Journal of Danish Archaeology vol. 4, 1985, pp 121–128

A Pollen Analytical Investigation of a Bronze Age and Pre-Roman Iron Age Soil Profile from Grøntoft, Western Jutland

by BENT VAD ODGAARD

In an investigation of the postglacial vegetational history of western Jutland (Odgaard 1985) sites for regional and local pollen diagrams are selected. The regional sites chosen are lakes with non-calcareous (C-14-datable) deposits like lake Solsø (fig. 1, Odgaard 1981, Andersen et al. 1983) and lake Skånsø near Skive (working project). Local sites are kettle holes or undisturbed acid soils. Small kettles often contain lake or fen deposits from the entire postglacial period and are very suitable for describing local landscape development (Andersen 1985), but unfortunately they are very rare in the even landscape of western Jutland. Thus soil profiles containing records of former soil and vegetational stages must be used as local sites. Recent podzols in the area contain records of usually the last few centuries but fossil soils may provide pollen assemblages from older periods (Odgaard 1985). Archaeological investigations regularly reveal undisturbed fossil soils buried by prehistoric monuments and furthermore often provide dates of the time of burial. Thus the well-known escavations at Grøntoft (fig. 1, Becker 1965, 1968, 1971) uncovered a number of such dated prehistoric surfaces, a few of which are still preserved. As part of the description of the postglacial landscape development of western Jutland the present paper presents the main results of a pollen analytical investigation of one of these fossil soils.

The site

Grøntoft is situated in an area of Saalian (last-but-one glaciation) sandy till. Though the morphology of the landscape has been levelled by solifluction during the Weichselian (last glaciation), the relief is still strong, exhibiting some of the highest hills in western Jutland. The Grøntoft locality is situated on a west-facing slope and on the plateau behind this (fig. 2). Map no. 7 by *Videnskabernes Selskab* (1803) shows a landscape dominated by heaths and almost devoid of forests. The area is today intensively cultivated for agriculture with small scattered stands of coniferous plantations and heathlands. Small stands of semi-natural forests – oak-shrubs – are still found in the vicinity (Degn og Emsholt 1983).

The celtic field system at Grøntoft was originally described by Hatt (1949). The large excavations by Becker (1965, 1968, 1975) revealed traces of a large number of houses dated to the pre-roman Iron Age as well as a few houses dated to the Bronze Age (fig. 2). The majority of the Pre-Roman Iron Age houses are from period I (c. 500 – 300 BC) while only the village A (fig. 2: *landsby* A) is from period II (c. 300 – 150 BC, Becker 1965, 1968, 1971).

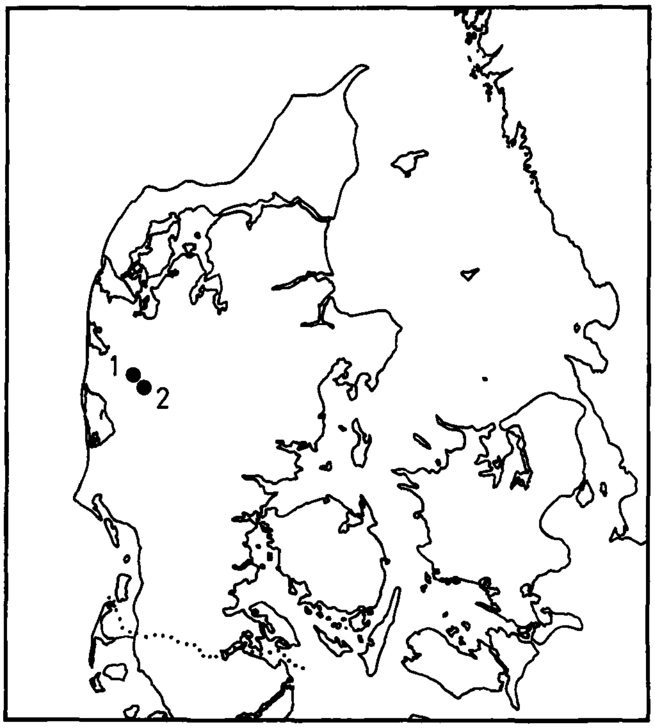

Fig. 1. The location of Grøntoft (1) and lake Solsø (2).

