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Pollen Analyses from Early Bronze Age Barrows in Thy

by Svend Th. Andersen

INTRODUCTION

Since the early works of Waterbolk (1954;1958), Dimbleby (1962) and Groenman-Van Waateringe (1974), the potentials of studying soils buried under earthworks by pollen analysis have received wide attention. Dimbleby (1962;1985) showed that pollen spectra from barrow fills can be used for revealing stages in their construction. It is, however, the interpretation of the pollen spectra in terms of former land use, which is the most important aspect of pollen analysis of soils from barrows and other human earthworks. These earthworks were mostly, or often, erected in the open cultural landscape, and therefore can reveal land-use practices in a more direct and quantitative way, than investigations from dwelling sites or lake and peat deposits. Thy's landscape is richly provided with Bronze Age barrows. Consequently it vas tempting to collect and analyse pollen samples during excavations from these barrows, in order to obtain a more direct picture of aspects of the Bronze Age agriculture, than could be provided by pollen diagrams from lake and bog sites in the same area (Hassing Huse Mose: Andersen 1995 and Ove Sø: Andersen and Rasmussen 1994).

POLLEN ANALYSIS OF SOILS PRESERVED IN BARROWS

Pollen grains falling on a land surface become buried in the soil by the activity of burrowing animals. The grains are destroyed within a short span of years in neutral soils due to biological breakdown (Havinga 1971; Dimbleby 1985). Because of the gradual downward transport, the oldest pollen grains tend to occur deepest in these soils; differing pollen assemblages may, however, become more or less homogenised by the activity of the soil animals (Havinga 1974; Andersen 1979a; Dimbleby 1985). Plowing may also cause downmixing of pollen assemblages.

Aerobiological studies have shown that the pollen falling on a land surface is mainly derived from vegetation on the sampling site or within 10-20 m distance (Raynor *et al.* 1974; 1975). If situated in a clearance, pollen from trees growing at a larger distance may also influence the pollen spectrum (Berglund *et al* 1986).

Pollen spectra from neutral soils are thus narrowly focussed in time and space compared with pollen spectra from lakes or bogs. Pollen analyses are therefore useful for studies of former vegetation. Fossilised pollen assemblages are often preserved in soils beneath prehistoric barrows due to lack of oxygen and hence may indicate vegetation and land-use at the site when the barrow was constructed (Dimbleby 1985; Andersen 1992a). The barrows often display a turf structure or contain humic layers within the fill material because soil material was used for their construction. Pollen spectra from the barrow fill therefore indicates vegetation at sites around the barrow, which may be similar to or may differ from that found at the barrow site itself (Dimbleby 1985; Andersen 1992a). In cases, where abarrow has more than one building phase, pollen spectra from the fill layers may indicate changes in land-use (Dimbleby 1985; Andersen 1992a; 1992b).

Samples for pollen analysis were collected in soil and fill layers from Bronze Age barrows in Thy during recent excavations performed by Thy og Vester Hanherred Museum in Thisted, and in connection with Thy Archaeological Project. All these barrows had been destroyed and tilled, and only the lowermost parts of the original barrows were preserved.

SITES

Egshvile (THY 2554, Vester Vanned Sogn, sb. nr 12. Fig. 1, 1). The overplowed barrow at Egshvile was excavated by A.-L. Haack Olsen for Thisted Museum (Olsen 1992). It is situated on a moraine ridge south of Nors Sø. The barrow was built in three phases. The phase 1 barrow was built over an urn grave, not later than period II of the Early Bronze Age (1500-1300 BC). The barrow of phase 2 was built over and around the barrow of phase 1. It contained an urn grave from late period II. In phase 3 a stone cist from period III (1300-1000 BC) was dug into the foot of the phase 2 barrow, and the barrow was extended.

Pollen samples were secured from a 4-6 cm deep layer of brown humic sand, which represents an original surface horizon from phase 1, and from humic layers in the fill from phase 1. Pollen samples from phase 2 derive from a humic sandy layer, 5 cm deep, the original surface, and from layers of humic sandy clay in the fill. From phase 3, samples derive from humic layers in the fill (for details, see Andersen 1992b).

Torsted (THY 2159, Torsted Sogn, sb. nr. 50. Fig. 1,2). The barrow is situated on a hill west of Torsted village. A stone cist was excavated 1953. It contained a richly furnished grave from period III. Part of the barrow was excavated 1992 by A.-L. Haack Olsen for Thisted Museum. The barrow had been built in three phases (communication from the excavator). The phase 1 barrow was built over a stone cist with burial gifts from period III. The phase 2 barrow was built over and around the barrow from phase 1. It contained the stone cist examined 1953. The phase 3 barrow was an extension to the phase 2 barrow. No grave was found in the excavated part of this barrow.

