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Natural and Cultural Landscapes Since the Ice Age

Shown by Pollen Analyses from Small Hollows in a Forested Area in Denmark

by SVEND TH. ANDERSEN

INTRODUCTION

Small wet hollows, which are covered by the canopy of the trees surrounding them, are likely to record tree assemblages in a narrow area around the sites (within 30 m) and to reflect the impact of human activities on the vegetation in the vicinity by the pollen preserved in their sediments. Hence, pollen diagrams from such sites may reveal in detail past forest communities and anthropogenous vegetation in a time sequence (Andersen *et al.* 1983). The natural tree assemblages can be assumed to have varied in space according to differences in soil and hydrology, but we still know very little about such variations. Pollen diagrams from different small hollows may give insight as to variations in the forest communities at various times. A comparison of different sites may also reveal uniformity or differences in former human land use (Andersen 1984).

A small hollow in Næsbyholm Storskov on Zealand, Denmark, (Fig. 1, site 1 on Fig. 2) was studied in detail and preliminary results have been discussed (Andersen 1985, in press). Some dolmens and a passage grave are found in the eastern part of the forest, which is rich in Bronze-Age barrows, and the whole area is covered by extensive, somewhat younger, field systems (Nielsen 1984, Fig. 2). The topography is rugged with many hills and numerous small wet hollows. Another hollow situated about 700 m north of the former site (site 2, Fig. 2) was selected and investigated by pollen analysis for a comparison with site 1.

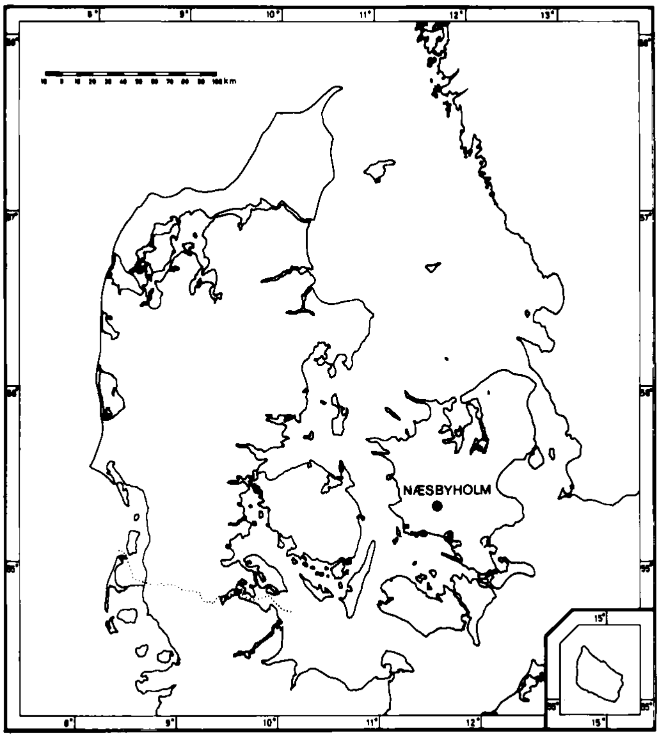

Fig. 1. The location of Næsbyholm Storskov.

RESULTS FROM SITE 1

This small hollow is 18 x 12 m wide and is delimited on the western side by a field lynchet. A colluvial layer derived by ploughing of the field is included in the peat and extends across the hollow. The lowermost 10 cm of this layer are mixed with the underlying peat, above is stony clay and then peat derived from the time after cultivation of the field had ceased.

The vegetational development reflects an early Holocene natural sucession from pine-birch forest over hazel-dominated forest to lime-hazel forest up to the elm-decline. At the elm-decline pure lime forest was produced by man by felling of other trees probably with the pur-

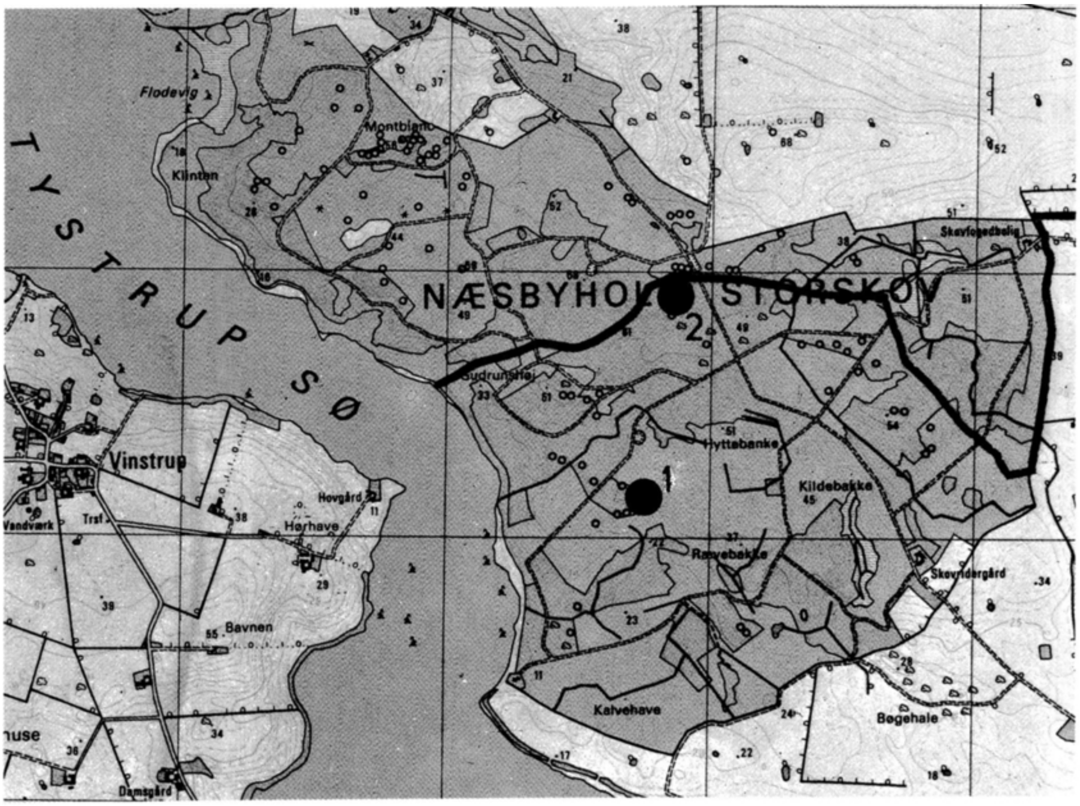

Fig. 2. Næsbyholm Storskov with the location of site 1 and site 2. Reduced section of Geodætisk Institut, Danmark 1:25.000, 1412 IN. (With permission from *Kort- og Matrikelstyrelsen* (A. 881/71)).