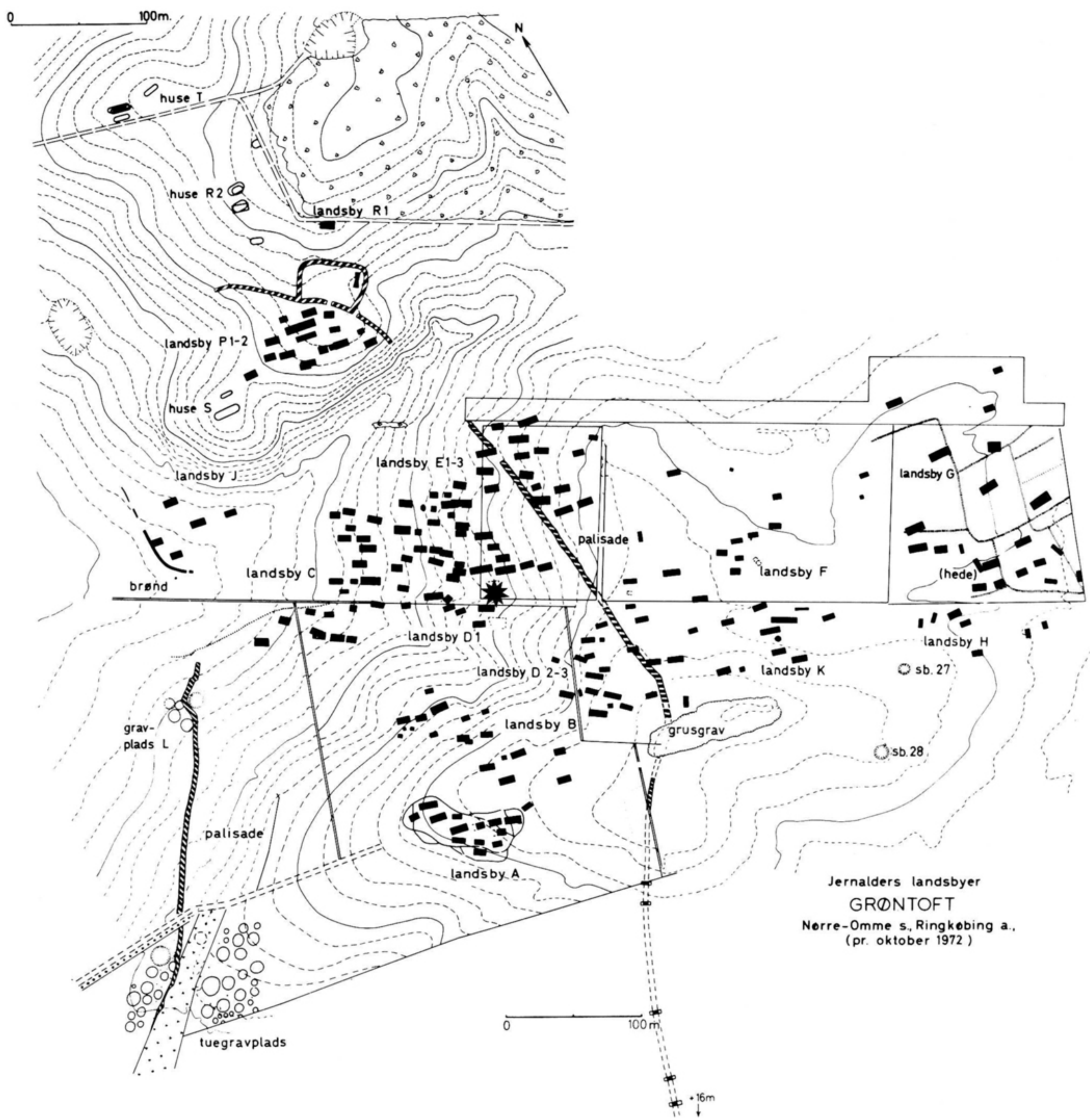

Fig. 2. The area escavated by Becker at Grøntoft with indications of the houses found. Solid signature: Pre-Roman Iron Age houses, open signature: Bronze Age houses. *huse* = houses, *landsby* = village. The position of the section E XV D is marked by an asterisk. Courtesy of C.J. Becker.

Methods

Two sections at E XV, B2 and D, described during the 1967 excavations (Becker 1971) were relocated and sampled from open profiles. The results presented here are based on the section D, which gave the most complete soil profile. Continous samples of one to a few centimeters thickness were taken and at the laboratory they were divided into subsamples for pollen analysis, loss on ignition, grain size analysis and chemical analysis. Al and Fe were extracted by boiling 20% HCl and measured by atomic absorption. P was measured spectrofotometrically as P_2O_5 after extraction by cold 1% HNO_3 (Christensen 1935). An additional 1.5 kilogram sample of the O/Ah horizon taken as close as possible to the other samples was fractionated according to the scheme of fig. 3 and fractions 1, 2, and 3 were radiocarbon dated separately. Pollen grains of cereals were identified according to Andersen (1979b).