Fig. 1. The locations of the six Bronze Age barrows and two sites for regional pollen diagrams. 1: Egshvile. 2: Torsted. 3 and 4: Bjergene 1 and 2. 5: Damsgård. 6: Visby. 7: Ove Sø. 8: Hassing Huse Mose.

Pollen samples were secured by the excavator from a 16 cm deep soil horizon (grey-brown sandy clay) beneath the phase 1 barrow, overlying yellow clay. A sample at 0-2 cm depth was rather poor in pollen. Samples taken deeper in the soil horizon were very poor in pollen. The fill layer from phase 1 showed turf structures with layers of grey-brown sandy clay. The fill from phase 2 and 3 was without turf structure. Samples were collected from yellow-brown sandy clay from phase 2 and from dark-brown fine clayey sand from phase 3.

Bjergene, barrow 1 (THY 2758, Hørsted Sogn, sb. nr. 17. Fig. 1,3). The barrow was excavated as part of the Thy Project by Inge Kjær Kristensen. It is situated near the top of a hill 56 m above sea level. The barrow consisted of two phases. The barrow from phase 1 was built over a stone cist, and was later extended in phase

2. The stone cist is from Early Bronze Age, most likely period II or III (J.-H. Bech personal communication). A soil horizon below the barrow contained artefacts from a Late Neolithic settlement.

Pollen samples were secured from sections in the phase 1 and phase 2 barrows. Section A from phase 1, near the stone cist, contained the soil horizon of brown-grey stony clay, with ard tracks at the lower limit, at 63-75 cm depth, overlying light-yellow stony clay (pollen analysis at 0-2 cm below the soil surface). Samples taken deeper in the soil contained very few pollen grains. The overlying fill showed a diffuse turf structure with alternating layers of light-yellow and brown-grey stony clay. Samples were analysed at 54-56 and 42-44 cm depth.

Section B, from the phase 1 barrow, 3.2 m north of section A, contained a layer of light-yellow clay with smears of grey-brown clay, at 36-66 cm depth, overlying and covered by grey-brown stony clay.

Section C at 4.65 m north of section A contained 65 cm fill from phase 2 consisting of alternating dark-grey and light-grey stony clay above light-yellow clay from phase 1 (at 54-59 cm depth).

Bjergene, barrow 2 (THY 2453, Sønderhå Sogn, sb. nr. 204. Fig. 1,4). This long-barrow is situated about 400 m west of barrow 1. A cross section was excavated in connection with the Thy-Project by Michael Rowlands. Below 75 cm fill a soil horizon of dark-grey stony clay (5 cm deep, section D) and light-grey stony clay (9 cm deep) over yellow stony clay occurred. Ard tracks were found at the lower limit of the light-gray stony clay. The soil horizon contained artefacts from a Late Neolithic settlement (J.-H. Bech, personal communication).

The barrow fill showed a distinctive turf structure. The turfs were inverted and each turf contained layers of dark- grey stony clay (2 cm deep, lowermost), light-grey stony clay (7-8 cm deep) and light-yellow stony clay (2-3 cm deep). These layers are similar to the soil horizon beneath the barrow in inverted sequence. Samples from the dark-grey stony clay from two turfs were analysed.

A layer of light-yellow stony clay with dark coloured horizons was seen in the barrow fill, at 28-62 cm depth, 1 m north of section D (section E).

Damsgård (THY 2954, Sønderhå Sogn, sb. nr. 52. Fig. 1,5). The barrow was partly excavated in 1992 by J.-H Bech, Thisted Museum, and the work was continued in 1993 as part of the Thy Project (Olsen & Bech 1996). The barrow is situated near Damsgård, south of Sønderhå. Samples for pollen analysis were secured by the excavator from a soil horizon of grey-brown clayey sand, 10 cm deep and from layers of dark-brown clayey sand, which were included in the fill. Ard tracks were observed at the lower limit of the soil horizon.

The barrow contained a stone cist with a cremation burial from the Early Bronze Age, period III, and a pit close by with remnants of the funeral pyre. A sample from the burial contained burnt plant tissue and a few pollen grains of hazel and birch, which had become deformed due to heating.

Visby (THY 2563, Visby Sogn, sb. nr. 109. Fig. 1,6). The long-barrow at Visby is situated on a moraine ridge near the shore of Visby Bredning. It was excavated in 1989 by A.-L. Haack Olsen for Thisted Museum. The barrow contained a stone cist from the Early Bronze Age, most likely from period II (J.-H. Bech, personal communication). Samples were secured from a soil horizon of grey-brown stony sand, 13 cm deep, overlying grey yellow stony sand and covered by fill material (section A, 2 m east of the grave), and from layers of grey-brown stony sand included in the barrow fill (section B, 3.5 m east of the grave, 65-67 and 47-49 cm below the surface).

