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EDITORIAL NOTE

The section "Recent Excavations and Discoveries" will no longer appear in the Journal. Readers who seek information about the most recent archaeological events in Denmark are referred to the annual issues of *Arkæologiske udgravninger i Danmark*, published by The State Antiquary's Office, The National Museum, Copenhagen.

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Analyses of Shell Increment and Microgrowth Band Formation to Establish Seasonality of Mesolithic Shellfish Collection

by VIBEKE BROCK and
EDWIN BOURGET

INTRODUCTION

The Mesolithic "Køkkenmødding" at Ertebølle, Denmark contains typical hard substrate vestiges from the culture such as flint tools, fractions of pottery, and left overs from meals based on hunting and fishing, e.g. bones from fish, birds and mammals. In particular, the kitchenmidden consists of shells of the following sea molluscs: *Ostrea edulis, Cardium* (*Cerastoderma*) *edule* and *C. lamarcki, Littorina littorea, Mytilus edulis,* and *Bittium reticulatum.*

No permanent housing has been excavated at the Ertebølle Settlement (Andersen and Johansen 1986) which may suggest that it was only used as summer residence. However, skeleton parts from seabirds that occur only during winter have been identified in the midden in quantities suggesting that extensive hunting took place also during that period (Enghoff, 1987). Sea food gathering can be maintained throughout the year except during periods with heavy icecover. In order to determine whether such seafood was collected in the warmer part of the year (as a supplementary gourmet diet?) or throughout the year (survival supplement in periods of starvation?) we wanted to determine seafood sampling dates using backdating techniques on the midden shells. The mussel shells from the midden were so disintegrated that only the region of the umbo and hinge was moderately well preserved, and the oyster shells, through superficially well preserved, could not even be aged by means of annual growth bands, and their shell matrix was much too loose for micro growth band identification. In contrast the *Cardium* shells were well preserved, annual growth marks could be identified (Orton, 1926), and measurements of shell length and the last shell increment could be obtained. Further, the shell matrix was sufficiently coherent in extensive parts for clear microgrowth lines to be found in a fair number of the shells.

Microgrowth lines are circadian growth lines formed in the shell matrix in periods where the cockle is active and the mantle lobes protrude between the shells. Such microgrowth lines have been used for studies of problems concerning use of a "biological clock", e.g. in paleaoecology, (Bourget 1980, Jones 1981, and Deith 1983). In habitats of regular tidal impact where the sediment is exposed to air at low tide, microgrowth band formation may reflect the tidal shifts as shown by Richardson *et al.* (1981); however, periodicity differs in *Cardium* from different environments (Bourget *et al.* 1991) and the finding of daily microgrowth band formation in *Cardium edule* by House and Farrow (1968) should still be considered. Many authors hypothesize that the narrow band which is formed in connection with shell closure

Fig. 1. The present coastline of the Limfjord with the Mesolithic locality, Ertebølle (E) and area of the modern samples, Aggersborg (A).

and which separates the wide bands, contains more organic material than the wide bands (Farrow 1971, Richardson *et al.* 1981 and Evans 1988). However Deith (1985) has presented convincing evidence that the narrow bands which dissolve slower in acid than the wide bands contain the same calcium compound as those, yet in a denser form.

Cardium edule is valued seafood as the latin name indicates, especialy in France, England and Ireland (remember Moly Malone's "cockles and mussels alive"?). Its close relative, *C. lamarcki* is not appreciated though commercial utilisation has been suggested (Iwell, 1979). However, when the two species co-occur they are not easily separated, and at the tidal flat of Andernos in Archachon Bay (France) where the two species were found in sympatry in 1987 and 1990 (Brock, in prep.) local people utilize both for consumption. The settlers at Ertebølle also consumed the two cockle species and we are confident that they would have distinguished between the two species if one had been considered without value. Having identified the habitat properties of the cockle sampling area (Brock et al. 1987) we used shells from samples of living *C. edule* and *C. lamarcki* collected at different times throughout a year from a habitat with similar properties. This recent material was used as reference for identification of collection dates of the midden cockles by means of backdating techniques. Two independent methods were used, correlation between the shell increments formed after the last annual growth mark (in mm) and sampling dates, and correlation between the sampling dates and the numbers of microgrowth lines formed after the last annual growth mark.

MATERIAL AND METHODS

Shells of the two *Cardium* species were sorted out from a midden core (30x30x160 cm) that had been subsampled horizontally by means of archaeological criteria and dated by means of C-14 technique to 5270–5540 BP (Andersen & Johansen, 1986). The separation of the two species was based on shell edge identification (Brock 1978), and an identification of the *C. edule* ecotype which co-occur with *C. lamarcki* was based on cluster analysis (see Brock et al. 1987). The classified midden shells (sympatric *Cardium edule* and *C. lamarcki*) were used for the determinations of the cockle sampling periods at the settlement (see Table 1).

Archaeological strata	Layer	*C. edule*	*C. lamarcki*
Shells	5	1	1
	6	3	4
	7	1	2
	8	0	2
	9	21	26
	10	62	18
	11	44	19
Transition between shells and fireplace	12	37	12
Fireplace	13	60	9
Shells below fireplace	14	26	0
Fishbones and shells	15	40	4
Shells	16	1	0
	17	5	0
Black layer, rust coloured shells, firepl.	18	3	0
Rustcoloured shells	19	3	0
Shells	20	1	0
Large shells	21	1	0
Black/rusty shells	22	11	0
Grey layer	23	1	0

Table 1. The occurrence of *Cardium lamarcki* and the sympatric *C. edule* ecotype (numbers of whole shells) in the different layers of the N-core from the Mesolithic shell midden at Ertebølle.

The recent material for growth comparison was sampled alive in 1978 at the following dates, Feb. 2, Mar. 15 and 30, Apr. 18 and 27, May 17, Jun. 12 and 20, Jul. 17, Aug. 1 and 11, Sep. 8 and 22, Oct. 10, and Nov. 1. from a population which consists of both *Cardium* species at the Limfjord locality, Aggersborg (See Fig. 1).

Comparisons of species specific annual growth rates using the van Bertalanffy growth parameters, e^{-K} and L_∞ showed that growth of the sympatric mesolithic cockles equaled those of the Aggersborg samples (Brock et al. 1987). Growth increment (y = the difference between the actual shell length and the length of the shell at the previous annual growth mark) was measured to the nearest 0.1 mm using a caliper.

Microgrowth bands in the crystalline matrix of the shells (Bourget 1980) were counted on acetate peels of radial shell sections using a modification of Clarcks method (Clarck 1980). Shells were cut in halves along the ribs, the section area was polished and eventually grinded with silicon carbide (1000 grit), then etched in 1N HC1 for 30 sec., rinsed in water, dried, and set on acetate film with acetone. After 5 min. the shell was removed and the imprint on the peel ready for microscopy.

RESULTS

For both species and for each of the three year classes examined (e.g. 2+: third growth period) the relation between sampling time (x) and corresponding shell increment (y) was estimated assuming linearity of growth (Table 2). Using the equations from Table 2, dates of death were obtained for the well preserved midden material (Fig. 2). Fig. 3 shows that shell increments of 82% of the midden material correspond to collection in the period May 15 to October 15. In 10% of the material no increment could be measured after the last annual growth mark indicating sampling prior to May 15, and on the last 8% of the shells, growth increments suggested sampling after October 15 but before formation of the annual growth mark.

Species	age	N	Relation between shell increment in mm (y), and time in days (x)
Cardium edule	2+	34	y = (0.03 ± 0.004)x + (1.40 ± 0.29)
Cardium edule	3+	48	y = (0.03 ± 0.002)x + (0.98 ± 0.22)
Cardium edule	4+	17	y = (0.02 ± 0.004)x + (0.42 ± 0.51)
Cardium lamarcki	2+	62	y = (0.024± 0.003)x + (1.75 ± 0.28)
Cardium lamarcki	3+	64	y = (0.01 ± 0.003)x + (1.60 ± 0.30)
Cardium lamarcki	4+	11	y = (0.008± 0.004)x + (1.26± 0.38)

Table 2. Relation between sampling time in days counted from May 15 (x) and corresponding shell increment in mm (y) assuming linearity from June 5 to October 15. The equations are based on modern sympatric *C. edule* and *C. lamarcki* sampled alive at two to three weeks intervals from February to November 1978 at the Limfjord locality, Aggersborg (e.g. 2+: cockles in their third growth season).

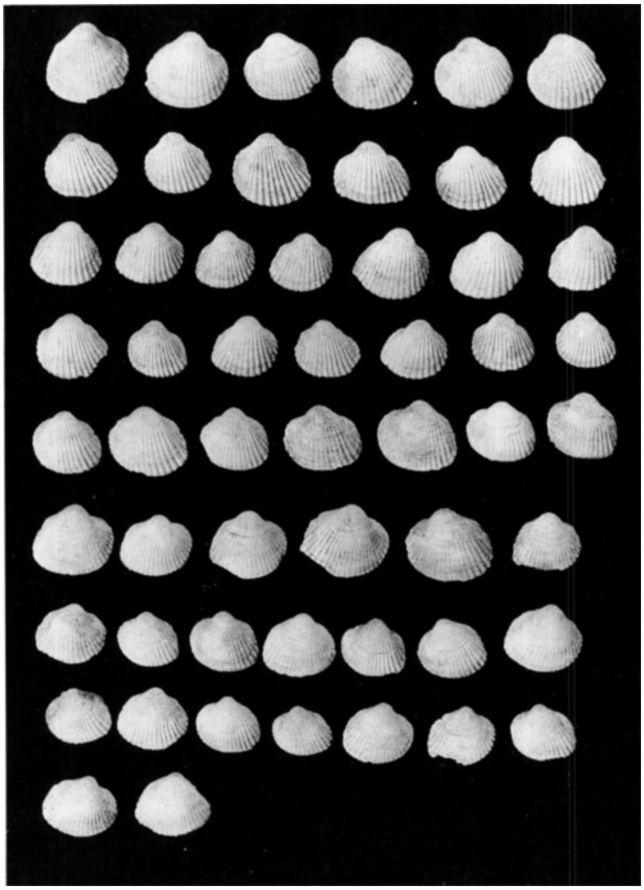

Fig. 2. Shells of *Cardium lamarcki* (mostly in 2nd, 3rd, and 4th row) and *C. edule* from the Ertebølle Køkkenmødding layer 13N (age of layer determined by means of C-14 analysis: 5540 + 95 y B.P.).

