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Pollen Spectra from two Early Neolithic Lugged Jars in the Long Barrow at Bjørnsholm, Denmark

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INTRODUCTION

The long barrow at Bjørnsholm, northwest Denmark, was excavated and described by Søren H. Andersen and Erik Johansen (this volume). A longitudinal section through the eastern part of the barrow showed a 12 cm deep horizon of grey-brown sandy brown earth over subsoil of yellow stony sand and covered by brown-grey sandy fill with humic horizons and recently plowed soil (Andersen and Johansen 1992, this volume fig. 5). In the section was seen traces of a transversal ditch, which had been filled with grey-white sand. Two complete lugged jars, and fragtments of a third, of Volling style (labelled AAVW and AAVT), and other objects were found in the ditch during the excavation. Similar pot-sherds were found in the top layer of the nearby kitchenmidden. Oyster shells from this layer were radiocarbon-dated at 3160±95 and 2940±95 ^{14}C years BC (see Andersen and Johansen 1992, this volume, average date 3940–3700 BC, calibrated, note 1). Samples of soil found within the jars were secured by the excavator.

POLLEN ANALYSES

None of the samples from the soil horizon and the fill contained pollen. The destruction of pollen can be ascribed to seepage of oxygenated rain water through the shallow sandy deposits, and a high biological activity, which is indicated by numerous vertical earthworm-casts.

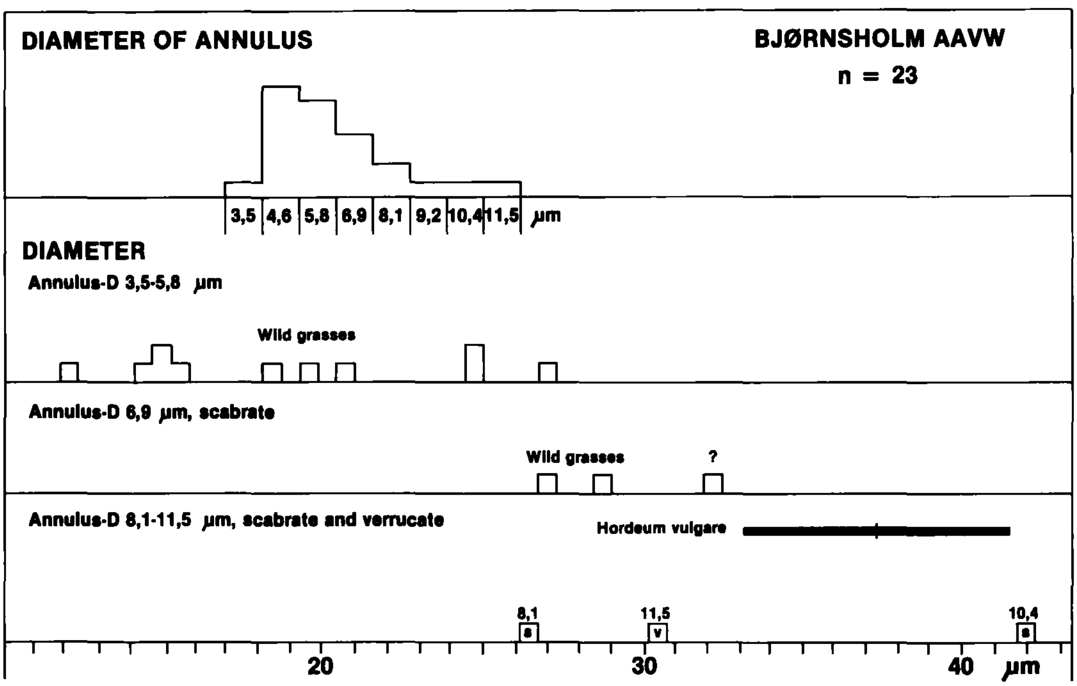

Fig. 1. Diameter of pore *annulus* (an1-D) in 23 Gramineae pollen, and average size (M+ + M-/2) of individual pollen grains from jar AAVW from the long barrow at Bjørnsholm, and size range (x ± 2s) for modern pollen of barley (*Hordeum vulgare*, from Andersen 1979).