The soil section

The section E XV D is situated on a west-facing slope (fig. 2) and is orientated in north-south direction. In the right part of the section a buried podzol profile with an O-horizon is seen (fig. 4). In the central part of the section the podzol profile is truncated by ard ploughing, the typical marks of which can still be seen in the top of the Ae horizon. In a small area to the left also the Ae layer has been removed. This erosional furrow is better developed in other sections a few meters downslope and is probably formed by water erosion during heavy rainfalls. The podzol is covered by humic sand with an intercalated layer of sandy, humic clay containing ceramics. In the profiles downslope this sandy clay layer is broader and thicker.

The position of sampling is marked on fig. 4 and a description of the profile at this point is given below.

0 – 40	Ap. Dark greyish brown, loose, humic, medium-grained sand. Recent tillage horizon.
40 – 79	Ap. Greyish brown, somewhat compact, humic, medium-grained sand with a little gravel and some pebbles. Old tillage horizon.
79 – 84	Ap. As above but colour very dark grey.
84 – 87	O. Black, greasy, sandy humus. Upper limit sharp.
87 – 92.5	Ah. Dark grey, loose, humic, medium-grained sand with a little gravel and a few pebbles.
92.5 – 100	Ae. Light grey, loose, medium-grained sand. A few pebbles.
100 – 102.5	Bh. Very dark, greyish brown, very compact, humic, greasy sand.
102.5 – 106	Bhs. Dark, rusty red, very compact, medium – grained sand with a few pebbles.
106 – 114	Bs. Brownish red, rather compact, medium-grained sand with thin dark bands. A few pebbles.
114 – 150	Bs – C. Reddish yellow, medium-grained sand with a few pebbles.
150 –	C. Yellow, loose, medium-grained sand.

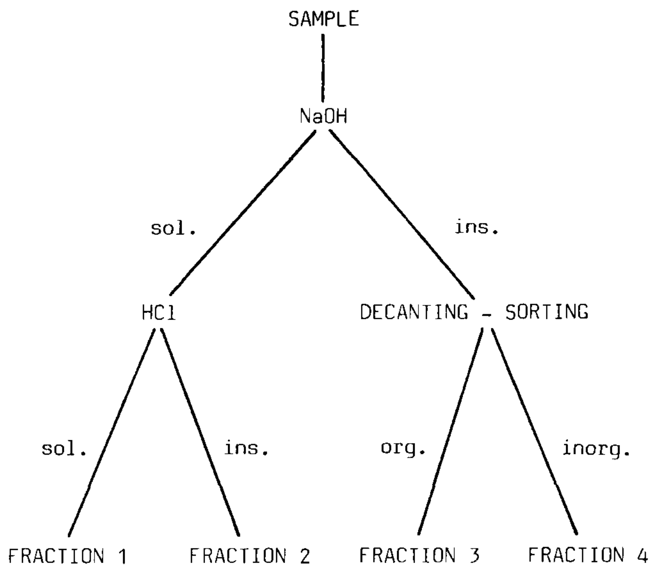

Fig. 3. Fractionation of radiocarbon sample from the O/Ah layer. sol. = soluble, ins. = insoluble, org. = organic, inorg. = inorganic.

The profile is developed in rather homogenous medium-grained sand but the silt/clay fraction is almost lacking in the C layer (fig. 5). The pH is about 5 in the Ap to Ae horizons but lower in the B and higher in the C layers. Iron and aluminium show the minima in the Ae horizon typical for podzols. The phosphorus values are low in the podzol but about 7 times as high in the Ap layer above.

FRACTION	C-14 YEARS BP	CALENDER YEARS BC
1. Acid soluble	2010 ± 210	20
2. Base soluble	3260 ± 80	1610
3. Insoluble	3340 ± 80	1700

Table 1. C-14 dates of three fractions of the O/Ah layer (see Fig. 3).