POLLEN ANALYSES

Of the five barrows examined, Egshvile, phase 1 and 2, are from period II of the Early Bronze age, barrow 1 at Bjergene and Visby may also belong to period II, and Egshvile, phase 3, Torsted and Damsgård are from period III. The age of barrow 2 at Bjergene is somewhat uncertain. Ard tracks were observed at the lower limit of the soil horizons at Bjergene 1 and 2, and at Damsgård.

Pollen spectra derive from increasing depth levels in the soil horizons at Damsgård, Bjergene 2 and Visby. The deepest pollen spectra in these soil horizons are likely to be the oldest due to gradual downmixing of pollen, but changes in the original pollen assem-

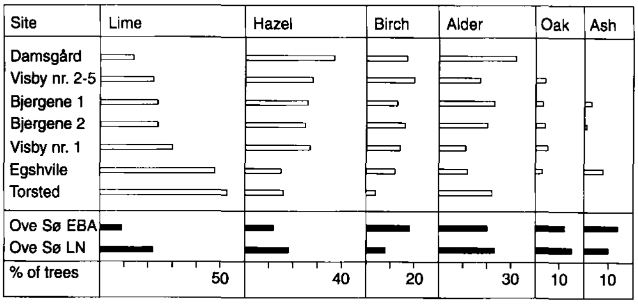

Fig. 2. Tree frequencies in samples from the six Bronze Age barrows, and in two samples from Ove Sø (EBA: Early Bronze Age, LN: Late Neolithic).

blages may have become modified due to bioturbation. The other pollen spectra derive from the topmost parts of soil horizons or from fill material and are contemporaneous with the barrow.

Tree pollen

Tree pollen, calculated in percentage of all pollen in each sample, is generally scarce (varying 1-43 %, Fig. 3). At Visby, the tree pollen frequency decreases from 43 % at the bottom of the soil horizon to 15-17 % in its topmost part (Fig. 3). Clearance of trees and increasing herbaceous vegetation is indicated. Tree pollen is fairly frequent in samples from Bjergene 1 (12-34 %) and Bjergene 2 (6-29%), and scarcer in samples from Egshvile, Damsgård and Torsted (1-15%). It is indicated that woodland remnants were present around the barrows at Visby and Bjergene, at least some time before they were built. Trees were very scarce or absent around the barrows at Egshvile, Damsgård and Torsted. Increased deforestation is indicated for the youngest barrows (Egshvile phase 3, Damsgård, Torsted).

The numbers of tree pollen were too low in most samples for a calculation of percentages for the tree species. Average percentages were calculated for all samples from each barrow with the exception of one sample from Visby and one from Egshvile, which differed distinctly from the other samples in the same barrow. The percentages shown in Fig. 2 shows tree coverage after correction for differences in the pollen productivity of the tree species (Andersen 1970; 1980). They are arranged after decreasing frequencies for lime. These tree frequencies are compared with the frequencies in samples from the late Neolithic and the Early Bronze Age from Ove Sø (Andersen & Rasmussen 1994).

Lime or hazel dominated the tree vegetation, birch and alder were frequent, and oak and ash were scarce. Lime and hazel were scarce in the woodlands around Ove Sø in the late Neolithic and Early Bronze Age. The high frequencies at the barrows therefore indicate local populations. The high frequencies of hazel, birch and alder indicate disturbed woodlands. Lime had decreased distinctively in the uppermost soil and the fill samples from Visby (nr. 1 and 2-5 in Fig. 2), presumably due to felling. The very high frequencies for lime at Egshvile and Torsted may indicate that the tree pollen present in the soil at these locations were residuals from former vegetation.

Tree pollen deformed by heat from burning of the vegetation were very scarce. Hence, it is indicated that fire was not used commonly after the clearance of tree vegetation in contrast to Middle Neolithic, where fire clearance was a common practice (Andersen 1992a). A sample from the barrow fill at Egshvile differed distinctly from the other samples by dominance of birch (75 %). This pollen was deformed due to heat from burning of vegetation. It is indicated that this sample derives from a place, where birch woodland had been cleared and burned.

The tree pollen in the barrow samples thus indicates that remnants of disturbed coppice woodlands had been present in the vicinity of barrows probably dating from period II, whereas the barrows from period III were situated in treeless areas.