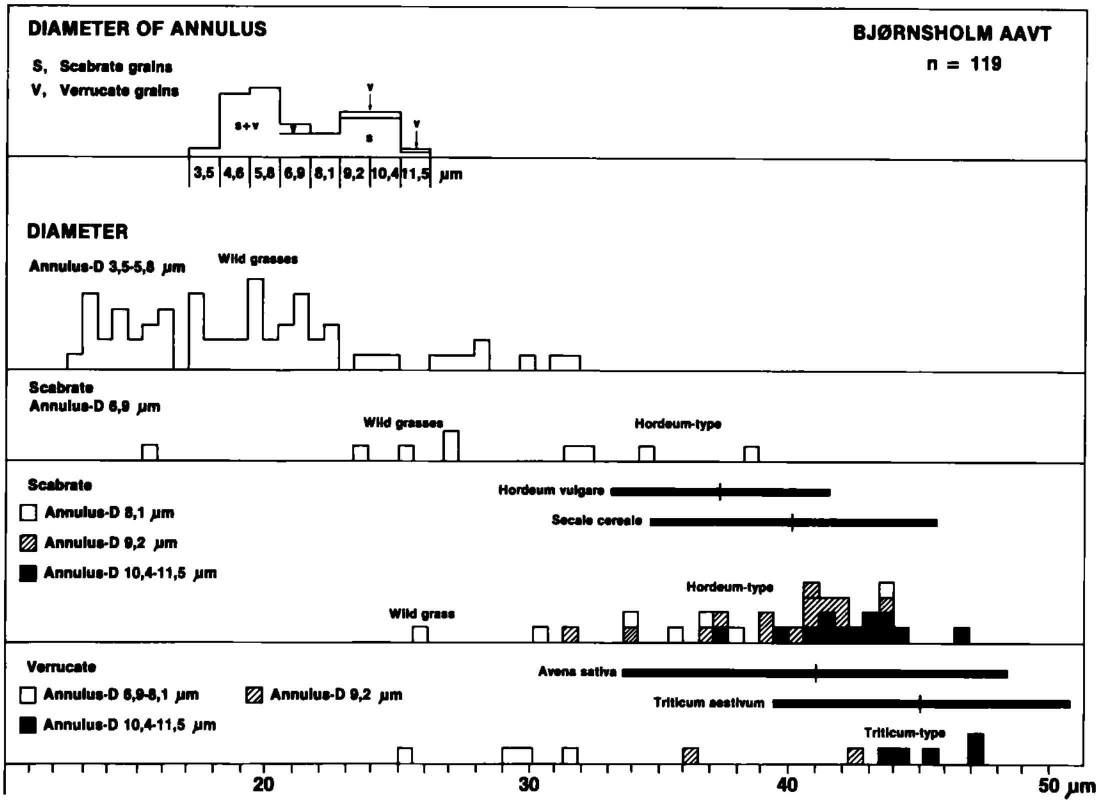

Fig. 2. Diameter of pore *annulus* (an1-D) in 119 Gramineae pollen, and average size (M+ + M-/2) of individual grains from jar AAVT, and size range (x ± 2s) for modern pollen of barley (*Hordeum vulgare*), rye (*Secale cereale*), oats (*Avena sativa*), and wheat (*Triticum aestivum*, from Andersen 1979).

The samples from the lugged jars, in contrast, contained abundant pollen. It can be suggested that soil moisture created an oxygen-poor environment unfavourable for pollen destruction inside the jars.

One sample from jar AAVW and two from AAVT were examined by pollen analysis. They were treated with potassium hydroxide, hydrofluoric acid, and acetolysis mixture, and were mounted in silicone oil. Pollen preservation varied considerably. In jar AAVW all pollen grains were crumpled. In jar AAVT there occurred crumpled as well as excellently preserved, inflated grains. The numbers of pollen grains counted vary 210–352. The names of plant species in latin follow *Flora Europaea*.