	Year 2		Year 3		Year 4	
Locality	A	E	A	E	A	E
No. of micro-growth bands	537	630	379	423	322	330
	436	505	336	369	310	
	500	550	367	365	287	
	453	317	437	355	255	
		289	404	400	221	
				250		
				533		

Table 3. Individual microgrowth band formation for three age classes of sympatric *Cardium edule* from Aggersborg (A) and Mesolithic Ertebølle (E). Note the pronounced whithin-group variation.

Microgrowth band formation in *Cardium* is age and habitat dependent (Bourget and Brock, 1990) and in order to compare the midden material with comparable recent material the Aggersborg cockles were chosen for this comparison too. Table 3 shows that the numbers of microgrowth lines between two annual growth bands for different yearclasses at Mesolithic Ertebølle agree with the results from the present Aggersborg population. Table 3 also shows the tendency that the older cockles form fewer bands during a growth season than the younger. Fig. 4 shows the microgrowth band formation during the forth growth season for *C. edule* and *C. lamarcki* at Aggersborg (1980). The equations are based on counts of bands formed after last annual growth mark related to actual sampling dates including the last sampling date with zero bands. These equations are independent of any assumptions of whether microgrowth band be formed daily throughout the year (House and Farrow, 1968) or twice a day induced by tidal cycles (e.g. Richardson et al. 1979, Lønne and Gray, 1988). For a discussion of how different factors influence upon micro band formation, see Bour-

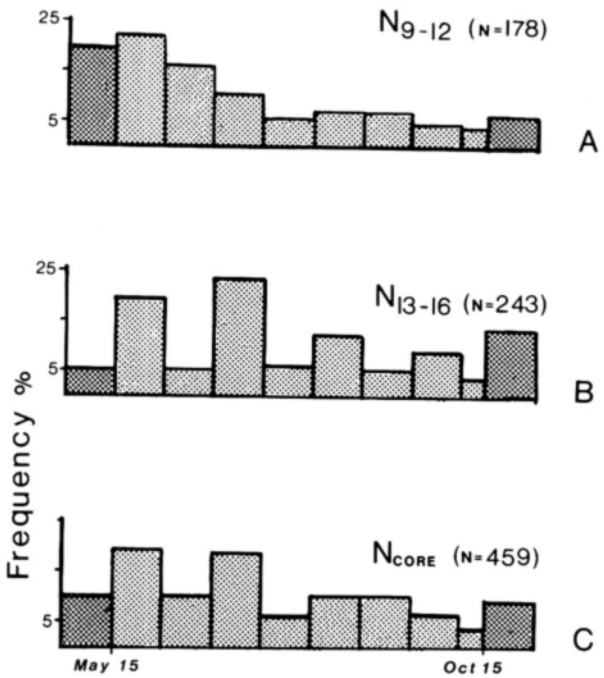

Fig. 3. Time of collection/death for sympatric *Littorina* Sea *Cardium edule* and *C. lamarcki*, B, and C: date related frequency diagrams obtained from comparisons of length increments in cockles from the N-core of the Ertebølle midden with standard data from modern populations at the Aggersborg locality. Collumn width: 20 days.

get and Brock (1990). The results suggest that countable microgrowth bands did not form during the first three months of the year.

Out of 41 examined midden *C. edule*, the acetate peels of the end bit (= micro growth bands formed after the last annual growth mark) was countable for 20 individuals, and of 11 *C. lamarcki* the end bit could be counted for 1. The sampling dates of individuals of the two species in their fourth growth season (n=10) were calculated by means of the equations in Fig. 4. For the C. edule in their second growth period (n=10), sampling dates were determined assuming that formation of countable microgrowth bands started day 106 and ended day 365 as was found for the older *C. edule* and assuming that 1.8 bands per day were formed during this period (mean of total numbers of microbands formed between 2nd and 3rd annual growth mark, see Table 3). The sampling dates of the 20 midden *C. edule* and 1 *C. lamarcki* thus determined were: April 29, May 4, 11, 16, 17, 27, 30, June 1 and 28, July 2, 7, 10, 27, 29, August 15 and 26, September 12 and 18, October 6 and 10, and December 12.

The accuracy of the determinations of sampling date by both methods for 8 *C. edule* sampled at known dates in their 3rd growth season was determined separately and in combination (multiple regression). The standard error of the determination of sampling dates by both methods (for *C. edule*, n=8, sampled at known dates in their third growth season) was estimated separately and in combination (multiple linear regression). Table 4 shows that date estimates based on measurements of shell increment are as precise as of date estimates based on microgrowth line counts, and that only little extra precision is gained by combining both methods.

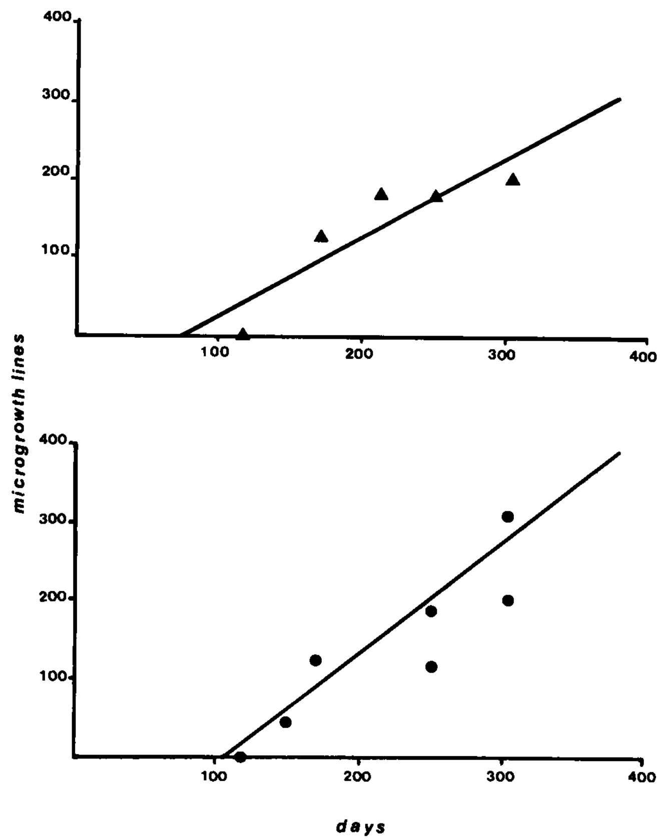

Fig. 4. Microgrowth lines for *Cardium edule* (circles) and *C. lamarcki* (triangles) from Aggersborg sampled during their fourth growth period. The equations for number of lines (y) related to number of days counted from the initiation of micro growth band formation (x) is based on the date and holds no assumption of when micro growth band formation starts, ends, or how many bands that are formed per day.

Cardium edule: $Y = 1.23x - 130.6$; $r = 0.92$

Cardium lamarcki: $y = 1.01x - 74.95$; $r = 0.79$

Model	Independent variable	R^2	R^2 change
1	Microgrowth bands	0.849	
2	Increment (mm)	0.979	0.0006
3	Increment and Microgrowth bands	0.979	(F = 0,14)

Table 4. Multiple linear analysis with the three time-related variables: number of microgrowth lines, shell increment in mm, and days. *Cardium edule* (3+; n=8) from Aggersborg.
Model 1 (bivariate): y=(0.69+0.12)x + (121.4+18.9)
Model 2 (bivariate): y=(44.1+2.7)z + (108.6+7.5)
Model 3 (multivariate): y=(0.047+0.125)x + (41.51+7.44)z + (108.5+8.1)
(y=days, x=microgrowth bands, and z=mm shell increment).

DISCUSSION

In contrast to oysters and mussels which attach to hard surfaces, cockles burrow in the sediment. Since it is difficult to maintain them alive in larger quantities in wellboxes or cages (Brock 1980) and since experienced cockle collecters (as the settlers at Ertebølle probably were) rarely mistake dead for live cockles we assume that the midden shells mainly represent cockles collected for immediate consumption and thus, that their date of death represent the collection date. However, some midden shells may have a different origin. On soft and sandy shores mussel attach to stones and shells of dead cockles that protrude from the bottom. Therefore, whole aggregations of stones, shells and mussels held together by mussel byssus can be collected quickly during wading or diving and sorted out later at the coast. Extensive occurrence of small stones in the midden which has puzzled the archaeologists (S. Andersen, pers. com.) may well origin from such aggregations, and it is plausible that also some of the cockle shells we have studied were brought to the settlement as parts of such quickly gathered mussel aggregations (Fig. 5).

It may seem contradictory that this work deals whith two different growth periods, one for microgrowth formation that is considerably longer than the one for shell increment formation. The explanation is simple. During the period where microgrowth bands are formed whithout addition of the shell length, the microgrowth bands are very narrow and adds only to the thicknes of the shell, not to the length (Deith 1985). This explanation conform with our finding that the edge of the cockle shells are generally thicker in spring than in the fall. It is not the goal of this study to offer a precise model which describes cockle growth during a growth season but an adequate tool with easy applicabilities. The determination of very small increments is difficult, therefore the linear growth equations are based exclusively on material sampled after June 1. For midden material with y-values > 0 but smaller than what correspond to June 5 there is no date determination. Such material is simply referred to the period May 15 – June 5.

Since the shell part used for the determination of collecting date is the most fragile, this and therefore micro growth bands may easily have been eroded away. Therefore, we have avoided inclusion of shells with damaged outline. Our findings reject the theory that this type of seafood was used by the Ertebølle settlers mainly in periods of malnourishment, it is more probable that sea food supplemented their other food items during summer. This is supported by the finding (Fig. 3) that sampling was less intense in the middle of the summer where cockles are less valuable due to their gamete release.