Non-tree pollen

Treeless vegetation dominated around the barrows and increased in importance in the course of the Early Bronze Age. Frequencies of non-tree taxa were calculated in percentage of the non-tree pollen sums. These pollen sums vary from 75 to 163. Pollen from ligulate composites (Liguliflorae) and fern spores (*Dryopteris* type) were excluded. Pollen from ligulate composites is buried in soils by burrowing bees and may occur with high frequencies. The fern spores may

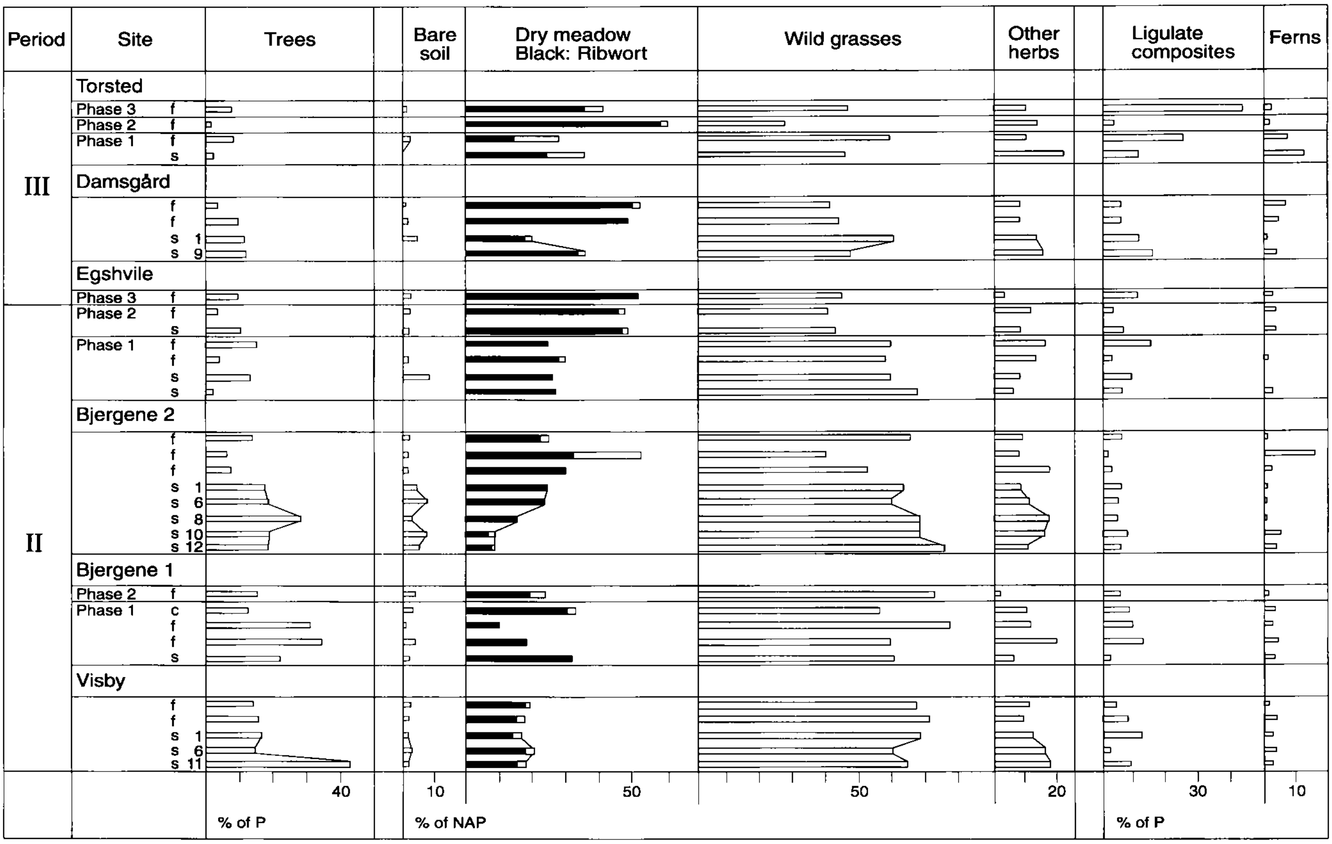

Fig. 3. Tree frequencies and non-tree pollen frequencies for samples from the six Bronze Age barrows. f: sample from barrow fill, c: sample from clay layer, s: sample from continuous soil horizons (the figures indicate depth levels in cm in the soil horizons). The percentage bars for samples from soil horizons are connected with lines.

accumulate in soils because they are very resistant to decomposition (Andersen 1990).

The non-tree taxa were grouped into bare soil plants, dry meadow plants, wild grasses, plants from woodlands and coppices, plants from heaths and bogs, and other herbs (Andersen 1990; 1992a Fig. 3).