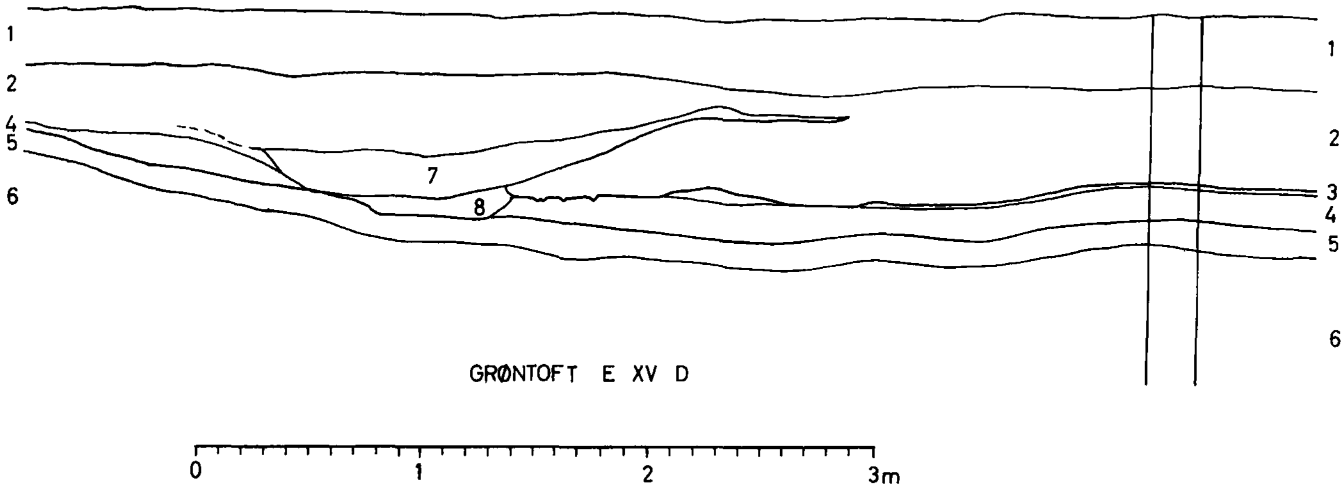

Fig. 4. Section E XV D redrawn and amended from Becker (1971). 1: Ap (recent), 2: Ap (Pre-Roman Iron Age), 3: O, 4: Ah + Ae, 5: Bh/Bs, 6: Bs/C, 7: dark, brownish-grey, clayey sand with ceramics, 8: dark, greyish-yellow sand.

The radiocarbon dates of the fractions 1, 2, and 3 are shown in table 1. Since the datings are done on material accumulated during a longer period of time the smooth curve of Clark (1975) has been used for calibration to calender years instead of the wriggled curve of Pearson et al. (1983).

The ceramics of the sandy clay horizon in the Ap layer is dated by Becker (1971) to an early part of period II of the Pre-Roman Iron Age (c. 300 – 200 BC).

The pollen diagram

Most deposits chosen for pollen analytical studies are sedimentated in cumulative geological systems with no or insignificant postdepositional disturbances. Such systems are i.a. bogs, fens and lakes but not mineral soils. Pollen deposited on a soil surface is liable to transportation during bioturbation and to a smaller degree also to downwashing. Although soil pollen diagrams cannot be interpreted as straigthforward as can pollen profiles from peat and gytja, former local vegetational stages may nevertheless be reflected in the pollen assemblages of acid soils (Andersen 1979a, Aaby 1983).

In the Grøntoft diagram (fig. 6) the pollen spectra are almost identical throughout the podzol with high values of heather and single grains of bearberry (*Arctostaphylos uva-ursi*), a plant of dry heathland. At 99 cm there is a single-sample maximum of spurrey (*Spergula arvensis*). The lime curve shows decreasing values up through the podzol profile. In the Ah and O horizons the curve of plantain (*Plantago lanceolata*) is rising. Barley (*Hordeum*-type) occurs as single grains in the Ah and O horizons.

At the transition to the Ap horizon the curves for sum trees, plantain and bracken (*Pteridium*) change abruptly. Through the lower part of the Ap layer there is a gradual rise in the curves of grasses, sorrel (*Rumex acetosella/thyrsiflora*) and spurrey accompanied by a decrease in sum trees and heather. Pollen types occurring with low values are i.a. annual knawel (*Scleranthus annuus*) spotted persicaria (*Polygonum persicaria*-type), knotweed (*Polygonum aviculare*), goosefoot family (*Chenopodiaceae*), sheep's bit (*Jasione montana*) and hemp-nettle (*Galeopsis*).