pose to gather leaf fodder for cattle by shredding of the trees. The lime forest was later succeeded by hazel-oak forest with glades with shrubs and herbs probably used for grazing by cattle. Upon this pastoral stage followed forest of lime, oak, and ash with few traces of activity by man. This forest persisted up to around 1000 BC. After 1000 BC, the forest was cleared and the field at the hollow was established. The cultivation of the field ceased shortly after the Birth of Christ and the field was invaded by oak and hazel, but glades with shrubs and herbs were maintained, probably for grazing by cattle, up until around 500 AD. Beech forest then expanded but became later more open due to establishment of glades used for cattle grazing.

SITE 2, COUNTESS HOLLOW

Site 2 is locally called Countess Hollow (Grevindens Mose). The hollow is orientated west-east and is about 60 x 12 m wide (Fig. 3). Hence, the tree crowns extended over it at times when continuous forest occurred around the site. Today the hollow is surrounded by planted spruce and is drained by a ditch established in the 19th century. Formerly there was beech forest around the site.

The hollow is filled with 3.64 m organic sediment. Below is late-glacial clay. The sediments can be described as follows (cp. figures 5 and 6):

0–28 cm:	Humic sediment (dy)
28–74 cm:	Humified swamp peat
74–236 cm:	Humic sediment (dy)
236–242 cm:	Slightly humified moss peat
242–303 cm:	Humic sediment (dy)
303–308 cm:	Slightly humified swamp peat
308–312 cm:	Humic sediment (dy)
312–335 cm:	Slightly humified swamp peat
335–355 cm:	Coarse-detritus gyttja
355–364 cm:	Slightly humified moss peat
364–370 cm:	Clay-gyttja

The deep hollow probably originated as a sink-hole formed by melting of a block of dead ice, as shown by the occurrence of peat layers in the deepest part.

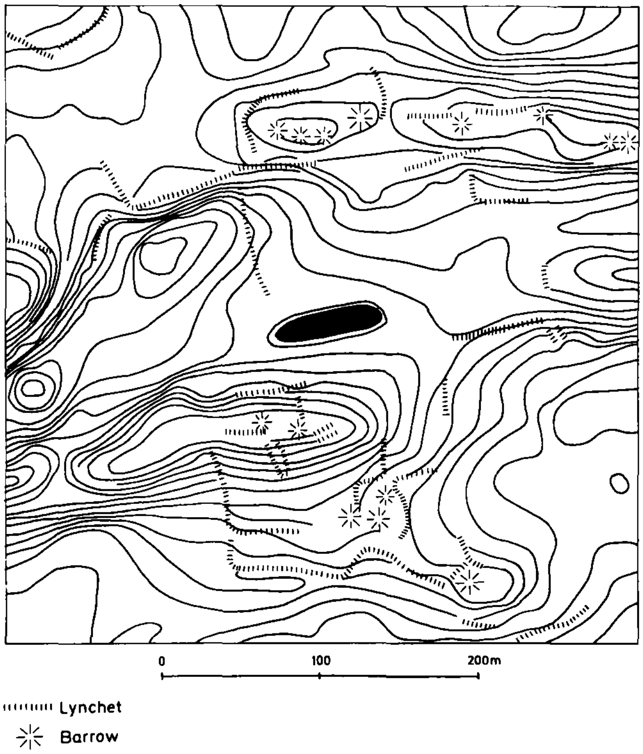

Fig. 3. Map with surface contours (1 m) and prehistoric barrows and lynchets around site 2 (black). Redrawn after original map by V. and G. Nielsen.

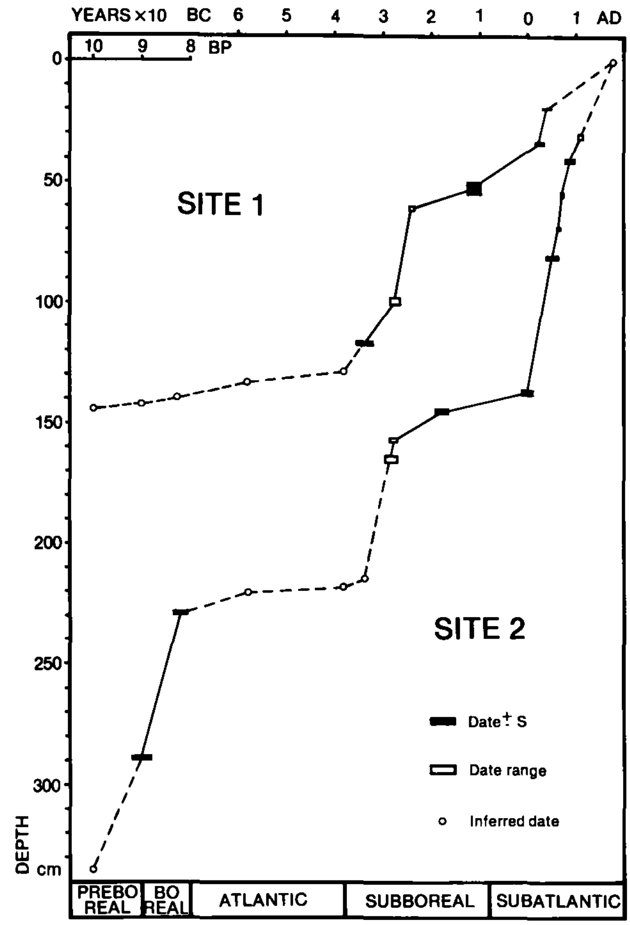

Fig. 4. Radiocarbon dates and age-depth curves for site 1 and site 2.

The lowermost organic sediments, at 335–364 cm depth, proved to contain pollen of Boreal and Atlantic age. Purely Preboreal pollen assemblages occur in the peat just above this level. The younger pollen was obviously washed into a cavity, which had formed under a floating peat mat of Preboreal age. Hence, the deposits below 335 cm depth will be disregarded at present.