Reference populations must be chosen with care since environmental factors as well as the age of the cockle strongly influence the microgrowth band formation (Bourget and Brock, 1990). A future study of archaeological cockles sampled in an area with pronounced tidal impact should for example not be compared with material sampled at the less exposed Aggersborg locality. The pro-

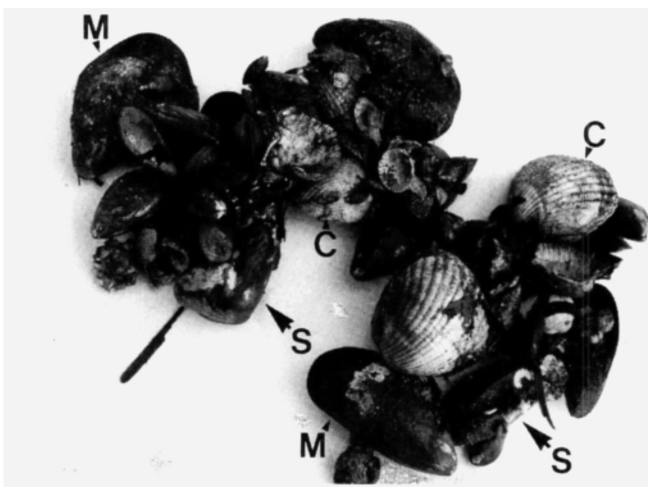

Fig. 5. Mussel aggregations held together by byssus threads. M: mussel, S: stone, C: cockle. Photo by Terkel T. Due.

blem of finding recent populations with growth rates comparable to those of the archaeological material one wants to study is facilitated when winter marks can be identified and annual shell increments measured. Growth rates can then become compared by use of the van Bertalanffy growth equation (Bertalanffy, 1957). Choice of a modern control environment is supported if species specific growth rates of more species are compared and found similar (Brock *et al.* 1987). Since time studies on *Cardium* shells from archaeological deposits can be studied with comparable error levels by means of shell increment measurements and microgrowth band counts in the period June to mid October, and since the former requires less equipment and skills we recommend this method for future studies whenever more exact information concerning the period mid October to mid May is unimportant.

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Norsminde

A "Køkkenmødding" with Late Mesolithic and Early Neolithic Occupation

by SØREN H. ANDERSEN

HISTORY OF RESEARCH

From 1945, and especially since 1960, continuous archaeological investigations have taken place along the beaches of Norsminde Fjord, positioned on the East Jutland coast, c. 20 km south of Aarhus (fig. 1). During this project a long series of essential settlement sites and single finds were recorded and excavated, i.e. the big Ertebølle kitchenmidden "Flynderhage" (S. Gabrielsen 1953), the stratified Ertebølle site "Norslund" (S. H. Andersen and C. Malmros 1966 and 1981), and the Neolithic shell-midden "Kalvø" with finds from the Single Grave Culture (S. H. Andersen 1983).

As a result of this extensive archaeological research, this area is one of the most thoroughly and intensively researched regions for Stone Age settlements in Den-

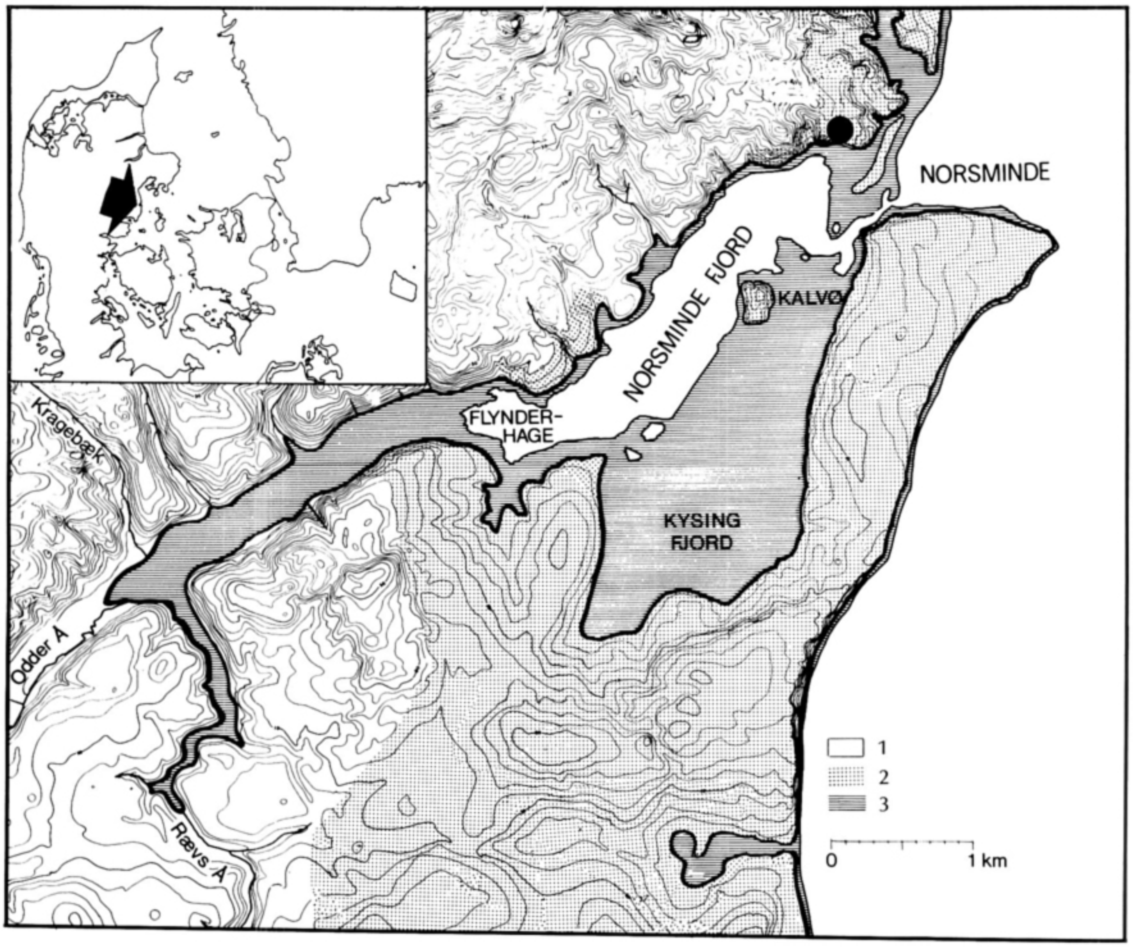

Fig. 1. The position of the Norsminde fjord and the Norsminde settlement. E. Morville *del.* Legend: 1) Morainic clay. 2) Glacial sand. 3) Raised sea-bottom.

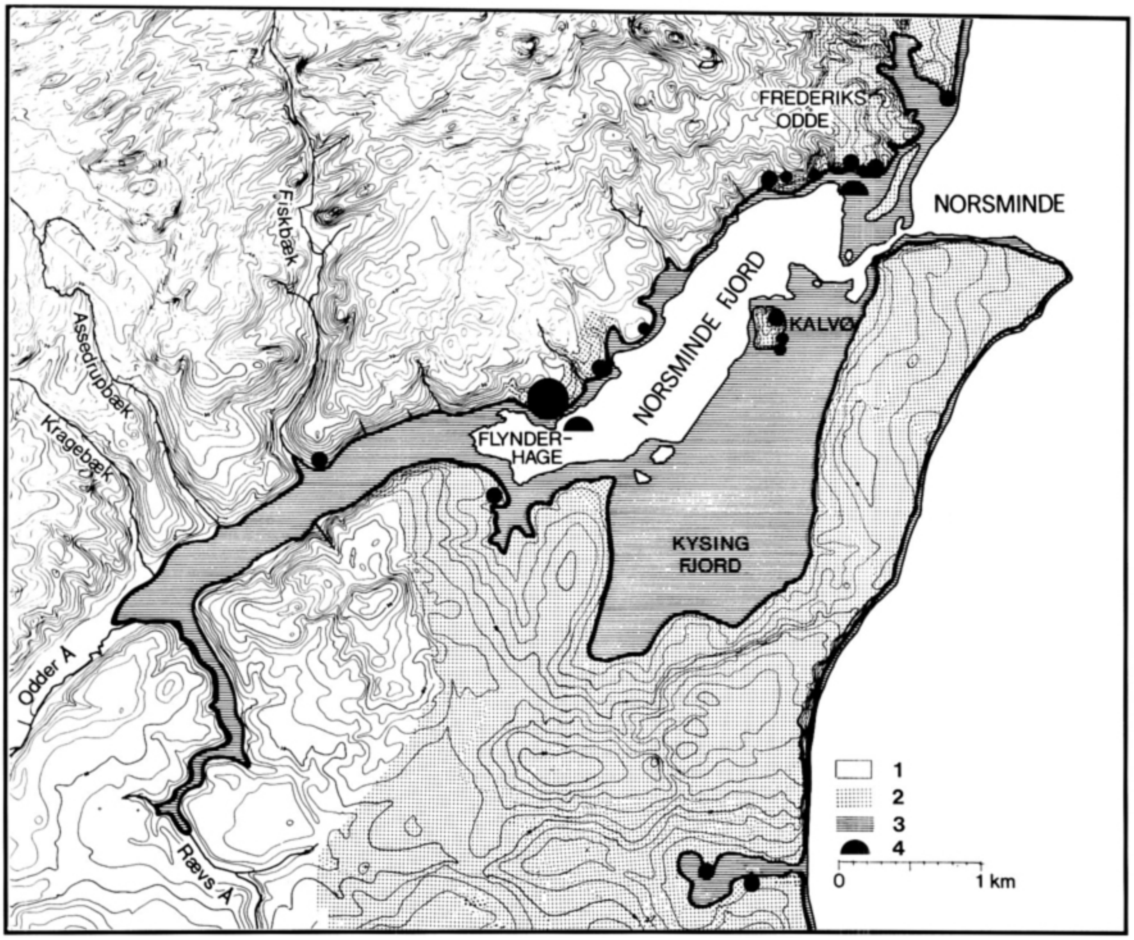

Fig. 2. The Norsminde fjord with all known Ertebølle sites. E. Morville *del.* Legend: 1) Morainic clay. 2) Glacial sand. 3) Raised seabottom. 4) "Natural" shellbanks from the Stone Age.

mark. A survey of all the recorded finds from the different prehistoric periods was published in 1976 (S. H. Andersen 1976).