Discussion

The radiocarbon age of the acid-soluble fraction of the O/Ah horizon is younger than the age of the other fractions. The most reliable date is the one of the insoluble fraction but the base-soluble part gives approximately the same age. The acid-soluble fraction contains young organic material dissolved at higher levels in the profile and precipitated in the O/Ah horizon. Ellis and Matthews (1984) in a series of radiocarbon datings of a fossil mor layer in Norway, found the base-soluble and insoluble fractions to give correct ages, while the acid-soluble fractions were mostly too young. Since there is no reason to suspect the reliability of the C-14 dates there exists a conflict between the early Bronze Age

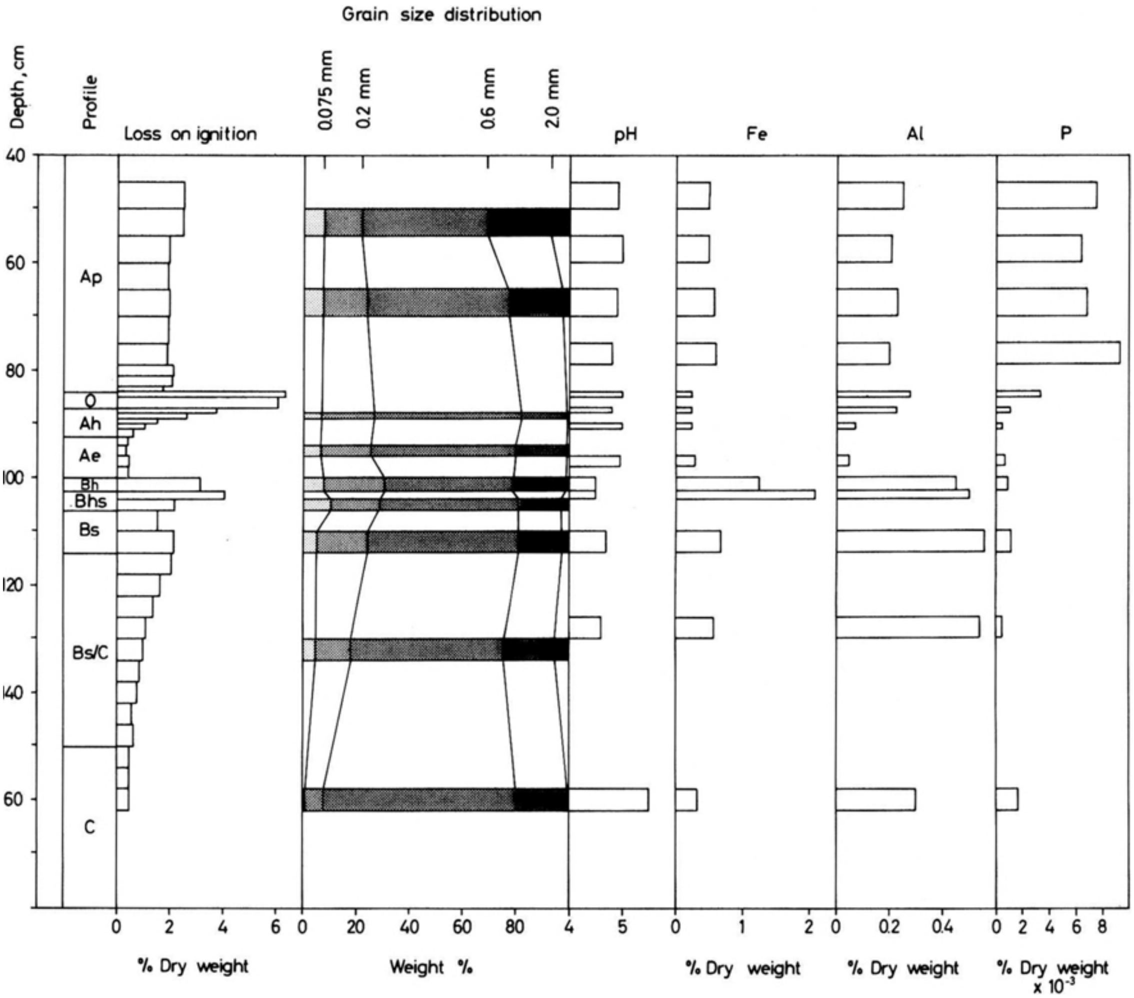

Fig. 5. Physical and chemical analyses from section E XV D.

dating of the O/Ah horizon and the Pre-Roman Iron Age period II dating of the ceramics found in the sandy clay layer in the Ap horizon. There is a timespan of about 1500 years between these two horizons, otherwise expected to be almost synchronous. There are two possible explanations of the conflicting dates:

1. The podzol profile was buried long before tillage began at the site.
2. The topmost part of the O horizon has been removed.

Becker's (1965, 1968, 1971) finding of a large number of Iron Age Houses but only a few rather distant Bronze Age Houses (fig. 2) makes a burial of the podzol profile before the Iron Age improbable.

Removal of the mor layer (Danish: *fladtørv*) of heaths is known from historic time from western Jutland. In the opinion of Iversen (1964) the well-known remark of Plinius concerning the soil used for fuel by the german tribes refered to *fladtørv*. However, Plinius explicitly states that the soil was taken from swamps and he simply refered to ordinary peat digging. The practise of *fladtørv* digging seems to be rather young, connected with medieval agricultural techniques (cf. Behre 1979). It seems much more probable that at the point of sampling the O layer has been removed by the ard ploughing and incorporated in the Ap horizon above.

