysis), *Populus*, *Corylus*, *Alnus*, *Salix*, Pomoideae (*Crataegus*, *Malus* or *Sorbus*), *Tilia* and *Quercus* were spread to the basin. The whole charcoal sequence between 1.18 m and 1.27 m has an average ^{14}C age of 4750 ± 60 BP which exactly corresponds to the pollen-analytical level SB1 g (cf fig 2).

Stones, black from charcoal, but not fire-cracked, are found in the muddy clay. The forests were damaged above the elm decline, the forests did burn - at least in patches - the groundwater level rose and the sedimentation of muddy clay accelerated. Round stones could easily roll down into the kettle hole from the glaciofluvial eskar. Charcoal from the trees, destroyed by fire, followed the "rolling stones" into the kettle hole. Naturally, the charcoal particles could also have been blown into the basin.

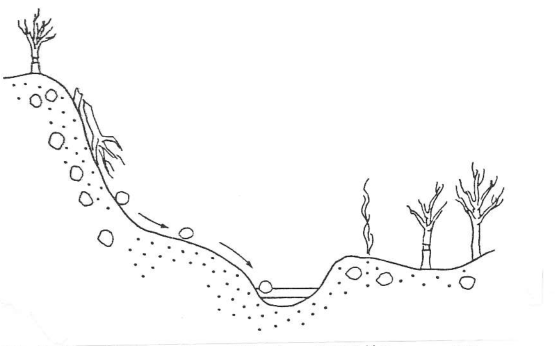

Fig 8. The kettle hole at Nässja c 5000 ^{14}C-years BP.

Another explanation is that the kettle hole at Nässja was a votive site - a holy well, a sacred place - where offerings were made. Stjernquist found hearth-stones in the immediate vicinity of votive wells in Scania (Stjernquist 1968). Such cult-places are being studied by my colleague Mats Regnell (Regnell in prep.). The pollen curves from the kettle hole at Nässja are, however, not disturbed - they are very "logical". No digging, tramping or other cult activities have mixed the sediments.

After 3400 BP - from the beginning of the Bronze Age - the kettle hole was filled in with peat (see the stratigraphy column of the Nässja diagram). Thus there was no open water surface - no well - since that time. Stones are, nevertheless, found in the whole peat sequence. These stones were very likely "released" during - for instance - grazing epochs.

The investigations at Nässja are very fragmentary. I hope, however, that I have been able to show other quaternary biologists a way to go. One of the most important questions to be answered is: why are the forests damaged at the transition Late Atlantic/Early Subboreal Time?

Perhaps future investigations of extremely small kettle holes on slopes will contribute to the answer of this question?

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