In order to acquire both an overall and a detailed picture of Late Mesolithic Ertebølle habitation along the coastlines of the Norsminde Fjord, a series of intensive reconnaissances were undertaken in 1972. As a result, a new and completely unknown shellmidden – "køkkenmødding" – was found in the vicinity of the village of Norsminde (fig. 1).[1] A trial excavation revealed that the site had a cultural layer up to 1.5 m thick with a well defined stratigraphy, composed of a Late Mesolithic "Ertebølle horizon" at the bottom, superposed by an Early Neolithic "Funnel Beaker" (TRB) horizon. The midden was covered by a 1–2 m thick deposit of sandy humus.

Norsminde represented a new, undisturbed, completely *in situ* shellmidden, which furthermore was rather small compared to other Danish "køkkenmøddinger". Thus, the midden offered a unique opportunity for a total excavation – with modern techniques – of a "classical" type of Danish Stone Age site. In addition, the site contained a stratigraphic sequence covering the transition Late Mesolithic / Early Neolithic. We had, therefore, a good opportunity of obtaining new data to revaluate the introduction of farming in this region. These were all essential arguments in favour of an excavation, which was undertaken from 1972–1989.[2]

The investigation has partially been carried out in collaboration with the Institute of Archaeology and Ethnography, Cambridge.[3] The following is a survey of the preliminary results of this investigation.

ERTEBØLLE SITES IN THE NORSMINDE FJORD

The Late Mesolithic habitation along the shores of the Norsminde Fjord has been dense. The Norsminde settlement is just one of 15 Ertebølle sites. Four are regular "køkkenmøddinger", while the others are either "ordinary" coastal sites without shellmiddens or eroded, redeposited sites (fig. 2). With a single exception, all the Late Mesolithic sites – including all "køkkenmøddinger" – are positioned along the northern coastline of the fjord (fig. 2). All the sites are excavated – either totally or by sampling.

The Ertebølle sites are concentrated in two areas: in the centre of the fjord at Flynderhage and near the mouth of the fjord, where the Norsminde settlement is positioned (fig. 2).

Just 50–75 m to the west and 200 m to the east there are other Ertebølle sites. With a few exceptions, they are all contemporaneous "in an archaeological sense" and belong to the Younger or "Ceramic" Ertebølle Culture, 3.600–3.100 b.c. (All dates in the article are expressed in conv. C-14 years). The largest "køkkenmødding" is Flynderhage (S. Gabrielsen 1953), while the other sites are relatively smaller. The detailed relationship between these various types of sites is still to be determined.

The Norsminde "køkkenmødding" distinguishes itself from other coastal settlements in this region by the fact that it is the only one that contains thick layers of Late Mesolithic Ertebølle material (hereafter ETBK) as well as of Early Neolithic Funnel Beaker Culture (TBK). At two of the other sites traces of Early Neolithic occupation were also recorded, but then only as very thin horizons with few artefact types (fig. 3).

GEOLOGY AND TOPOGRAPHY

Today the Norsminde fjord is an estuary (Muus 1967) and belongs to the smallest Danish fjords. It is c. 6 km long, 200–300 m wide and runs SW-NE, with a 40–50 m wide entrance into the open sea Kattegat in the NE (fig. 1). The fjord was formed as a valley by the melt-water during the last advance of the Weichselian glaciation (Harder 1908, Milthers 1948). Originally it was a large freshwater basin – a lake or a river (in the Late Glacial and Boreal periods). Initially – in the Early Atlantic period (c. 5.500–5.000 b.c.) – the area was transformed into a saltwater fjord. The fjord forms a sharp border line between two very different geological-topographical areas to the north and the south – and, therefore, between two rather different biotopes.

To the north and the southwest the subsoil is heavy morainic clay. These areas are very hilly and characterised by several narrow valleys and many small rivers running down to the northern coastline of the fjord. From the coast northwards the terrain rises steeply, up to c. 40 m. Therefore, the northern coastline is very irregular with many small and larger bays intermixed with peninsulas (fig. 1). To the northeast – by the mouth – the topography is more even; the subsoil here is glacial meltwater sand and gravel.

The area south of the fjord is completely different: the landscape is flat, gently rising to the south up to 10 m and the subsoil consists of glacial melt-water sand. With a single exception no fresh-water streams are found here. Also, the southern coastline of the fjord is more straight and without bays. To the south is the large, shallow area formed by the previous "Kysing fjord", which today is a reclaimed area (fig. 1).

The biggest rivers emptying out into the fjord are in the southwest: Odder Å, Ræves Å, and Assendrup Å (fig. 1). To the northeast is the only island, Kalvø, but our investigations have demonstrated that originally one more small island was present in the fjord – c. 500 m south of Kalvø. The bottom of the fjord itself is characterised by a narrow and deep channel following the northern coast, while the rest of the area – especially to the south – is very shallow.

As the fjord is positioned north of the so-called "tilting-line" this region has raised 2–3 m since the Stone Age – also an indication of the maximum level of the Littorina Sea (Mertz 1924); however, it is impossible to tell which transgression actually formed the sea level maximum (most probably the subboreal transgression). Because of the higher sea level in the Atlantic period, the fjord had a much larger extension than today – especially to the south and southwest, while the northern coastline remained relatively unchanged. During this period the length amounted to c. 10 km, and the width to c. 2.7–3 km. The mouth was originally c. 500 m wide, but has gradually been closed by sand banks and beach ridges (fig. 1).

Our investigations reveal that in the Atlantic period the channel which runs along the northern coast had a maximum depth of c. 9 m, and the "Kysing fjord" formed a large shallow bay. The presence of the channel with its

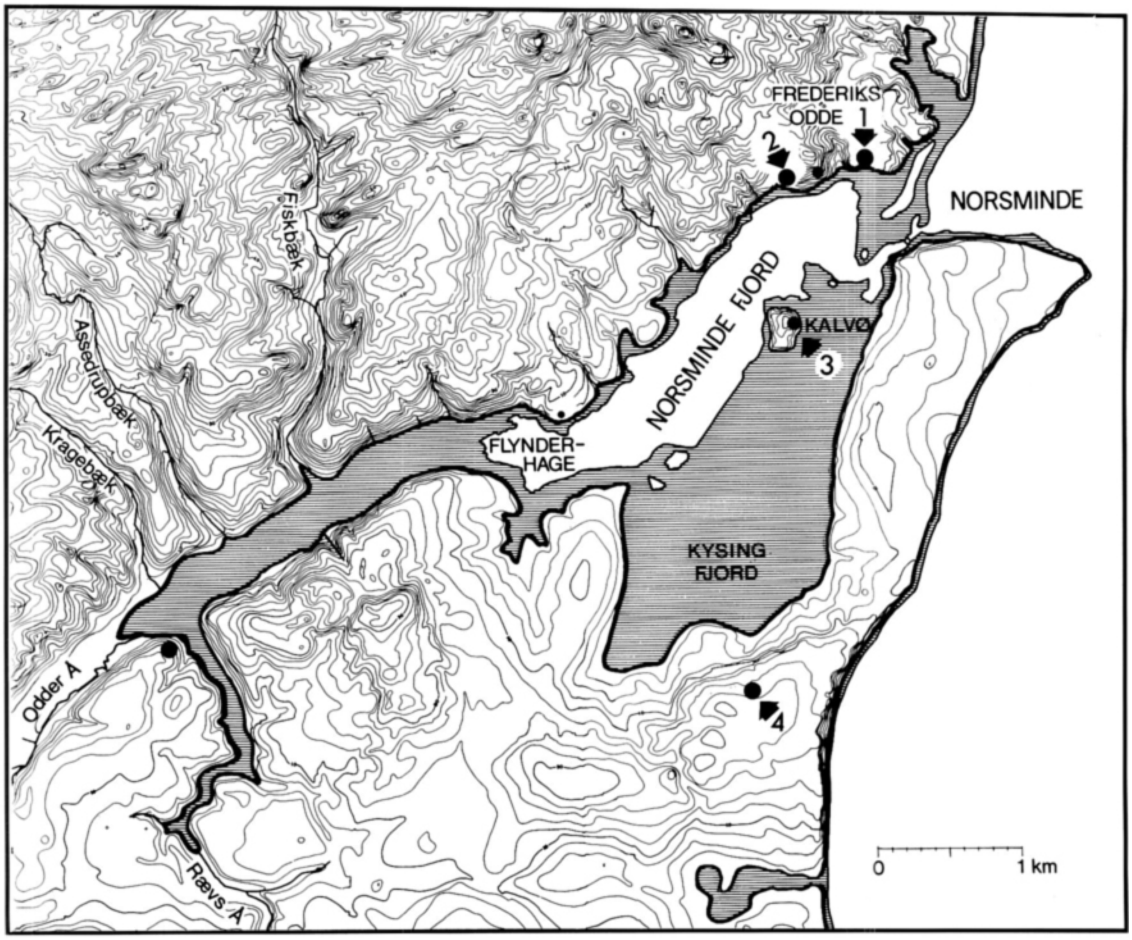

Fig. 3. The Norsminde fjord with all known Early Neolithic Funnel Beaker settlements. E. Morville *del.* Legend: 1) The Norsminde site. 2) Store Nor. 3) Kalvø. 4) Saxild.

fresh, nutritious water provided good conditions for a rich marine food-chain, and this is probably one of the explanations why all the "køkkenmøddinger" and most of the Stone-Age settlements are positioned along the northern coastline of the fjord.