The podzol profile thus seems truncated at the point of the C-14 sampling and therefore probably also at the point of pollen sampling.

The pollen spectra of the podzol reflect an open landscape locally dominated by a dry *Calluna*-heath. The single-sample maximum of the insect-pollinated

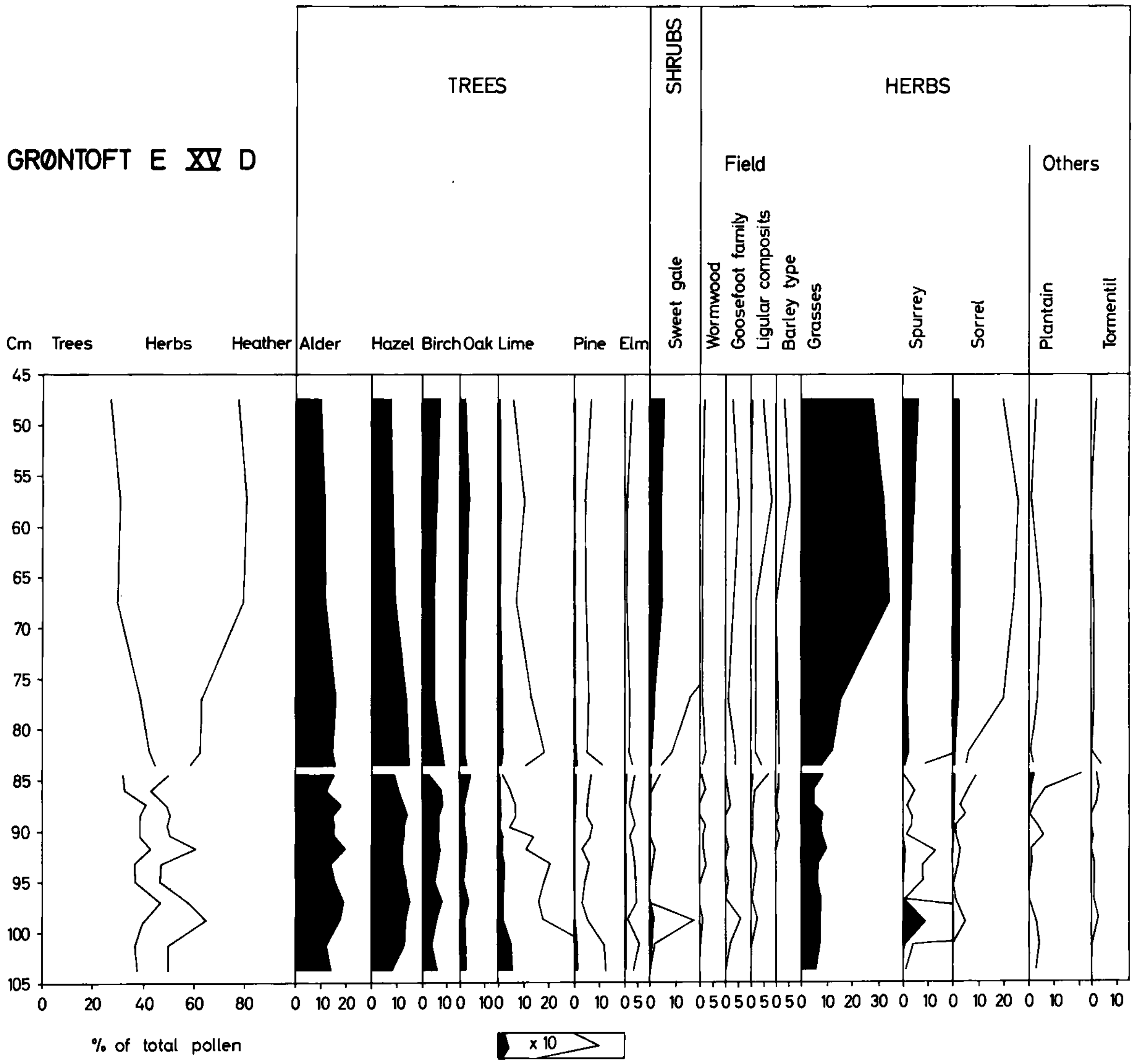

Fig. 6. Pollen diagram including a survey diagram (left) and separate curves for selected trees, shrubs and herbs.

spurrey is probably the effect of burying bees having collected pollen in the later field stage when spurrey was common. The decreasing lime values indicate that this tree was getting more rare during the formation of the profile. The rising curve of plantain and the single grains of barley-type in the Ah and O horizons reflect increasing human activity in the area.