The clay and sand content increases above 145 cm depth to about 10% (Fig. 6), but a continuous colluvial layer, as observed at site 1, did not occur. Scattered stones, a flint artefact[1] and burned flint were found by excavation at 80–130 cm depth. It may be concluded that fields did not extend right to the hollow, as they did at site 1.

A flat area occurs east, north and west of the site, and a hill with prehistoric barrows just to the south. Further hills with barrows occur in the vicinity. Scattered field lynchets occur in the area around the hollow, according to Viggo and Gudrun Nielsen (Fig. 3). An Early Roman Iron Age settlement deposit was found on a hill 600 m west of the site (Nielsen 1984).

RADIOCARBON DATES FROM SITE 1 AND SITE 2

Eight radiocarbon dates are now available from site 1 and thirteen from site 2. They were converted to calendar years using dendrochronologically established calibration curves.[2] Dates older than 6000 years BP could not be calibrated.

Age-depth curves for the two sites are shown on Fig. 4. Some of the dates were inferred from other sites or transferred from site 1.[3] The age-depth curves indicate highly variable sediment accumulation rates probably due to variations in hydrological conditions at the sites.

The age-depth curves in Fig. 4 were used for calibration of the pollen diagrams. It was not attempted to smoothe these curves, and a linear accumulation rate was as-

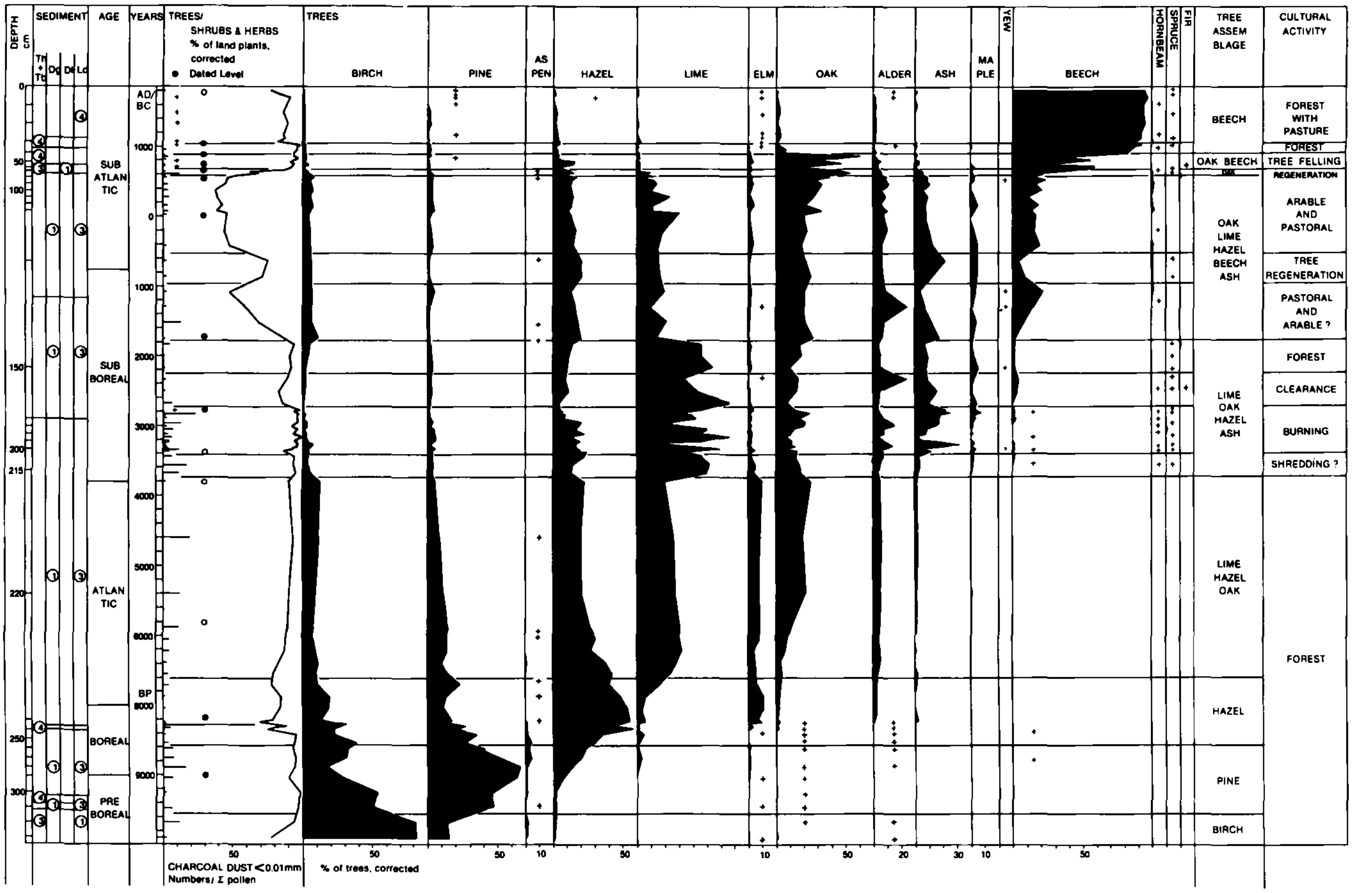

Fig. 5. Pollen diagrams from site 2. Trees and charcoal dust. Sediment components according to Troels-Smith (1955). Th, turfa herbacea. Tb, turfa bryophytica. Dg, detritus granosus. Dl, detritus lignosus, Ld, Limus detrituosus. The figures indicate fractions of volume on a four-degree scale.

sumed between the dated levels. This procedure may induce an uncertainty in the ages of individual levels of the pollen diagrams, especially around points where the age-depth curves change drastically.

POLLEN DIAGRAMS FROM SITE 2

Pollen diagrams and sediment analyses from 0–335 cm depth drawn on time scales are shown in figures 5 and 6. Time scales were preferred to depth scales, as the latter are difficult to evaluate due to the strong variations in sediment accumulation rate.

Fig. 5 shows a curve for tree pollen, frequencies for charcoal dust, and curves for individual trees. Fig. 6 shows a curve for the mineral content of the sediments, and curves for categories of non-tree pollen, pollen concentration, pollen corrosion and sediment accumulation rates.