SITE TERRITORY

The Norsminde "køkkenmødding" is located on the north coast, c. 200 m west of the entrance to the fjord, on an old beach cliff, eroded by the Littorina transgression before the earliest habitation (fig. 4). To the rear of the site is a shallow valley bordered by two small hilltops. The valley has been eroded by a small spring which had its outlet on the beach where the site is. Today the area in front of the site is raised sea bottom, containing sand and gravel.

The area within a 5 km radius of the site must be characterised as highly variable, consisting of several different biotopes: land (50%), fjord (10%), fjord entrance, and open sea (40%). Because of the rather steep northern coastline the relationship between land and sea has not changed very much since the Atlantic period. Therefore, the beach zone has always been very narrow, but because of the very irregular outline of the coast it represents a very long and mixed habitat.

The subsoil is made up of light sandy, morainic clay with many boulders. Therefore, access to good flint and clay for pots and houses was always good. The light sandy soil may have been covered by a rather open oak/lime forest which would have provided possibilities for hunting of red and roe-deer, wild boar, aurochs, and furred animals such as pine marten, fox, etc. In the later habitation periods the rather sandy subsoil must have offered good possibilities for farming.

The location of the site – close to the open sea, but in the protected fjord, and in front of the deep channel gave excellent possibilities for gathering of shellfish, fowling, and for different types of fishing and sea-mammal hunting in the more open water (Kattegat) (figs. 2–4).

Larger freshwater lakes or rivers are not represented within a 5 km radius of the Norsminde-settlement (fig. 3), but the many small streams running down to the coastline must have provided good possibilities for fishing (figs. 3–4). Just in front of the Norsminde køkkenmødding there is evidence of a natural shell-bank – probably one of the localisational factors for the site (figs. 2–4).

As for the vegetation, pollen analysis has not been completed. Animal life is well documented, as illustrated by the preliminary list of species from the Norsminde site and from the Norslund and Kalvø-settlements (S. H. Andersen and C. Malmros 1966, S. H. Andersen 1983).

All in all the biotope seems to have been highly varied, and the long occupation period – c. 1.200 years – further indicates that essential aspects of the environment must have remained constant and economically prosperous for Man during the Late Mesolithic and Early and Middle Neolithic periods.

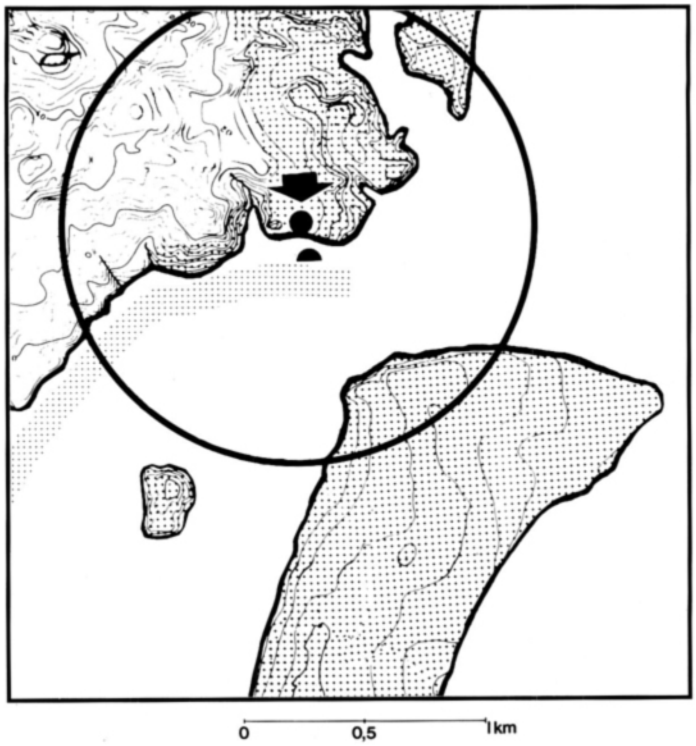

Fig. 4. Site territory within a one kilometer radius. E. Morville *del.* Legend: Similar to figs. 1 and 2. The deep-water channel along the north coast is indicated by shading.

INVESTIGATIONS BEHIND THE "KØKKENMØDDING"

In order to define the limits of the site, excavations were carried out in areas ajacent to the midden, i.e. behind and in front of the midden. Just north of the eastern part of the "køkkenmødding" a stonebuilt hearth associated with a few scattered pieces of flint debris was recorded; no additional datable cultural layer or structures were found in the vicinity of the fireplace.

Despite all our efforts, no traces of Ertebølle-habitation outside the midden area have been documented. This observation is in accordance with the results obtained by the new excavations at the Ertebølle midden (S. H. Andersen and E. Johansen 1987, 39–40) and other Ertebølle coastal sites.

However, on the more flat plateau c. 50 m north of the kitchenmidden, a settlement area with a thin cultural horizon and some pits containing Early Neolithic type flint debris and pottery was found. This area with finds and structural remains measures c. 30x30 m, and it is not stratigraphically connected with the midden on the prehistoric beach. The thickness of the cultural layer, its small size, and the relative paucity of finds are all characteristic traits for the Early Neolithic settlements of the TBK, for instance Mosegården (Madsen and Petersen 1984). All observations indicate the presence of a small Early Neolithic settlement. Although impossible to prove, it is reasonable to assume that it is contemporaneous with, but positioned at a certain distance from the midden. If this assumption is correct the Norsminde site in the Neolithic consisted of a habitation area on high, dry ground and an associated midden area on the beach, the two areas separated by a 50–60 m zone without many finds.

In an attempt to locate a waste area in front of the site – common at many Danish Mesolithic sites, – both inland and coastal – i.e. Ringkloster, Tybrind vig (S. H. Andersen 1975, 1986) etc., several trenches were excavated in the marine sediments. However, nothing of this sort was

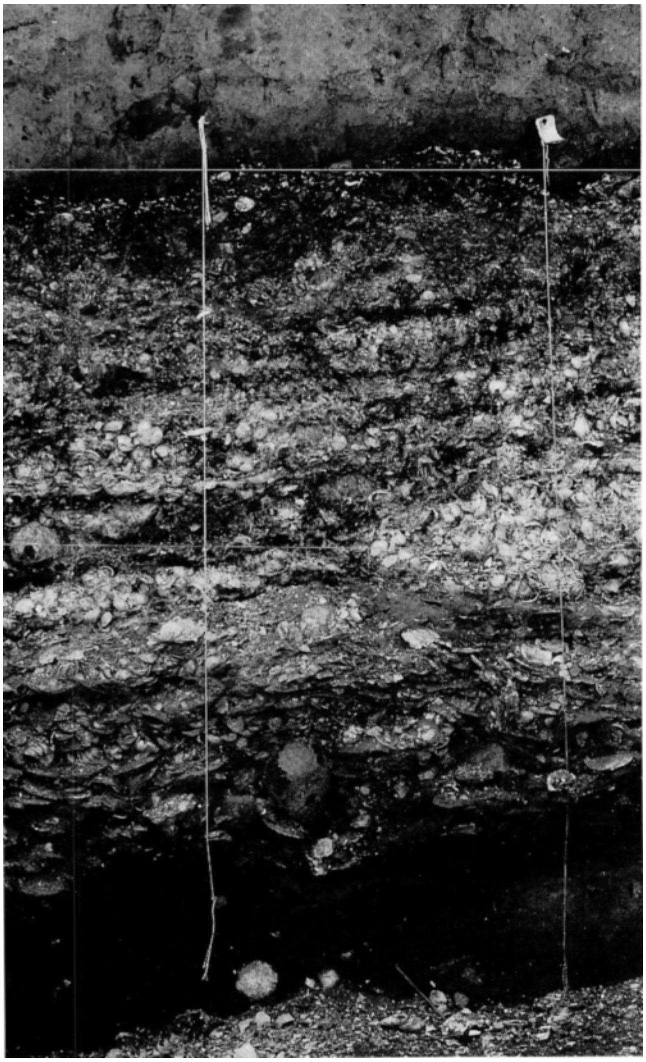

Fig. 5. Photo of section through the "Køkkenmødding" showing the complete sequence og layers (*Cf.* fig. 6).

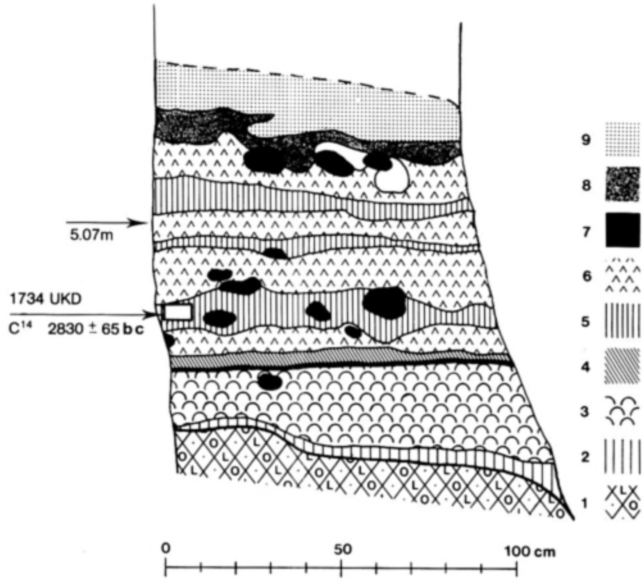

Fig.6. N-S going section (1734 RLH) through a square meter of the central part of the "Køkkenmødding". The position of the funnel beaker UKD (see fig. 20, 2) and the C-14 dating are indicated. O. Svendsen *del.* Legend (from bottom to top): 1) Subsoil. 2) Ash layer. 3) Køkkenmødding characterised by large oysters (*Ostrea sp.*). 4) Light yellow, fine sand. 5) Ash and charcoal horizons. 6) Køkkenmødding characterised by cockles (*Cerastoderma sp.*). 7) Fire-cracked stones. 8) Black, clayey cultural layer. 9) Lightbrown sand with humus.

found; just scattered animal bones and water-rolled/patinated flint artefacts, imbedded in marine sand and gravel. The explanation for the lack of such a dump area is probably to be found in the topographic position of the site, which is towards the longest free stretch in the fjord (towards the southwest); the site has therefore always been heavily exposed to high tide and wave action, sea currents, etc.; all of which would long ago have washed away all types of waste and materials dropped into the sea in front of the site.