IDENTIFICATION OF GRASS POLLEN AND CEREAL POLLEN

In order to separate pollen of cereals from wild grass pollen, the pore *annulus* was measured in all grains. The average pollen diameter (largest and smallest diameter, divided by 2) was measured in all grains with *annulus* larger than 6 µm, except for ruptured pollen, and the sculpturing (scabrate or verrucate) was noticed with phase contrast equipment. The pollen diameter is more or less modified in crumpled grains, whereas the *annulus* diameter is not affected. The pollen grains with *annulus* diameter smaller than 6 µm belong to wild grasses, and grains with a larger *annulus* may belong to cereal species (Andersen 1979). The pollen of barley (*Hordeum vulgare*) and rye (*Secale cereale*) have a scabrate sculpture, those of wheat (*Triticum*) species and oats (*Avena sativa*) are verrucate, and are larger than most wild grasses. Inflated rye pollen grains can be distinguished from barley pollen by shape, whereas crumpled grains of rye and barley cannot be separated.

Wild grasses with small pollen grains (less than 30 µm) and *annulus* diameter (less than 7 µm) dominate in the sample from jar AAVW (fig. 1). 4 grains with a larger *annulus* and scabrate sculpture belong to barley or some wild grasses such as couch-grass (*Agropyron*), lyme-grass (*Leymus arenarius*), and marram-grass (*Ammophila arena-*

	AAVW	AAVT	
Analysis, nr.	1	2	3
Pollen sum, P	357	210	240
Tree pollen sum, AP	315	134	75
Trees, % P	88,2	63,8	31,3
Birch, *Betula*, % of trees	93,0	91,8	90,7
Hazel, *Corylus avellana*	3,2	6,7	5,3
Alder, *Alnus glutinosa*	3,2	1,4	4,0
Oak, *Quercus*	0,6	–	–
Deformed tree pollen, % AP	57,3	23,9	36,0

Table 1. Tree pollen in samples from the two lugged jars from the Bjørnsholm long barrow. The tree pollen percentages were corrected according to Andersen (1970, 1980).

rius). One grain with verrucate sculpture and a large *annulus* (11,5 μm) belongs to wheat or oats.

Wild grass pollen with small pollen grains and *annulus* diameters are less frequent in the samples from jar AAVT and there is a considerable proportion of pollen with a large *annulus* (8.1–11.5 μm), most of which are scabrate (fig. 2). 6 inflated grains belong to rye. The other scabrate pollen grains larger than 32 μm or with *annulus* larger than 7 μm belong to barley, rye or the wild grasses mentioned above (*Hordeum*-type in figure 2). The verrucate grains with *annulus* larger than 9 μm are likely to belong to wheat or oats (*Triticum*-type in fig. 2).

RESULTS OF THE POLLEN ANALYSES (TABLES 1–2)

Pollen numbers and tree pollen spectra are shown in table 1, and pollen spectra for non-tree pollen in table 2.

The pollen of ligulate composites (Liguliflorae) and ferns (*Dryopteris*-type) were calculated outside the pollen total. The pollen of ligulate composites often occurs in large numbers in soils and are likely to have been buried by burrowing bees (see Andersen 1988). Their presence with high frequencies (10–14%, table 2), may be taken as an indication that the jars were filled with near-surface soil, probably fetched in the surrounding area at the time when the trench was filled.

The *tree* pollen frequencies differ considerably in the three pollen spectra (table 1). Tree pollen dominates in jar AAVW (88%), it is less frequent in one sample from AAVT (64%), and non-tree pollen dominates in the other sample from this jar (31% tree pollen). In contrast, the tree percentages in the three pollen analyses are very alike each other. Birch (*Betula*) dominates strongly (91–93%), and there are only slight traces of other trees. Much of the tree pollen was deformed due to heating (24–57%, see Andersen 1988). It can be concluded that the tree pollen derives from birch populations, which had been burned before the soil was dug.