The distinct ard marks at some places in the top of the podzol profile shows that the Ap horizon was undoubtedly tilled and this layer is probably colluvial in origin. The overall similarity of the pollen spectra of the lower Ap horizon and the spectra of the O/Ah layers indicates that the former consists of topsoil transported downslope during ploughing. The pollen spectra of the upper Ap horizon seem mostly to reflect the pollen rain on the field and thus give information about the agriculture in the Pre-Roman Iron Age.

The values of cereal pollen grains seem very low. However, cereals – except rye (*Secale*) – are autogamous plants and do not spread pollen until the harvest is thrashed, a work often done near the dwellings (Behre 1981). Andersen (in Andersen et al. 1983) found very few cereal pollen grains in the sediments of a small kettle-hole in Geel Forest, northeastern Zealand, although the site is surrounded by a Pre-Roman Iron Age field system. Thus, despite the low pollen values, barley may have been a major crop at the field of Grøntoft.

Spurrey has long been known to have played a not insignificant role in Bronze and Iron Age agriculture. Thus Jessen (1933) found 6 liters of pure spurrey seeds in a Roman Iron Age house. Seeds of this plant were also frequent or even dominating in the stomach contents of the bog corpses of Borremose (Brandt 1950), Tollund and Grauballe (Helbæk 1958), which have been C-14 dated to the late Bronze Age and the Pre-Roman Iron Age (Tauber 1980). The high pollen frequencies of spurrey in the Ap horizon at Grøntoft may be due to the occurrence of the plant as a weed, but it seems more likely that spurrey was one of the crops grown on the field.

The pollen analyses do not indicate that other crops were cultivated on the field.

The high frequencies of grasses reflect a very weedy field. Other weeds present, though only with low pollen frequencies, were annual knawel, spotted persicaria-type, knotweed, goosefoot family, sheep's bit and hemp-nettle. The value of sorrel are strikingly low bearing in mind that sorrel until fertilizers and pesticides became common practise was one of the dominating weeds in western Jutland. Thus the author (in Vejbæk 1984) found 8 percent of sorrel pollen in a soil sample from an early medieval field at Filsø, Varde. However, sorrel is especially favoured in fields with winter crops and intervening fallow years and the low values in the Ap horizon at Grøntoft simply reflect a different practise. Probably one of the differences were that Iron Age crops were spring-sown forms.

Since phosphorus is quickly immobilized in the soil after supply the high phosphorus levels in the Ap horizon cannot be due to modern application of fertilizers. Instead the P values indicate a high nutrient status of the Pre-Roman Iron Age field and it may have been possible to have crops on the field almost every year with only short periods of fallow. The phosphorus enrichment may be due to deliberate manuring of the field during the Pre-Roman Iron Age but may also be the result of more casual disposal of waste products around the houses, which were – or had been – closeby (fig. 2).

Conclusion

The Grøntoft diagram gives local details about the Bronze Age heathland and especially about agricultural practise of the Pre-Roman Iron Age. The crops were probably barley and spurrey and the nutrient status was presumably high enough to allow tillage during longer periods perhaps with only short or even no fallow periods.

The regional pollen diagram from lake Solsø (Odgaard 1985), 6 km SSE of Grøntoft (fig. 1), mirror an open landscape with large heathland areas during the Bronze Age and Pre-Roman Iron Age. Barley-type pollen and the sorrel curve reflect agriculture during these periods but the values are low indicating that fields only occupied a small part of the pollen source area. There are hardly any differences between the pollen spectra of the Bronze Age and those of the Pre-Roman Iron Age except that the plantain values are slightly lower during the Iron Age. Thus if there was any change in land use during these periods this was not dramatic enough to be reflected to any extend in the regional pollen diagram. From the large heathland areas it may be suspected that animal husbandry was of great importance during both periods.

Local and regional pollen diagrams supplement one another but several local diagrams are nescessary to understand the developments reflected by the regional diagrams. Thus for instance the Grøntoft diagram gives no information about the vegetation type that preceded the Bronze Age heath and it tells very little about the looks and use of the comtemporary forests.

Bent Vad Odgaard, Geological Survey of Denmark, Thoravej 31, DK-2400 Copenhagen NV.

Acknowledgements

The radiocarbon dates were done by H. Tauber, the physical analyses by H. Bahnson and B. Stavngaard, and the chemical analyses under the supervision of H. Kristiansen. I am grateful to all for their skilful assistance. Special thanks are due to C.J. Becker for help and interest during the entire investigation and for permission to use unpublished material. I am also grateful to S. Stumman Hansen for help and cooperation.