The tree pollen numbers were corrected according to Andersen (1970, 1980) before percentage calculation.[4] For non-trees, the numbers of pollen from wind-pollinators were divided by 2, in order to correct for over-representation in the percentage calculations. Similar methods were used for the diagrams from site 1 in Andersen 1985 and in press.

At times with dense tree cover, the tree pollen percentages can be assumed to indicate tree areas in percentage of the total tree area near the site rather faithfully. Low figures (less than about 10%) may be due to pollen transported from trees which grew at a larger distance. When trees were scarce, the source area for tree pollen probably increased. The pollen representation of non-trees is not well known – variations in their percentages indicate

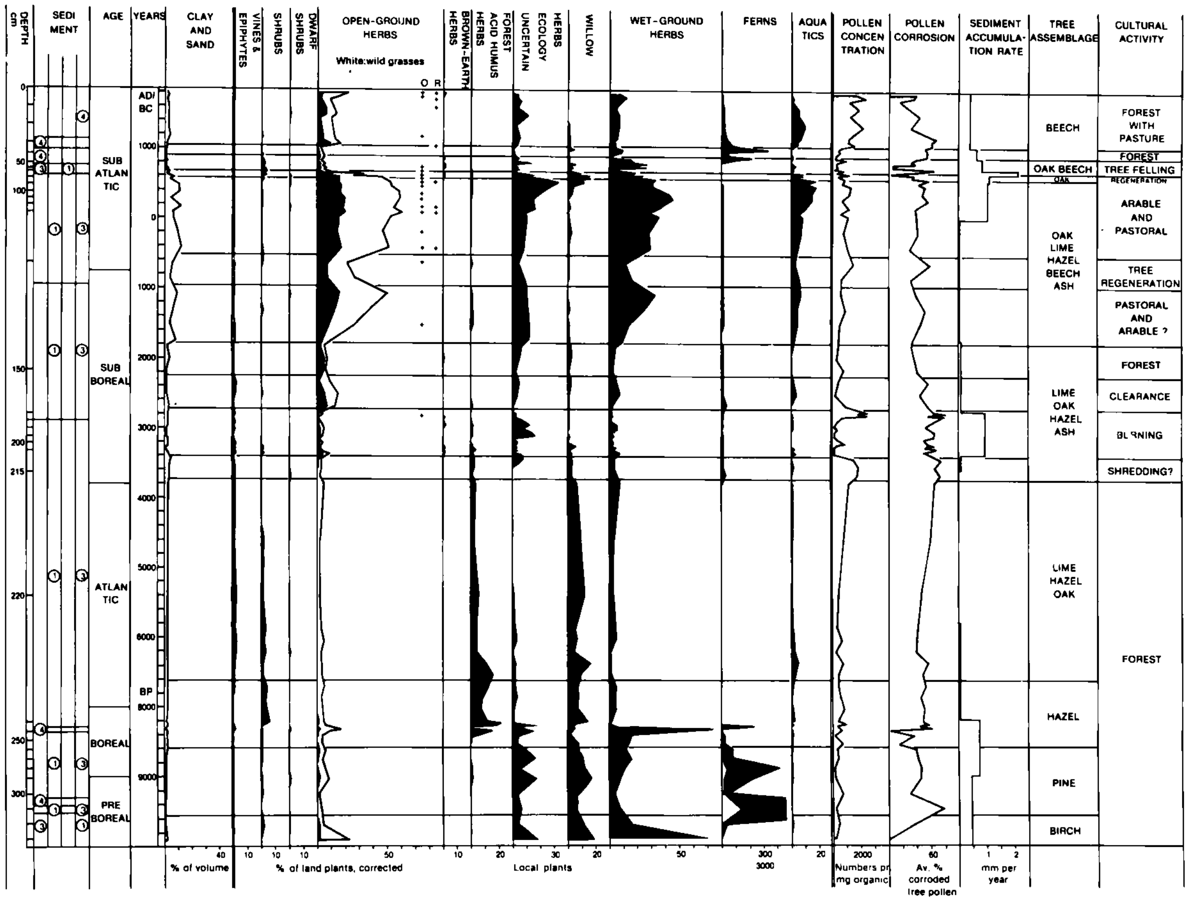

Fig. 6. Site 2. Sand and clay content, groups of non-tree pollen, pollen concentration, pollen corrosion and sediment accumulation rate. O = oats-type, R = rye.

abundance or rareness around the site rather than areal extent. The percentages for local plants are high if the plant occurred richly near the sampling spot. The distinction of wild grass and cereal pollen was based on extensive size statistics.

The curves for pollen concentrations and pollen corrosion on Fig. 6 are somewhat correlated. High values for both curves may indicate particularly dry periods with stronger decomposition of the organic matter and stronger deterioration of the pollen grains. The variations in sediment accumulation rate tend to be inversely correlated with these changes.

VEGETATIONAL DEVELOPMENT AT SITE 2

The vegetational development at site 2 is outlined here. Later, a comparison with site 1 will be attempted for the younger part of the sequence. The plant names in Latin follow *Flora Europeaa.*

Early Preboreal, 10000–9500 BP. Birch forest. The lowermost pollen analyses indicate dominance of birch. Pine was low and may not have been present yet. Birch dominance also characterizes early Preboreal pollen spectra in regional pollen diagrams (e.g. Holmegård Bog, Aaby in Andersen *et al.* 1983, Aaby 1986), but not at site 1, where pine dominates even the earliest Preboreal spectra. One may conclude that pine was present but unevenly distributed. The herbaceous land plants decreased from 20 to 10%, and willow and wet-ground plants were abundant in the hollow.

Preboreal and early Boreal, 9500–8600 BP. Pine forest. Pine expanded quickly and replaced birch. Hazel began to expand slightly later. A similar, but less pronounced pine maximum can be seen in regional pollen diagrams. Non-tree land plants were scarce, but willow, wet-ground plants and ferns (probably marsh fern, *Thelypteris palustris*) were abundant. The ferns probably grew at the coring site. Charcoal dust indicates fires in the pine forest, probably provoked by lightning (cp. Uggla 1958). Fires may also have been started by man in order to promote deer browsing, as suggested for England by Simmons *et al.* 1981, but there is no other evidence that such activity took place. The fires probably caused the increase for birch seen in the upper part of the pine stage.