Bare soil plants. Pollen grains from plants which grow on bare mineral soil were generally scarce in the barrow samples examined. This plant group includes plants, which to-day may occur as weeds in cultivated or fallow areas, and the cereals.[1] The highest frequencies of the bare soil plants were found in samples from the soil at Bjergene 2, where ard tracks at the lower limit of the soil indicate former cultivation. Pollen from sheep's sorrel, the goosefoot family, knotgrass, and one cereal pollen grain (barley type) were noticed. Traces of cultivation of fields thus are present in the soil at Bjergene 2. At other barrows (Visby, Bjergene 1, Egshvile and Damsgård), there may be slight traces of former field cultivation. Ard tracks were also observed at Bjergene 1 and Damsgård.

1 The identification of cereal pollen by size measurements was hampered by modification of the size due to crumpling. Nine pollen grains with scabrate sculpture, diameter of the pore *annulus* 8.1-9.2 µm and average size (average of the largest and the smallest diameters) 25.3-38.5 µm were identified to barley type (*Hordeum* type). Four verrucate grains with *annulus* 9.2-12.7 µm and average size 39.6-43.7 µm were identified to oat type (*Avena* type). Barley type includes barley and a few wild grasses. Oat type includes oat and wheat (cp. Andersen 1979 b).

Dry meadow plants. The dry meadow plant group includes plants which occur in more or less dense herbaceous vegetation on dry soil. Their frequencies vary from 9 to 60%. Ribwort plantain is the most important species. Other dry meadow plants are the Pteriophytes adder's tongue (*Ophioglossum*) and moonwort (*Botrychium*), white and red clover (*Trifolium repens*-type and *T. pratense*-type), eyebright (*Euphrasia*-type) and bellflower (*Campanula* type). The spores of adder's tongue occur with high frequencies in two samples from Torsted (7 and 11%) and moonwort in one sample from Bjergene 2 (15%). Fern spores of *Dryopteris* type are also frequent in these samples. These high frequencies of Pteridophyte spores are likely to be due to loss of pollen, and hence do not indicate high frequency of these plants in the former vegetation.[2] The occurrences of dry meadow plants other than ribwort are, therefore, insignificant.

The ribwort pollen occurs with frequencies ranging from 7 to 37% in samples from Visby, Bjergene and Egshvile, phase 1. At Bjergene 2, the ribwort frequency increase from around 7% at the bottom of the soil horizon to around 24-37% in the topmost part and in the samples from the barrow fill. The ribwort pollen frequencies found at Egshvile increase from around 30% in the phase 1 barrow to around 50% in the phase 2 and 3 barrows. At Damsgård, these frequencies vary between 19 and 51%, and they increase from around 17-27% in the phase 1 barrow at Torsted to 37-59% in the phase 2 and 3 barrows. Hence, ribwort frequencies below 37% occur at the barrows from Visby, Bjergene and Egshvile, phase 1, all probably belonging to period II. Very high pollen frequencies of ribwort (above 37%) occur in the youngest phases of the barrows at Egshvile and Torsted, and at Damsgård.

Ribwort plantain is found in various plant communities such as fields, fallow fields, meadows and pastures (Behre 1981), and is most frequent in grazed pastures (Berglund *et al.* 1986). The highest ribwort pollen frequencies occurred in a grazed pasture (28%, calculated in percentage of the non-tree pollen). Many authors consider ribwort as a pastoral indicator (see Maguire *et al.* 1983). Like most other plants, ribwort is damaged by grazing (Groenman-van Waateringe 1986). The leaf rosettes of ribwort, however, survive grazing and continue to produce new flowering spikes throughout the summer, whereas heavy grazing reduces the pollen productivity of the grasses (Groenman-van Waateringe 1993).

It was concluded that the varying frequencies of ribwort pollen found in soil samples from Neolithic barrows indicated varying grazing pressure (Andersen 1992a). The ribwort frequencies found in the Bronze Age barrows from Thy are also considered indicative of variations in the intensity of grazing.[3] Moderate grazing is indicated in the samples from Visby and Bjergene 1. At Bjergene 2, there was a change from ungrazed to moderately grazed vegetation prior to the construction of the barrow. The samples with low rib-

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2 Pollen grains were present in nearly all the samples from the sites mentioned above. At another barrow, at Tovsgård, Vigsø parish, no pollen grains were present. The samples from this barrow consisted of calcareous clay, where all pollen grains had been destroyed due to very intensive biological activity at the time of burial.

Pollen assemblages preserved in soil samples may become modified by loss of pollen due to biological breakdown (Havinga 1974). Pollen grains with thinned exines (Aaby 1983) were frequent in the present sample set. The corrosion by thinning of the pollen exines indicates incipient breakdown of the pollen grains. Pollen grains with strongly thinned exines were, however, scarce. As Pteridophyte spores are particularly resistant to breakdown (Havinga 1971), these spores may become overrepresented in soil pollen spectra due to loss of pollen (Andersen 1992a). Spores from Pteridophytes (Adder's Tongue, *Ophioglossum vulgatum*, Moonwort, *Botrychium*, and ferns, *Dryopteris* type) were scarce in nearly all the present pollen spectra. Spores of Moonwort and ferns occur in unusually high frequency in two samples from the barrow at Torsted and one from Bjergene 2 . Significant loss of pollen may be indicated in these samples. Modern pollen derived from the plow layers were not observed.