INVESTIGATIONS IN THE "KØKKENMØDDING"

The "køkkenmødding" is oval in outline, c. 30 m from East to West and c. 5–12 m wide. The maximum width (c. 12 m) and thickness (c. 1,5 m) is found in the most eastern part of the midden, which gradually becomes more narrow (5–7 m) and thin (c. 0.40–0.60 m) towards the west (fig. 7). The base of the midden is flat – following the sloping subsoil, and the surface is horizontal – slightly falling towards the south. The delineation of the midden is distinct in all directions; especially to the south it is abrupt and bears evidence of secondary erosion by the sea.

The Norsminde site is not a single uniform unit, but the cumulative result of activities on this location during c. 1.200 years. It is made up of several individual heaps of shells and debris of different types.

Because of the necessity of controlling the exact position of all finds in relation to the Mesolithic and Neo-

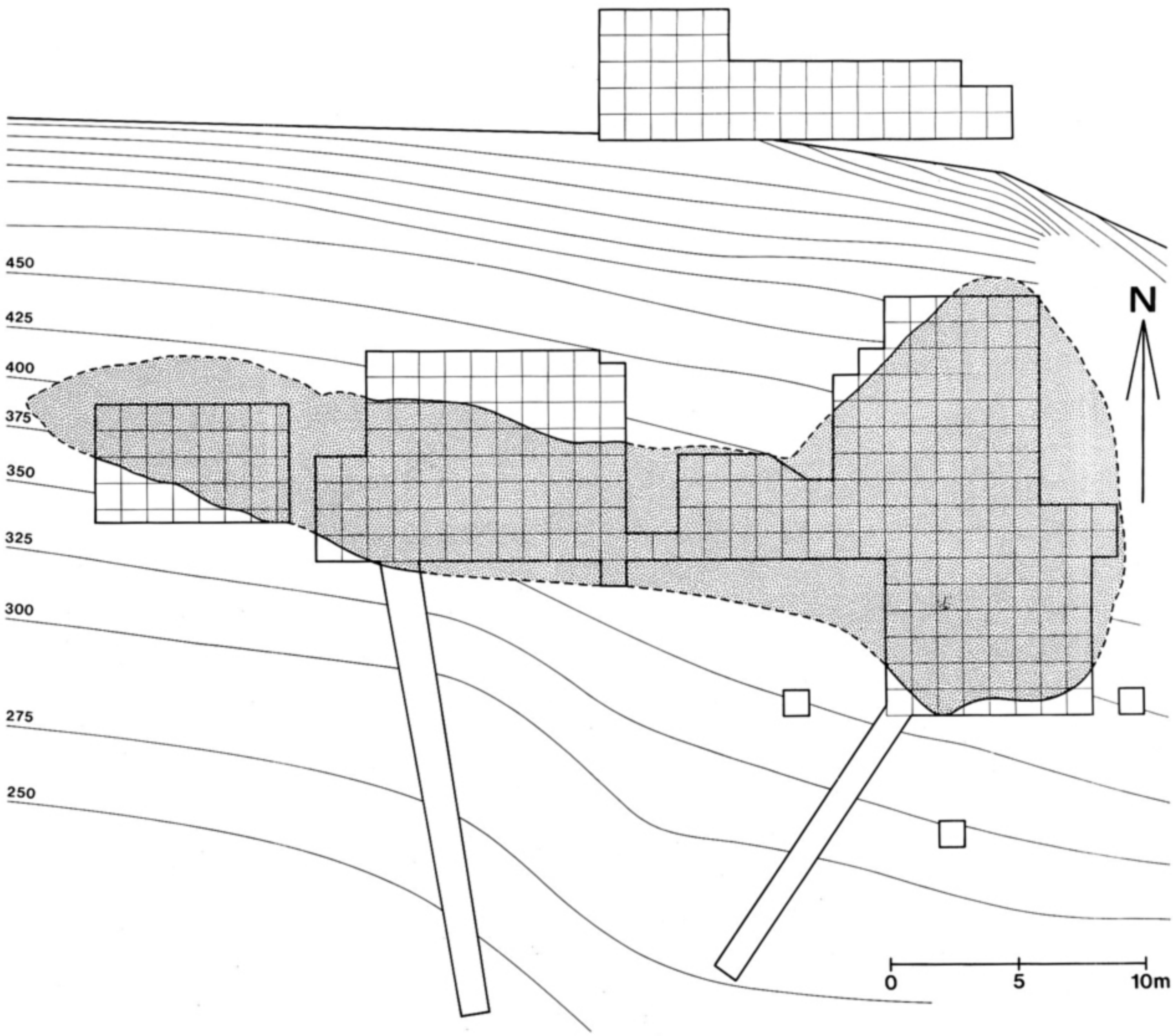

Fig. 7. Maximum extension of the "Køkkenmødding". O. Svendsen *del.*

lithic horizons, it was decided to excavate the site in a continuous series of 1 m wide sections, running N-S and E-W through the central and eastern (the thickest) part of the kitchenmidden. The method of excavation was a combination of following original midden layers and digging in levels of 5–10 cm spits. A distinction was made between special finds, i.e. retouched types, pottery, and bones whose exact position was recorded in three dimensions, and other finds, which were collected by spits. After excavating each of the sections the profiles were recorded and midden-samples – both individual as well as column – were cillected for scientific analysis.[3] Therefore, this part of the settlement was "covered" by a fine-meshed system of profiles, so that no finds are more than 0.50 m from a profile. This excavation method gives a careful control of the stratigraphy and an exact correlation between finds and horizons, but at the same time it is nearly impossible to obtain a larger over-all-survey of structural remains, distributional patterns of finds etc. To cope with this deficit the excavation procedure was changed so that the western part of the site was investigated in larger coherent squares measuring 6x3 m and 6x6 m, respectively, to expose synchronous horizons.

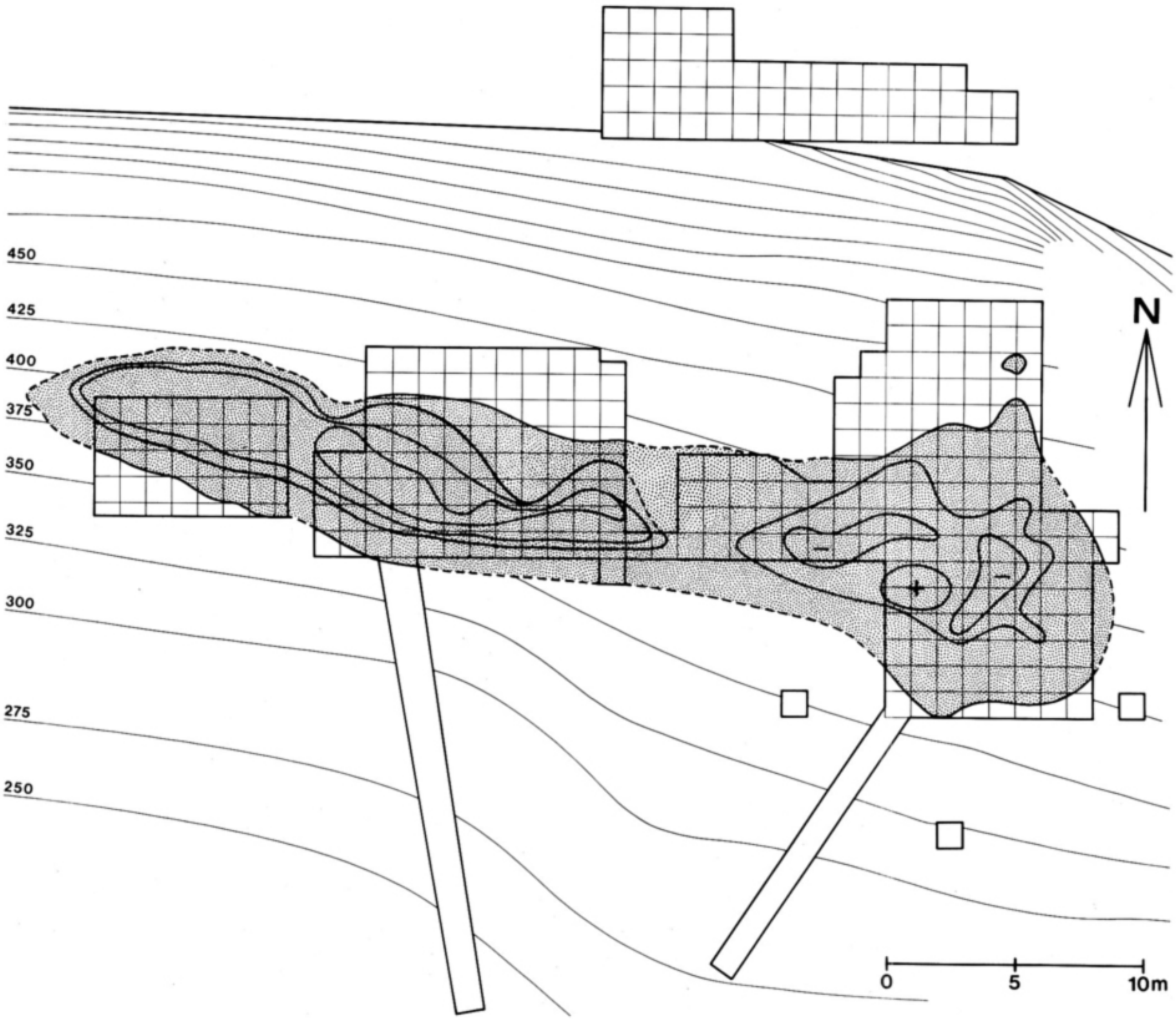

Fig. 8a. Maximum extension of the Ertebølle Køkkenmødding. Equidistance of contours in the midden = 25 cm. O. Svendsen *del.*

Stratigraphy of the Midden

The subsoil (consisting of morainic clay with many stones) slopes gradually from the cliff southwards. The cliff has been eroded by the sea at a level of c. 3.00 m above modern sea level (High Atlantic Transgression) (fig. 11).