Late Boreal and early Atlantic, 8600 BP-6600 BC. Hazel forest. Hazel dominated the forest and birch and pine decreased. Elm probably occurred rarely near the site. One pronounced peak of charcoal dust indicates a fire at the site. Peaks on the birch curve and for several herbaceous plants were a response to this fire, which was probably natural, as pine was still rather common at that time. Acid-humus plants, particularly bracken (*Pteridium aquilinum*), were common, indicating open spaces on already leached soils.

Atlantic, 6600–3800 BC. Lime-hazel-oak forest. Lime became common in Atlantic time but was less common (20–30%) than at site 1 (40–60%). The hazel frequencies were similar to site 1 (20–30%). Oak expanded in middle Atlantic time, as at site 1 and at other sites in Denmark (at about 7000 BP, Andersen 1978, Aaby in Andersen *et al.* 1983), and became more common (20%) than at site 1 (10%). The birch and pine frequencies are slightly higher than at site 1, and may indicate local presence and hence more open tree cover at site 2. Herbaceous plants, however, were scarce. Charcoal dust occurs rather frequently in the late part of the Atlantic contrasting to site 1, where charcoal dust was scarce throughout Atlantic time. The fires were probably due to presence of pine trees. As the open-ground herbs remain scarce, there is no evidence that fires were provoked by man in order to promote browsing.

Subboreal, 3800–1800 BC. Lime-oak-hazel-ash forest. The Subboreal is assumed to begin at a distinctive decrease in the elm curve.

Lime increases abruptly at the elm decline and there are several peaks for lime. Ash increases slightly above the elm decline and has several peaks, which alternate with the peaks for lime. Oak, alder, hazel and maple mirror to some degree the changes in the curve for ash. Beech pollen occurs with low frequencies.

The first lime maximum at 3800–3400 BC coincides with high frequencies for charcoal dust and may indicate a stage where man felled other trees than lime in order to use lime for shredding of leaf fodder, as at site 1. Dryland plants are scarce, but ferns increase distinctively (to about 20%) indicating a decrease in the tree cover over the hollow. A few pollen grains of ribwort (*Plantago lanceolata*) occur.

At 3400–2700 BC there are several abrupt minima for lime of short duration, about 100 years, and about 100–200 years apart. More light-demanding trees, oak, alder, ash and hazel, replace lime at these minima. There are also some slight peaks for non-tree pollen. A few shrubs and open-ground herbs (grasses, wormwood, *Artemisia*, ribwort and others) occur. One pollen grain of oats-type probably belongs to wheat. Charcoal dust is frequent. It appears that lime trees were felled and burned repeatedly giving way to quickly reproducing pioneer trees and herbaceous vegetation. No extensive pastures were created, however, and man rather promoted short-term grazing or fields. A slash-and-burn procedure thus seems indicated. There are peaks for wet-ground herbs (sedge) and ferns indicating increased illumination in the hollow.

At 2700–2300 BC there is evidence of a more extensive clearance of forest. Lime gives way to oak, alder, ash and hazel, and there is a peak for non-tree pollen (up to 20%). Wild grasses and perennial herbs such as wormwood, sheep's sorrel (*Rumex acetosella*), ribwort and St. John's wort (*Hypericum*), appear. Forest was cleared, apparently, probably for pasture.

At 2300–1800 BC lime-dominated forest regenerated and the area around the hollow was abandoned for some time.

Late Subboreal and Subatlantic time, 1800 BC-600 AD. Arable and pastoral farming. Extensive clearance of forest began at 1800 BC and the area was settled by man for two and a half millenia. Non-tree pollen increased to a peak at about 900 BC, then receded somewhat 1000–500 BC, and then increased again 500 BC–600 AD.

Trees were prominent in the landscape around the Countess Hollow, but the tree assemblage had changed drastically, as lime was suppressed, and a mixed community of trees prevailed, among them beech.

The open-ground herbs were common up to around 1000 BC. Pollen of wild grasses predominates, several perennial herbs were common (ribwort, sheep's sorrel, wormwood, white and red clover, *Trifolium repens*, and *T. pratense*, sheep's bit, *Jasione montana*, and knapweed, *Centaurea jacea*), and a few annual weeds occurred too (goosefeet, Chenopodiaceae, knotgrass, *Polygonum aviculare*, black bindweed, *Bilderdykia convolvulus*, hemp-nettle, *Galeopsis*, and *Anchusa*). These plants may have occurred in pastures or as weeds in fields.

A few pollen grains of oats-type, probably oats, occurred. Pollen of barley could not be identified due to common occurrence of pollen of float grass (*Glyceria fluitans*), which grew in the hollow. However, barley pollen can only have been scarce.

It is difficult to say definitely whether the fields were established around the site at this time, that is, in the Bronze Age. The clay and sand content had increased (Fig. 6), but there is no evidence of fields, such as colluvial soil. Some of the weeds mentioned above point to presence of fields.

An open tree cover is indicated by increased frequencies of local plants (wet-ground herbs, ferns and aquatics).

At 1000–500 BC non-tree pollen receded somewhat, and the trees must have spread. The tree assemblage did not change greatly. The human activity around the site apparently decreased somewhat for about 500 years.

At 500 BC-600 AD, the non-tree pollen frequencies were high, 50–60%. Wild grasses are about 40% and ribwort nearly 10%. New perennial herbs are St. John's wort (*Hypericum*), hoary plantain (*Plantago media*) and field scabious (*Knautia arvensis*), and weeds such as great plantain (*Plantago major*), persicaria (*Polygonum persicaria*), spurge (*Euphorbia*), red bartsia (*Odontites*) and pearlwort (*Sagina*) appear. Scattered pollen grains of oats-type (probably oats) and rye occur, but barley pollen could not be identified.

We must imagine a landscape used by man for multiple purposes. Trees of oak, lime, hazel, beech, ash and maple were preserved and were probably used for gathering of leaf-fodder, mast, fuel and timber. Pastures used for grazing stock and probably mowing of hay were common mixed with fields for growing cereals.

Wet-ground plants such as sedges, ferns, float-grass and water-plantain (*Alisma*) and aquatics (water violet, *Hottonia*, duckweed, *Lemna*, and water crowfoot, *Ranunculus*) were common in the hollow.