The two *non-tree* pollen spectra from jar AAVT are very alike each other, and differ considerably from jar AAVW (table 2). Plants from bare soil (including cereals), dry

	AAVW	AAVT	
Analysis, nr.	1	2	3
Non-tree pollen, NAP	42	76	165
Bare soil, % NAP	21,4	31,6	32,1
Barley, *Hordeum*-type	9,5	7,9	17,0
Wheat, *Triticum*-type	2,4	7,9	3,0
Rye, *Secale cereale*		1,3	3,0
Sheep's Sorrel, *Rumex acetosella*	9,6	9,2	6,7
Knot-grass, *Polygonum aviculare*	–	3,9	1,2
Corn Spurrey, *Spergula arvensis*	–	1,3	–
Corn-flower, *Centaurea cyanus*	–	–	0,6
Goose-foot Family, Chenopodiaceae	–	–	0,6
Dry Meadow	–	3,9	5,4
Ribwort, *Plantago lanceolata*	–	2,6	1,2
White Clover, *Trifolium repens*	–	1,3	3,6
Hoary Plantain, *Plantago media*	–	–	0,6
Other herbs	47,6	57,9	56,4
Wild grasses, Gramineae undiff.	42,9	38,2	29,7
Milfoil, *Achillea*-type	2,4	–	–
Bedstraw, *Galium*-type	2,4	–	–
Crucifer Family, Brassicaceae	–	17,1	26,7
Cinquefoil, *Potentilla*	–	1,3	–
Dropwort, *Filipendula*	–	1,3	–
Shrubs	4,8	1,3	0,6
Black Elder, *Sambucus* nigra	4,8	1,3	–
Hawthorn, *Crataegus*	–	–	0,6
Forest and coppice	21,4	–	4,2
Mugwort, *Artemisia*	19,0	–	4,2
Bracken, *Pteridium aquilinum*	2,4	–	–
Heaths and bogs	4,8	5,3	1,2
Heather, *Calluna vulgaris*	2,4	3,9	1,2
Club-moss, *Lycopodium annotinum*	2,4	–	–
Sedge, *Carex*-type	–	1,3	–
Ligulate Composites, Liguliflorae, % P	14,3	12,4	10,0
Ferns, *Dryopteris*-type	–	1,0	–
Mugwort, *Artemisia*, deformed, %	75,0	–	71,4

Table 2. Non-tree pollen in samples from the lugged jars from the Bjørnsholm long barrow, in percentages of non-tree pollen (NAP) and total pollen (P, Liguliflorae, ferns).

meadow, and other herbs, are more frequent in the two samples from jar AAVT than in AAVW. Pollen of rye occurs in jar AAVT and pollen of plants from the crucifer family (Brassicaceae) are very frequent in the samples from this jar.

As mentioned above, there were many excellently preserved pollen grains in the samples from jar AAVT (cereal and crucifer pollen in particular). Rye, moreover, did not occur in the Danish Neolithic. One therefore suspects that much of the non-tree pollen in the samples from this jar derives from more or less recent vegetation, in particular cereal fields and fields with rape (*Brassica napus*) or mustard (*Sinapis alba*, both from the crucifer family), and was transported downwards by burrowing earthworms. The jar had a wide opening (19,5 cm in diameter) and was found with the opening turned upwards (Andersen and Johansen 1992, this volume). Vertical earthworm casts were frequent in the section, and it would not be unlikely that earthworms would migrate downwards in dry periods and seek out the moist interior of the jar, to deposit gut material with pollen grains from the surface. The tree pollen in this jar is likely to be original and was apparently mixed with differing amounts of young pollen in the two samples. It is impossible to evaluate the origin of other non-tree taxa, in these samples.

The sample from jar AAVW did not contain rye and crucifer pollen, and no well preserved pollen grains were seen. It therefore seems justified to assume that the pollen spectrum from this jar is uncontaminated with younger pollen. In contrast to the other jar, jar AAVW is narrow-necked (the opening is 6,9 cm wide), and was found with the opening pointing in a horizontal direction or obliquely downwards (see Andersen and Johansen 1992, this volume). This difference in accessibility explains the difference in the pollen spectra.