Above the moraine, there is a c. 10–15 cm thick sandy blackish-gray humus horizon (old land surface). Upon this follows a 5–10 cm gray, ash horizon with scattered finds of firecracked stones, large numbers of flint debris, bone fragments and charcoal. This ash layer is only found under the shellmidden proper, and its thickness and content of artefacts and bones is highly variable. In four different areas the ash layer was especially thick – and in three of these areas hearths were found (fig. 8b).

The Ertebølle midden which is oblong and irregular in outline is found through the entire excavation area and it measures c. 30 m x c. 12 m east to west, north to south, respectively (360 square metres) (fig. 8a). The eastern part of the Ertebølle midden is c. 0,75–1,00 m thick, while the thickness to the west is only c. 20–50 cm. The volume of shell is c. 170 cubic metres. Topographically, the midden is divided into three areas separated by

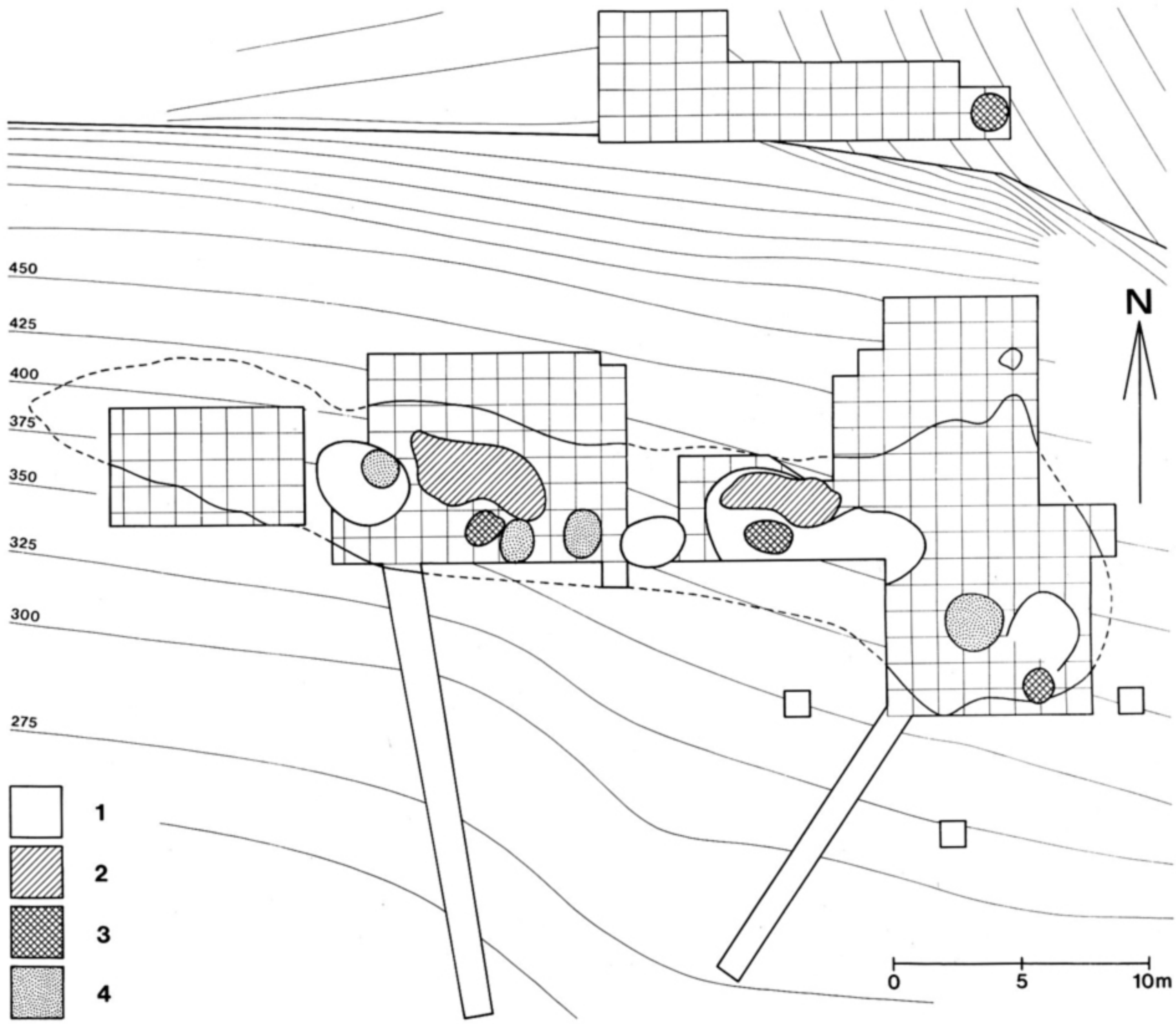

Fig. 8b. Maximum extension of the Ertebølle Køkkenmødding with indication of: 1) Ash layers, 2) Concentrations of flint debris, 3) Stone built hearths, and 4) Concentrations of fish bones. O. Svendsen *del.*

tions of the morainic cliff (fig. 8a). Apart from a few secondary pits and some marine erosion of the southern border this midden is completely preserved. It has been built up by local shell heaps which gradually grew both horizontally (along the coastline) and vertically (especially in the eastern area). Based on stratigraphic and topographic criteria the Ertebølle shellmidden could be divided into at least three fairly well defined areas centred around associated fireplaces (fig. 8b).

The midden consists of a mixture of marine molluscs, mainly large oysters (*Ostrea sp.*) (60–80% of shell), cockles (*Cerastoderma sp.*), mussels (*Mytilus sp.*), periwinkle (*Littorina littorea*), charcoal, flint tools and debitage, animal bones, antler, ceramics, and scattered stones of varying size.

Fireplaces of two types, layers of ash and fishbones and a few larger stones were also found. The shell composition of the layers varies, and in smaller areas one of the above mentioned species may dominate completely – most probably representing waste from the gathering (and subsequent consumption) of a single species.

The horizontal and vertical distribution of cultural remains also varies. Especially, the areas around the fireplaces are generally extremely rich in flint debris, bone

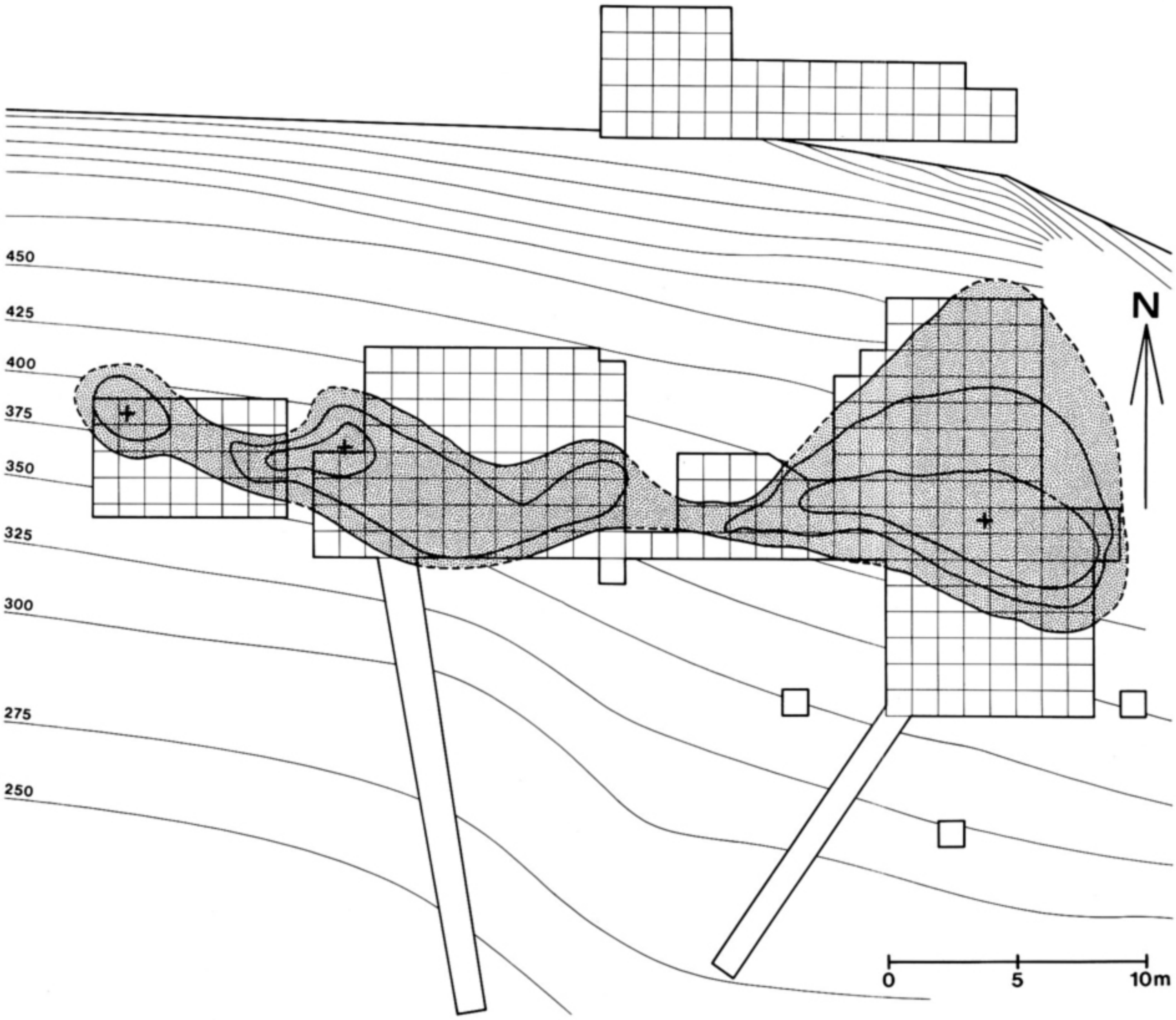

Fig. 9. Maximum extension of the Early Neolithic Køkkenmødding. Equidistance of contours in the midden = 50 cm. O. Svendsen *del.*

fragments, and sometimes fishbones. The range of artefact material is very uniform throughout the midden, suggesting that the types of activities remained constant during the occupation period.