Subatlantic, 600–700 AD, oak regeneration stage. At 600 AD tree pollen increases abruptly and the area around the site became covered by trees, predominantly oak. There is a maximum for shrubs (crab apple, *Malus*, rowan, *Sorbus aucuparia*, hawthorn, *Crataegus*, sloe, *Prunus spinosa*, elder, *Sambucus racemosa* and others). Beech began to expand slightly later. A willow-scrub developed in the hollow and the wet-ground herbs and aquatics decreased.

The human activities in the area thus ceased rather abruptly, and trees and shrubs invaded the abandoned pastures and fields. Oak was the first tree to invade, followed by beech.

Subatlantic, 700–900 AD. Oak-beech forest. Beech increased vigorously and lime was probably hampered by increased soil acidity under the beeches (cp. Andersen 1978, 1984, Aaby 1986). The beech expansion was interrupted by distinctive peaks for oak, which are accompanied by peaks for hazel and wet-ground plants. It appears that beech trees were felled by man and that oak, hazel and wet-ground plants increased due to the clearing. The purpose of this activity is not clear; the beech trees were probably felled for use as timber or fuel.

Subatlantic, 900–1800 AD. Beech forest. Beech attained full dominance. Non-tree plants were scarce 900–1000 AD, and the forest was left unattended by man for some time. Peat with abundant ferns formed in the hollow.

At about 1000 AD, non-tree pollen increased abruptly (to about 20%). This increase is mainly due to open-ground herbs, (grasses, sheep's sorrel, ribwort and others) and glades used for grazing are indicated. Man, however, did not try to suppress beech. Beech forest with glades was a well-known feature from times up to 1805 AD, when cattle grazing in the forests was forbidden by law. The hollow became wetter, and the aquatics (water crowfoot) were common.

THE CULTURAL HISTORY 4000 BC-1800 AD AT THE TWO HOLLOWS IN NÆSBYHOLM STORSKOV (SITES 1 AND 2)

Pollen diagrams offer areally narrowly delimited pictures of the cultural history in Næsbyholm Storskov at two sites 700 m apart. Bronze Age barrows and field lynchets occur around both sites, and a field extended right to the hollow at site 1. A comparison will reveal whether the activities of man were the same at various times and, hence, due to strategies organized at a high level, or whether man's exploitation was more sporadic.

The difficulty in distinguishing arable farming in pollen diagrams was emphasized by Andersen (1985, in press). At site 1, at close proximity to a cultivated field, grasses and perennial herbs dominate the pollen flora, and pollen of cereals and annual weeds is scarce. This may be explained in part by the fact that the tall herbs, especially those with wind-pollination, disperse their pollen better than the mostly insect-pollinated annual weeds and the cereals. One weed, knotgrass (*Polygonum aviculare*), was distinctively concentrated to the arable phase. Another difficulty is due to the fact that we have too little knowledge as to the presence of grasses and perennial herbs in the former field flora. However, perennial plants may have been more common than they are to-day (Willerding 1986, Groenman-van Waateringe 1986).

Survey pollen diagrams from the two sites are shown on Fig. 7. The curves for trees and non-tree pollen help to show the openness of the landscape around the sites. Columns for charcoal dust indicate the intensity of burning, and the curves for the shade trees, lime and beech, illustrate the degree of interference with the composition of the tree assemblages.

3800–3400 BC. Shredding stage. This stage has high frequencies for charcoal dust and lime trees at site 1, and these frequencies are lower at site 2. It seems indicated that man also promoted lime for shredding of leaf-fodder at site 2, but this activity was less intensive than at site 1. The early Neolithic shredding thus was more or less concentrated to areas favoured by man. Herbaceous vegetation was scarce. It is uncertain whether the dolmens in the eastern part of the forest were connected with this activity.

3400–2700 BC. Pastoral activity at site 1, burnings at site 2. At site 1 lime was suppressed and the forest was kept open by fire. Lime was replaced by hazel, oak, alder and ash, and open glades were created. Ribwort (*Plantago lanceolata*) and bracken (*Pteridium aquilinum*) were quite common, indicating that the glades were used for pasture. The grazing pressure was not very intensive as trees were common. They may have been utilized for various purposes. The occurrence of a few weeds may indicate presence of fields. The phase resembles Iversen's *landnam* (Iversen 1941) with a minimum for lime and maxima for hazel, alder, grasses, ribwort and bracken. Iversen interpreted the hazel- and alder-maxima as regeneration stages after one or several clearances. The *landnam* at site 1 rather reflects groves of hazel, oak, alder and ash maintained continuously along with pasture for about 700 years. At site 2 the activities of man were restricted to burning of the lime forest at intervals, but no extensive pastures were created. These activities were probably connected with the passage grave found in the eastern part of the forest.

2700– about 2200 BC. Forest with clearance. Lime expanded at site 1 and was twice replaced by other trees, oak and ash in particular. Non-tree pollen was rather scarce and no extensive clearings are indicated. More intensive clearance occurred at site 2, where glades probably used for pasture are indicated. Hence, the main activity changed from site 1 to site 2.

Man's activities thus were highly variable from 3400 to about 2200 BC. The most intensive activity was at site 1 3400–2700 BC, where lime was effectively suppressed and hazel-dominated forest with glades maintained for about 700 years. At site 2 grazing is indicated at 2700–2300 BC. Other clearances of forest were of short-term character, 100–200 years, and no extensive pastures were established.

2200–1000 BC. Forest at site 1, forest and clearance at site 2. Forest was re-established and the areas around the sites abandoned by man up to 1000 BC at site 1 and 1800 BC at site 2. Lime became dominant at site 1 for about 2000 years. Lime also increased at site 2 but was less dominating than at site 1.

Extensive forest clearance began at site 2 at 1800 BC. Lime, in particular, was suppressed and an open landscape with a mixed tree assemblage was created. Pastures were extensive, and fields were probably established. Hence, the activities of man were resumed only at site 2 at this time.

1000 BC-500 BC. Arable farming at site 1, tree regeneration at site 2. Tilling of the field ajoining the hollow at site 1 began at some time after 1000 BC as shown by the occurrence af colluvial soil with many stones in the hollow. Decreasing tree pollen and high frequencies for charcoal dust indicate clearance of the forest. Lime, however, retains high frequencies. The lime pollen probably belongs to peat antedating the tilling and mixed into the clay. Pollen from ribwort and other perennial herbs may indicate pastures near the site.