REFERENCES

AABY, B. 1983: Forest development, soil genesis and human activity illustrated by pollen and hypha analysis of two neighbouring podzols in Draved Forest, Denmark. *Danmarks geologiske Undersøgelse*, 2. rk. 114: 1–114.

ANDERSEN, S. T. 1979a: Brown earth and podzol: soil genesis illuminated by microfossil analysis. *Boreas* 8: 59–73.

– 1979b: Identification of wild grasses and cereal pollen. *Danmarks geologiske Undersøgelse, Årbog* 1978: 69–92.

– 1985: Natur- og kulturlandskaber i Næsbyholm Storskov siden istiden. *Antikvariske Studier* 7 (in print).

ANDERSEN, S.T., AABY, B. & ODGAARD, B. V. 1983: Environment and Man. Current Studies in Vegetational History at the Geological Survey of Denmark. *Journal of Danish Archaeology* 2: 184–196.

BECKER, C.J. 1965: Ein früheisenzeitliches Dorf bei Grøntoft, Westjütland. Vorbericht über die Ausgrabungen 1961–63. *Acta Archaeologica* 36: 209–222.

– 1968: Das zweite früheisenzeitliche Dorf bei Grøntoft, Westjütland. 2. Vorbericht: Die Ausgrabungen 1964–66. *Acta Archaeologica* 39: 235–255.

– 1971: Früheisenzeitliche Dörfer bei Grøntoft, Westjütland. 3. Vorbericht: Die Ausgrabungen 1967–68. *Acta Archaeologica* 42: 79–110.

BEHRE, K.E. 1979: Zur mittelalterlichen Plaggenwirtschaft in Nordwestdeutschland und angrenzenden Gebiete nach botanischen Untersuchungen. *Abhandlungen der Akademie der Wissenschaften in Göttingen. Philologisch-Historische Klasse. Dritte Folge* 116: 30–44.

– 1981: The interpretation of anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23: 225–245.

BRANDT, I. 1950: Planterester i et moselig fra Borremose (English abstract: Plant remains in an Early Iron Age body). *Aarbøger for nordisk Oldkyndighed og Historie* 1950: 342–351.

CHRISTENSEN, W. 1935: Jordens Fosforsyreindhold som Indikator for tidligere Kultur og Bebyggelse (With an English summary). *Danmarks geologiske Undersøgelse*, 2. rk. 57: 1–47.

CLARK, R.M. 1975: A calibration curve for radiocarbon dates. *Antiquity* 49: 251–266.

DEGN, H.J. & EMSHOLT, L. 1983: *Egekrat i Ringkøbing Amt. Ringkøbing.*

ELLIS, S. & MATTHEWS, J.A. 1984: Pedogenic implications of a ^{14}C-dated paleopodzolic soil at Haugabreen, southern Norway. *Arctic and Alpine Research* 16: 77–91.

HATT, G. 1949: Oldtidsagre. With an English summary. *Det Kongelige Danske Videnskabernes Selskab, Arkæologisk-kunsthistoriske Skrifter* II (1).

HELBÆK, H. 1958: Grauballemandens sidste måltid (English summary: The last meal of Grauballe man). *Kuml* 1958: 83–116.

IVERSEN, J. 1964: Retrogressive vegetational succession in the post-glacial. *Journal of Ecology 52 (Suppl.)*: 59–70.

JESSEN, K. 1933: Planterester fra den ældre jernalder i Thy (Deutsche Zusammenfassung: Pflanzenreste aus der älteren Eisenzeit in Thy). *Botanisk Tidsskrift* 42: 257–288.

ODGAARD, B. 1981: Hedebønder. *Skalk* 1981 (2): 8–11.

– 1985: Kulturlandskabets historie i Vestjylland. Foreløbige resultater af nye pollenanalytiske undersøgelser. *Antikvariske Studier* 7 (in print).

PEARSON, G.W., PILCHER, J.R. & BAILLIE, M.G.L. 1983: High-precision ^{14}C measurements of Irish oaks to show the natural ^{14}C variation from 200 BC to 4000 BC. *Radiocarbon* 25: 179–186.

TAUBER, H. 1980: Kulstof-datering af moselig (With an English summary). *Kuml* 1979: 73–78.

VEJBÆK, O. 1984: Hus og ager. Højryggede agre under en bebyggelse fra 1100-årene syd for Filsø i Ålborg sogn. *Mark og montre*. 1984: 49–58.