3 Gaillard *et al.* (1994) found ribwort plantain to be associated with present-day mowed and grazed meadows in pollen spectra from South Sweden. No analogues to the Bronze Age samples from Thy occurred in the South Swedish data set (M.-J. Gaillard, personal communication). Hjelle (1998) found high frequencies for ribwort pollen (up to 80%) in pollen spectra from grazed and mowed meadows at coastal sites and lower frequencies (up to 20 % at inland sites in Norway. The high ribwort-frequencies at the Bronze Age barrows in Thy may, therefore reflect oceanic climate at that time. The lack of a suitable technology (the scythe) makes it likely that extensive grazing rather than hay-mowing occurred around the barrow sites on hill tops in Thy during the Early Bronze Age.

wort frequencies are likely to reflect the former field cultivation. Hence, it is indicated that the former field was used for grazing at the time when the barrow was erected. At Eghsvile, a change from moderately grazed vegetation to very heavy grazing is indicated. It appears that the grazing pressure increased after the first barrow was constructed, in phase 2 (period II) and phase 3 (period III). At Damsgård, moderate grazing is indicated at the site of the barrow (soil samples) and heavy grazing around the site (fill samples). At Torsted, grazing was moderate at the time, when the first barrow was built, and the grazing was very intensive in the later phase.

Wild grasses. The grasses are abundant in treeless habitats such as cultivated areas, pastures, meadows, roadsides and wasteland. Grass pollen is abundant in all of the samples from the Bronze Age barrows from Thy (ranging from 26 to 76%). As mentioned above, grazing reduced the pollen productivity of grasses . The grass pollen frequencies are, therefore, inverse to those of ribwort plantain, high at sites with low, and low at sites with high grazing pressure.

Plants from woodlands and coppices, and heaths and bogs. The ferns bracken, oak fern and polypody were considered plants from woodlands or coppices. Their spores occur scattered and in very low frequencies. Hence, the vegetation of the tree communities represented at some sites (Visby, Bjergene) had been poor.

Plants from heaths and bogs are also very scarcely represented. Heaths and bogs were, therefore, not present. it is indicated that leaching of the soils had not taken place in spite of heavy exploitation. Wetland soils were not used for building the barrows, in contrast to Neolithic barrows (Andersen 1992a).

Other herbs. The plant group „other herbs" includes plants which could not be assigned to definite habitats. The most common taxa were mugwort (*Artemisia*), bedstraw (*Galium*-type), buttercup (*Ranunculus acer*-type), ragwort (*Senecio*-type), milfoil (*Achillea*-type), sandwort (*Arenaria*-type), and the crucifer family (Cruciferae).

In samples from Neolithic barrows mugwort was shown to have been associated with coppices that had been burned, as the mugwort pollen found were deformed by heating (Andersen 1992a). Deformed mugwort pollen grains were scarce in the present samples. The mugwort pollen, therefore, may derive from plants growing at a larger variety of habitats influenced by human activities. The other pollen taxa in this plant group each represents a number of species, which occur in a wide range of habitats.

Pollen in this plant group occur at all the sites with frequencies ranging from 2 to 21%. Mugwort pollen occurs in nearly all samples with frequencies 1-8%.

Ligulate composites. Pollen from ligulate composites (Liguliflorae) occur in all of the samples examined with highly varying frequencies (1-42%). Some of these pollen were obviously buried by digger bees. It is therefore impossible to estimate the importance of these plants in the vegetation.

Ferns. The fern spores of *Dryopteris* type occur in nearly all samples. These spores may be relics from former vegetation, as they are very resistant to breakdown. As mentioned above, they are overrepresented in some of the samples (with frequencies up to 15%).

DISCUSSION

Statistical analysis

The relationships of the various non-tree pollen taxa were examined by numerical principal component analysis. 20 taxa, which occurred in more than 5 samples, and 30 samples were used (excluding 3 samples with high frequencies for Pteridophyte spores). The results are shown in a biplot (Fig. 4, left). The biplot shows vectors for the most frequent taxa (maximum percentage >4.9%) on the first two axes of variability (see Gordon 1982). This representation includes 96% of the total variation. The lengths of the h-vectors on the first two axes indicate the importance of the taxa, and their angles the degree of correlation. The biplot indicates seven taxa, grasses, sheep's sorrel, bedstraw (type), ragwort (type), mugwort, buttercup (type) and ribwort plantain. Grasses and ribwort are antagonistic. Bedstraw, ragwort and mugwort are mutually correlated, sheep's sorrel is correlated with