At site 2 trees began to spread at about 1000 BC indicating a decrease of the pastoral and arable farming activities lasting up to around 500 BC. The main human activities thus shifted from the area around site 2 to site 1 during the Bronze Age, from which time many barrows are preserved in the forest.

500 BC-500 or 600 AD. Arable and pastoral farming. The trees decreased to very low values at site 1 at 500 BC and remained scarce up to around the Birth of Christ. The colluvial soil is rich in stones derived from the field. Pollen from weeds and cereals probably came from the field, but it is uncertain whether pollen from perennial herbs

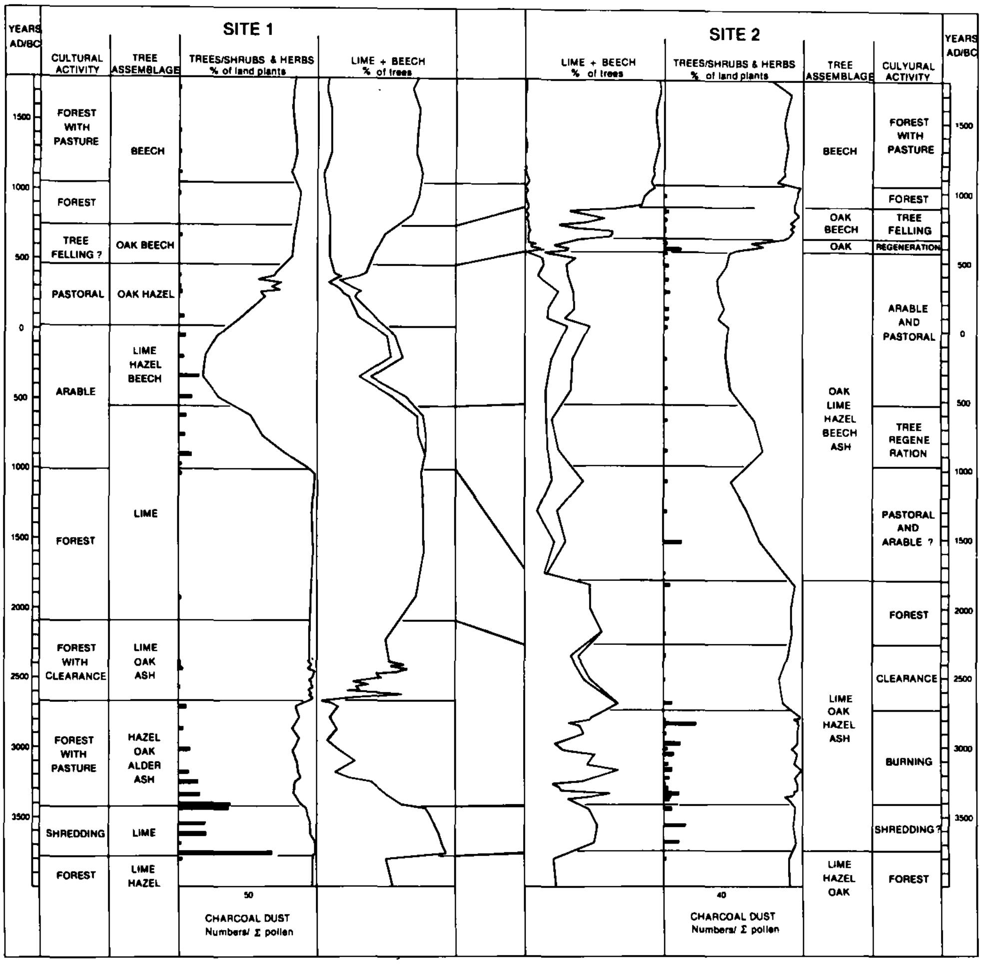

Fig. 7. Site 1 and site 2. Trees, charcoal dust, lime and beech.

derive from the field flora or from pastures in the vicinity. Lime was still the most common tree. A few lime trees may have been preserved for harvesting or leaf-fodder. At about the Birth of Christ, the tilling of the field ceased, and trees, mainly oak and hazel, invaded the area around site 1, whereas lime and beech were prevented from spreading. Various shrubs also spread, and the non-tree frequencies remained rather high up to around 500 AD. The area was presumably used for pasture with groves of hazel and oak preserved for various purposes.

Trees also decreased at site 2 at 500 BC, and an open landscape with scattered trees prevailed up to around 600 AD. The area round the site was apparently utilized for multiple purposes; trees were preserved for various uses and arable and pastoral farming occurred. The trees increased abruptly at 600 AD indicating abandonment of the farming activities.

Whereas the human activity changed at about the Birth of Christ from mainly arable to pastoral farming at site 1, there was no such distinction of activities at site 2, where cultivation of fields continued up to around 600 AD along with grazing by livestock. The importance of pasture is emphasized by the numerous bone fragments found at the Early Roman Iron Age settlement 600 m west of site 2, which reflects a grazing countryside with woodland close by (Nielsen 1984).

Large-scale farming thus occurred in Næsbyholm Forest from about 500 BC and up to around 500–600 AD. The area must have become densely populated by human communities organised at a high level and most of the field lynchets probably derive from this time. The abandonment of farming at 500–600 AD must express depopulation on a large scale.

500 or 600–1000 AD. Oak-beech and beech forest. Trees expanded at about 500 AD at site 1 and non-trees became scarcer. Beech began to expand, but oak remained frequent up to around 800 AD. The expansion of beech was apparently hampered for some centuries probably due to felling of beech trees up to around 800 AD, when beech became dominant.

Oak and shrubs invaded the abandoned farming areas at site 2 at 600 AD. Beech began to expand slightly later and began to suppress oak at about 700 AD. Two peaks for oak then indicate episodes where beech trees were felled, probably to be used for timber. Beech expanded again shortly before 900 AD.

Sporadic human activity thus can be traced at both sites up to around 800 or 900 AD. After that time no traces of human activity occurred up to 1000 AD.