The high dominance of tree pollen in the sample from jar AAVW (88% of the pollen total) indicates that the soil was retrieved shortly after the burning of the birch woodland and before the site was invaded by extensive herbaceous vegetation. *Artemisia* pollen is frequent (19%). The majority was deformed by heating (75%, table 2). It can therefore be assumed that *Artemisia* was present in the birch woodland before it was burned. Of the *Artemisia* species, mugwort (*A. vulgaris*) is nitrophilous and often occurs in agriculturally disturbed habitats. Nitrophilous plant communities are typical of edges around and openings within coppices (Burrichter et al. 1980). The presence of *Artemisia*, therefore, indicates human disturbance at the establishment of the birch woodland.

Although the pollen of *Hordeum*-type cannot be identified to barley with certainty, its presence together with pollen of wheat and sheep's sorrel (*Rumex acetosella*) may be taken as an indication of the growing of cereals at the site after the burning of the birches. Cultivation of wheat at that time is confirmed by the grain impressions in sherds from the kitchenmidden (see Andersen and Johansen 1992, this volume). The wild grasses (43%) may have been associated with fields or they may have grown around the site. Other non-tree taxa are scarce in the sample.

CONCLUSIONS AND DISCUSSION

The pollen spectrum from soil within the lugged jar AAVW found in a transversal ditch near the eastern end of the long barrow at Bjørnsholm indicates a recently burnt birch woodland with traces of cereal growing. It is assumed that the soil found in the jar was fetched in the vicinity of the long barrow and was deposited there during the filling of the ditch at the construction of the barrow. The birch woodland was, therefore, nearly contemporaneous with the jar and the youngest parts of the neighbouring Early Neolithic kitchenmidden.

The birch woodland at Bjørnsholm occurred there around or just after the elm (*Ulmus*) decline (about 4200–3700 BC, note 2). At that time lime (*Tilia cordata*) dominated the forests in Denmark, even on sandy soils (see Andersen 1984). It can, therefore, be assumed that cleared lime woodland preceded the birch woodland. The abundant presence of *Artemisia* (probably mugwort, *A. vulgaris*) emphasizes that the birch woodland was artificial and was influenced by agricultural disturbance. Birch propagates easily in cleared forest soil, and birch woodlands were formerly used for swidden cultivation of cereals in Finland in a regular rotation (Linkola 1916). Sheep's sorrel, found also at Bjørnsholm, was the most frequent weed in these swidden fields. It can therefore be suggested that birch woodlands were intentionally propagated to be used for swidden cultivation. Traces of similar birch woodlands occur at other early Neolithic barrows (Andersen, in print). Swidden cultivation based on self-propagated birch woodland may, therefore, have been widespread in early Neolithic time, together with pasture of husbandry in cleared areas (Andersen, in print). This assumption would explain the increase in birch seen in many Danish pollen diagrams just after the elm decline (in Jutland: Andersen 1975, Andersen 1984, Aaby 1986a and 1986b).

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NOTES

1. The radiocarbon dates were calibrated according to the programme C^{14}-CAL by J. van der Pflicht 1988, which is based on the calibration curve of Pearson et al. 1986 (and modified by Madsen 1990). The intervals in years BC indicate the range of possible ages with one standard deviation.
2. Radiocarbon dates of the beginning of the elm decline in Jutland. Draved Bog, SW Jutland (K-738): 4980±100 before 1950 (Tauber 1967, calibrated age 3940–3690 BC).
   Elsborg Bog, Djursland (K-2220): 5160±80 before 1950 (Andersen 1984, calibrated age 4218–3814 BC).
   Two dates appear from the pollen diagrams in Aaby 1986a and 1986b. Fuglsø Bog, Djursland: about 5050 before 1950 (calibrated age about 3900–3800 BC).
   Abkær Bog, SE Jutland: about 3900 BC (calibrated age).

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