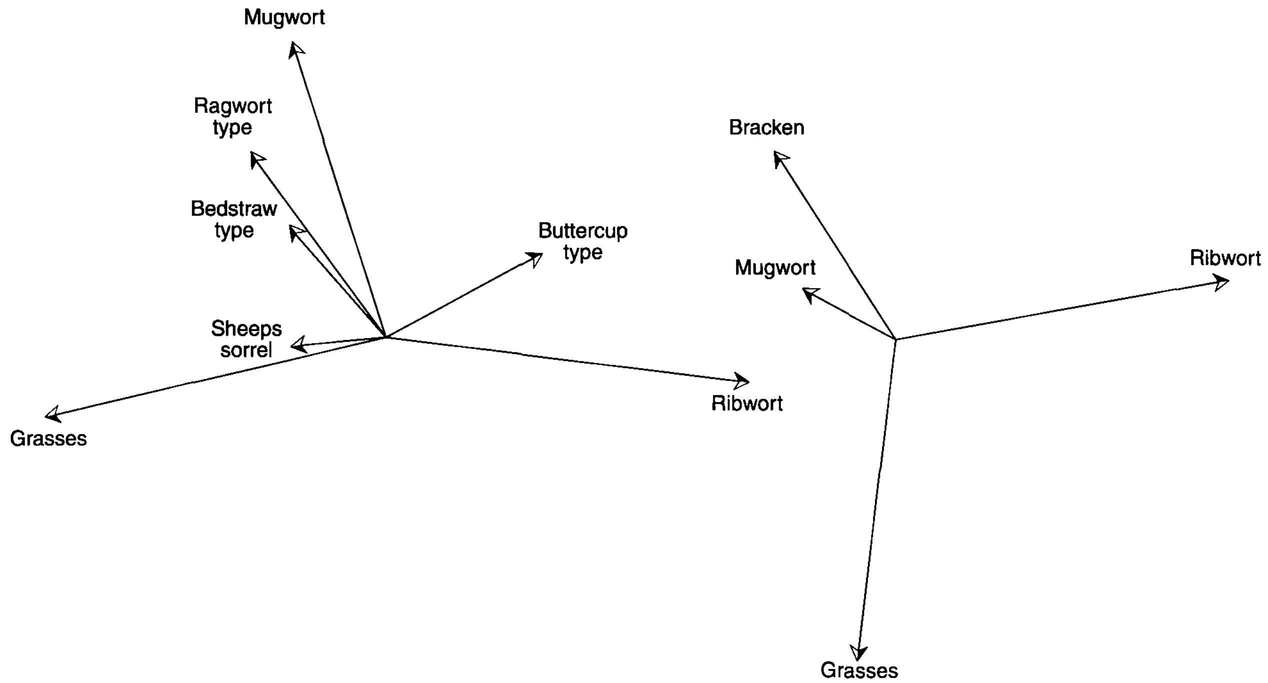

Fig. 4. Left, biplot of h-vectors for the most frequent pollen taxa (maximum percentage > 4,9) in samples from the six Bronze Age barrows. Right, biplot of h-vectors for the most frequent pollen taxa in samples from barrows from the Neolithic Funnel Beaker Culture (redrawn from Andersen 1991).

grasses, and buttercup is slightly correlated with ribwort. The frequencies of grasses and plantain were determined by grazing pressure. Sheep's sorrel occurred at ungrazed sites associated with cultivation. Buttercup was somewhat associated with grazing, and the other taxa were independent of grazing pressure.

The biplot from the Early Bronze Age barrows in-Thy is compared with a biplot of pollen spectra from Early and Middle Neolithic barrows (Fig. 4, left; Andersen 1992a). Ribwort and grasses are also uncorrelated in this biplot, while bracken and mugwort are correlated and here represent herbaceous vegetation from coppices. The two biplots in Fig. 4 illustrate a fundamental difference in land-use between the Early and Middle Neolithic and the Early Bronze Age. Coppice vegetation was frequent in the Neolithic and was widely used for swidden cultivation or grazing whereas the last remnants of coppice vegetation were cleared for cultivation and grazing in the course of the Early Bronze Age.