Beech forest with pasture. 1000–1800 AD. At about 1000 AD non-trees increase at both sites in Næsbyholm Forest, due to an increase in open-ground herbs. Glades presumably used for grazing were established, but there is no indication that fire was used extensively. Beech remained dominant, in contrast to the Iron Age pastoral stage, where beech was suppressed in favour of oak and hazel. This difference may express less interest in utilizing the forest in Medieval time and later, except for grazing and maybe foddering of pigs, probably because the dense settlements had moved to other places.

Glades continued at both sites up to the surficial part. The regeneration of the forest after 1800 AD is accordingly not registered probably because of drying out of the sites by ditching.

Lime, oak and ash occurred scarcely in the beech forest at site 1 but were absent at site 2. The soils at site 1 probably were somewhat more fertile than at site 2, where acid humus layers may have formed under beech. Later, lime disappeared from Næsbyholm Forest as it was unwanted by foresters (Vaupel 1863).

CONCLUSION

The pollen diagrams from the small hollows in Næsbyholm Storskov have indicated similarities and differences in the composition of the natural forest communities prior to the time when man began to exploit the forest. Leaching of soils thus seems to have had a more pronounced effect on the natural tree assemblages at site 2 than at site 1. Such small-scale variations cannot be traced in regional pollen diagrams with larger pollen source areas.

The pollen diagrams from small hollows also reflect small-scale variations in the intensity and nature of human exploitation. In the Løvenholm Forest in eastern Jutland, which was marginal to dense human settlements, human activities were concentrated around one site in Neolithic, Bronze Age and early Iron Age time, and more general, but of varying intensity, in Medieval and Recent time (after 1500 AD, Andersen 1984). In Næsbyholm Storskov, the human activities varied in intensity and method employed in the early and middle Neolithic. The area was abandoned in the late Neolithic, but exploitation of varying intensity was resumed in the Bronze Age. Large-scale exploitation occurred in the early Iron Age and was abandoned at around 500 AD. From that time limited human activity occurred for some time and the area was then unexploited for one or two centuries up to around 1000 AD, when grazing was resumed up to around 1800 AD.

At Tyste Bog, 3 km south of Næsbyholm, which records a larger area, up to 500 m distance (Mikkelsen 1986), human exploitation was low during the Iron Age. Fields were established in early Medieval time, and grazed oak-hazel forest was then maintained for some time at the cost of beech, in contrast to Næsbyholm Storskov. The forest was cleared and commons established around 1800 AD.

Small-scale variations in human activity are smoothed-out in regional pollen diagrams, which therefore show a more general picture of the changes in human exploitation, as also shown by Behre and Kučan 1986.

The nearest radiocarbon-dated pollen diagram in the Næsbyholm area is from Holmegård Bog 15 km southeast of Næsbyholm Storskov (Aaby in Andersen *et al.* 1983, 1986). Elm and alder were more frequent there in Atlantic time than at Næsbyholm, showing that these trees occurred mainly in wet-ground forest, which is not represented at the small hollows.

Early Neolithic pure lime forest as recorded at Næsbyholm cannot be recognized at Holmegård, probably because these shredded forests were of limited extent. A minimum for lime, and maxima for hazel, alder, open-ground herbs and bracken 3400–2900 BC at Holmegård is very similar to and contemporaneous with the Neolithic pastoral stage at site 1. This activity apparently was widespread and corresponds to Iversens *landnam* (Iversen 1941). Lime then was dominant at Holmegård up to around 1000 BC, and the area was abandoned by man. The human activities at Næsbyholm 2700–2200 BC cannot be traced in the regional diagram, accordingly.

The forest clearance 1800–1000 BC at site 2 is weakly represented at Holmegård, whereas the arable and pastoral farming at Næsbyholm beginning at 1000 and 500 BC is reflected more strongly there. This activity was widespread, accordingly.

The decrease of human activity at 500 AD was common to the Holmegård and the Næsbyholm diagrams and indicates large scale depopulation in these areas. Resumed human activity at 1000 AD lead to increasing deforestation at Holmegård. Fields were established at Tyste Bog, mentioned above, at this time, whereas the local beech forest at Næsbyholm was only slightly exploited for pasture. Deforestation culminated in the Holmegård area 1700–1800 AD contemporaneously with the establishment of commons at Tyste Bog.

Hence, pollen diagrams from small hollows can resolve local variations in the nature and intensity of human influence, which are masked in the pollen diagrams of regional influence. Regional pollen diagrams, on the other hand, reflect large-scale changes in human population and activity.

Svend Th. Andersen. The Geological Survey of Denmark. Thoravej 8, DK-2400 Copenhagen NW.

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NOTES

1. The artefact found at 120 cm depth, is a flint block, 8x6x3 cm large, with scars of chipped off irregular flakes. The edges of the scars are well preserved, and the flint block does not appear to have lain on the ground for a long time. Hence, it is probably contemporaneous with the deposit, in which it was found.
2. From site 1 two dates were obtained from samples of wood, one from the total organic matter (at 55 cm depth, just under the clay layer), and five from insoluble organic matter. Two dates (at 128 and 129 cm) were rejected because they were 2–3000 years older than expected. They consist presumably of redeposited material. From site 2 the dates were based on twigs or small pieces of wood. Two dates of wood (at 199 and 215 cm) were rejected because they were 500–1000 years younger than expected. These pieces of wood probably derived from roots or had sunk into older deposits when the wood fell into the hollow. Dendrochronological calibration curves were obtained from Stuiver and Pearson 1986, Pearson and Stuiver 1986, Pearson et al. 1986, and Limick et al. 1984. The calibrated dates were calculated with their standard deviations (± s) in cases where the calibration curves indicate one possible dendrochronological age, and with the range of age in cases where the calibration curves indicate several possible ages for one radiocarbon year.
3. The inferred dates are the following:
   Surface, 1800 AD.
   Increase in ash pollen at site 2, dates at site 1 to 3200–3550 BC.
   Elm pollen decline, inferred age 3800 BC.
   Oak pollen increase, inferred age 5800 BC.
   Lime pollen increase at site 1, dated at site 2 to 8215 BP.
   Hazel pollen increase at site 1, dates at site 2 to 9000 BP.
   Birch pollen maximum, inferred age 10000 BP.
4. The tree pollen counts were corrected before percentage calculation with the following factors: Pine, birch, oak, hazel, alder, yew, aspen x 0.25, hornbeam x 0.33, elm x 0.50, beech, fir x 1, lime, ash x 2.

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