The distribution of individual non-tree pollen spectra from the Early Bronze Age barrows is illustrated by the triangular diagram in Fig. 5. This diagram shows percentages for ribwort plantain, the grasses, and other non-tree plants for the same samples used for the biplot calculation. The samples are distributed along the right-hand side of the triangle. Ribwort varies between 5 and 60%, the grasses between 25-80%, and non-tree plants 5-25%. There are three sample groups. Ribwort is low, below 10%, in 3 samples, very high, 45-60%, in 6 samples, and intermediate for the rest with frequencies from 15 to 40% for ribwort. Hence, these three sample groups indicate sites without grazing, sites with moderate grazing pressure, and strongly grazed sites. The samples where grazing is absent are from formerly cultivated sites (Bjergene 1 and 2). The samples with high grazing pressure are from the late barrow phases at Egshvile and Torsted, and from the Damsgård barrow. Five of these samples are from period III of the Early Bronze Age. Hence, it is indi-

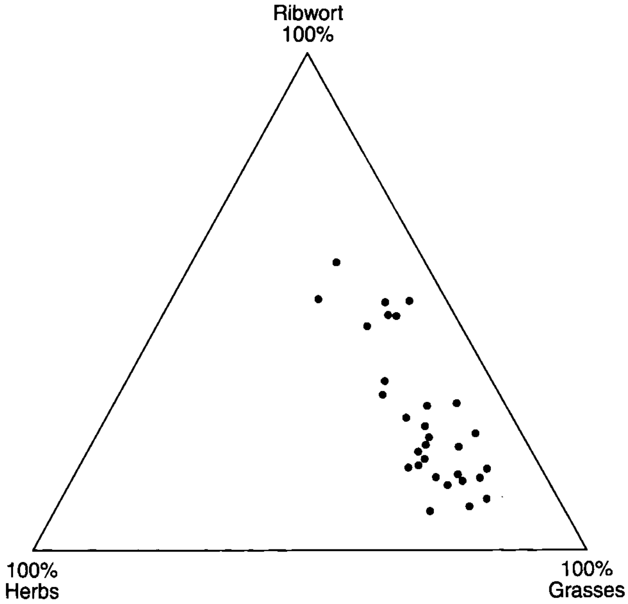

Fig. 5. Triangular diagram of pollen spectra from six Bronze Age barrows for pollen of ribwort plantain (100%), wild grasses (100%) and other non-tree pollen (herbs, 100%).

cated that grazing pressure increased after the building of the original barrows, and that grazing pressure had increased in period III.

Herbaceous plants other than ribwort and grasses were present at all the sites. Sheep's sorrel was associated with fields (together with knotgrass and chenopods), and buttercup was particularly frequent at grazed sites. Mugwort was common and indicates vegetation that was influenced by human activity, and plants from woodlands and coppices were scarce. Other herbaceous plants are difficult to characterise because of imprecise identifications. The numbers of plant taxa identified in each sample decreases somewhat with increasing percentages of ribwort. At 10% ribwort pollen 14 taxa were present, and 11 taxa were present in samples with 50% ribwort (32 samples, coefficient of correlation -0.52, P 0.24%). Hence it is indicated that strongly grazed sites were poorer in species than sites without grazing.

Changes in vegetation and land-use during the Early Bronze Age as reflected by the barrows.

The number of Bronze Age barrows examined by pollen analysis (six barrows) is small compared with the hundreds of barrows still present in Thy. The barrows, however, are well scattered geographically (Fig. 1) and represent period II and period III of the Early Bronze Age, in a time perspective. Hence, there are evidence available to allow a reconstruction of changes in the landscape and land-use during the time where building of the barrows took place.

Pollen diagrams from Hassing Huse Mose and Ove Sø in Thy (Fig. 1, 7 and 8, Andersen 1995; Andersen and Rasmussen 1994) indicate considerable clearance of woodland remnants during the Early Bronze Age. Relics of coppice woodlands were still present around the barrows at Visby, Bjergene and Egshvile, and the barrows were built in pastures with a moderate grazing pressure. The barrows at Bjergene were built in areas, which had been cleared for trees and were used for cereal cultivation for a short time, and then for pasture.

Tree vegetation was scarce or absent around the younger barrows at Egshvile (period II and III) and around the period III barrows at Damsgård and Torsted. It is therefore indicated, that clearance of coppice woodland increased during period II, and that trees were nearly absent around the barrow sites in period III.

The grazing pressure increased from moderate at the building of the first barrows at Egshvile and Torsted to very strong during the late barrow phases. It appears that continued land use around these barrows resulted in increased grazing pressure. There is also evidence of moderate to strong grazing pressure at the Damsgård barrow.

The Early Bronze Age Barrows in Thy were all built in pastureland. Some of the barrows were built in recently cleared coppice woodland that had been used for cereal cultivation in some cases. The grazing pressure became very strong around barrows built in period III.

It is indicated that land exploitation increased in the Early Bronze Age and that rearing of cattle was a main activity. Andersen (1995) discussed that the vigorous agricultural expansions in Thy in the Middle to Late Neolithic and in the Early Bronze Age may have as a background increased precipitation combined with a high demand for agricultural products.

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