By differences in composition, colour, density, and degree of decomposition, it is possible to divide the midden into 2–3 individual layers, a small number compared to that of other Danish middens, i.e. Ertebølle (S. H. Andersen and E. Johansen 1987). These individual heaps measure 5–10 m in a N-S and E-W direction and 30–50 cm in thickness. Such heaps of shell debris must represent occupational episodes, stressing that there is not necessarily a direct relationship between the number of deposition episodes and occupational episodes (Binford 1982, 16). An occupation may cause several shell heaps or non at all. Therefore, it is impossible to tell how large or how numerous the individual habitation units were.

The stratigraphic analysis and the number of shell horizons indicate that the Ertebølle occupations at Norsminde probably were very few and in rapid succession – observations which correspond nicely to the C-14 dates from the individual heaps. There are only few indications of a sterile layer or erosional level of the top of the Ertebølle-midden (fig. 6). The TBK-midden is situated directly upon the Ertebølle horizon with no "transitional level". These observations suggest that the Ertebølle and

TBK-layers must have been deposited at a steady, continuous rate, or at least without a long depositional break. However, it is impossible to prove that there was no "hiatus" between the Ertebølle- and TBK-occupations.

The TBK-midden is oblong in outline and a little smaller and thinner than the Mesolithic; the largest extension (width and thickness) is found to the east (fig. 9). This midden measures 40 m (E-W), 12 m (N-S) and its thickness is c. 20–100 cm. The area is c. 220 square metres and the volume is c. 100 cubic metres. It is easily separated from the Ertebølle-layer and consists of alternating strata of "fire affected" stones (cooking stones), charcoal and burned shells and shells. This midden is dominated by shells of cockles (*Cerastoderma ed.*) (80% of shell), some oysters (*Ostrea sp.*) (fewer and distinctly smaller than in the Mesolithic horizon), mussels (*Mytilus sp.*), and periwinkle (*Littorina littorea*). Apart from a few secondary roasting pits from the Early Bronze Age the TBK-midden is also undisturbed and an in situ deposit.

The shell horizon could be divided into three individual areas of which the eastern is by far the largest (fig. 9). The TBK-horizon is characterised by 5–10 cm horizontal layers of charcoal and cooking stones (fig. 6, 11). These layers are found all through the midden and they are especially clear and well defined in the (thick) eastern part of the site (fig. 11). Here we find 5–6 well-defined horizons, which may represent a similar number of occupational episodes.

The cooking stones are always of three kinds: Granite, sandstone and quartzite. The number in a 10 cm spit varies within very narrow limits: From 21–49 and from 4,800 kgs to 6,675 kgs. They differ clearly from the "fire-cracked" stones in the Mesolithic levels by the fact that the Neolithic ones are smaller and much more cracked. The cooking stones are very often found in well delineated heaps, usually measuring 0.50–1.00 m in diameter. Such "heaps" are interpreted as "dumps" from individual cooking-/boiling activities (fig. 10). Modern experiments heating similar types of stones and then dropping them into water show that after 4 successive heatings the stones crack in ways similar to those found in the TBK-layers. The practise of cooking with heated stones was observed i.a. among the Northwest Indians. (Krause 1956).

The Neolithic layers indicate a steady continuous accumulation rate, probably covering only a short time span. In these levels we have many localized lenses of grey-yellow ash and burned shell matrix 5–10 m thick, which may be fireplaces, but may just as well be interpreted as "dumps" or "refuse from clean-ups". The numerous occurrences of fire-cracked stones and ash strongly indicate activity differences in the Early Neolithic and in the Mesolithic levels. The horizontal sedimentation and wide extension of all the Neolithic ash layers must indicate some sort of "levelling" by the inhabitants, or the cooking must have taken place simultaneously on a large area of the midden surface (fig. 11).

Fig. 10. "Dump"or "clearing-up" of fire-cracked stones (cooking-stones). Photo P. Dehlholm.

There are other significant differences between the two main horizons in the Norsminde køkkenmødding: *No layers or concentrations of fish bone around the hearths are observed in the Neolithic midden.* This may be a question of preservation, but in relation to the other – and small well-preserved bones in these horizons, it is rather a reflection of differences in activities/economy.

The number of pieces of flint debitage is also remarkably smaller in the Neolithic level; this suggests that flint knapping did not normally take place on the midden itself in this period. The only really abundant artefact type in the TBK horizon is ceramics, which occurs in great numbers – often in the shape of large, well-preserved fragments of pots. No structural remains, i.e. pits, house floors, post holes or graves from this period were recorded.

This "køkkenmødding" is best interpreted as a specialised coastal activity *area*, which was mainly used for the cooking, smoking, or drying of shellfish.

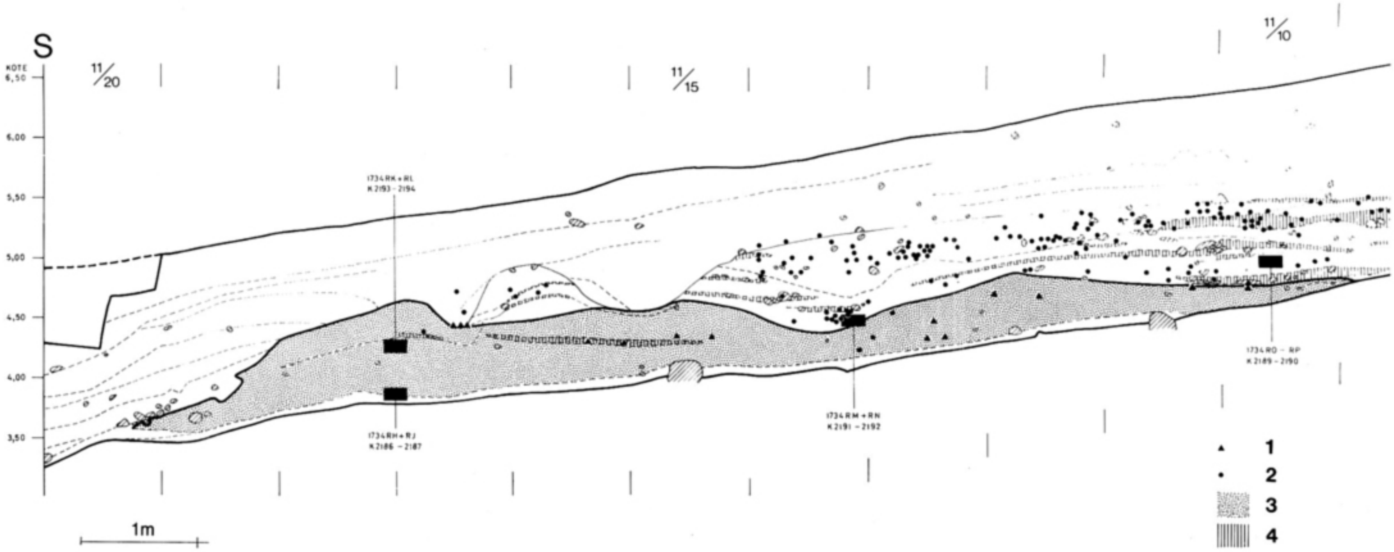

Fig. 11. Plot of all well-defined potsherds within the nearest meter-section of the profile. E. Morville *del.* Legend: 1) ETBK-ceramics. 2) Early Neolithic pottery. 3) Oyster-kitchenmidden. 4) Horizons of ash and fire-cracked cooking-stones. Partially after E. L. H. Olsen.

The "Black Layer"

On top of the shellmidden follows a c. 10–15 cm black clayey horizon with fragments of shells, ceramics, cooking stones, animal bones, and flint artefacts (fig. 6). The molluscs are once more dominated by Oyster (*Ostrea sp.*). This horizon contains artefacts from several Late-Early Neolithic and Middle Neolithic periods, which must reflect several, but short-time activities on the site – in contrast to the Mesolithic and Early Neolithic depositions. The "black" layer is deposited after the Early Neolithic occupation and during the period in which the midden was exposed.

Finally, the sequence ends with an up to 2 m thick level of fine light-brown sand (secondary deposits from the hills to the rear of the midden) (fig. 11).

Summary of Stratigraphy

The Norsminde site demonstrates a stratigraphy as follows (from bottom to top): Subsoil, ancient land surface mixed with ash and a high concentration of flint debris, shellmidden dominated by large oysters, and shellmidden dominated by cockles and charcoal horizons. On top of the midden is a black cultural layer. Finally, the site is buried under a thick deposit of sandy earth.

Correlation between Archaeological and Geological Horizons

A plot of the vertical distribution of pottery throughout the sections demonstrates that the occurrence of Ertebølle ceramics corresponds exactly to the midden layers dominated by the oyster. An identical situation is observed with the Early Neolithic TBK ceramics which corresponds closely to the cockle-dominated midden section (fig. 11). The black top layer is characterised by TBK-ceramics of Middle-Neolithic type.

This merging of ceramics and geological layers is also relevant for all the other well defined archaeological types and is an essential and characteristic trait of the Norsminde settlement, where the horizon with Ertebølle types is defined by a dominance of oysters and the Early Neolithic Funnel Beaker artefact types correspond with layers characterised by cockles, ash and cooking stones.

This phenomenon is not restricted to Norsminde, but has also been recorded at other Danish sites. First, about 100 years ago by the excavation at the "køkkenmødding"

Krabbesholm at Skive[5] (fig. 12), later at Bjørnsholm[6] (Mathiassen 1940). Similar observations have also been made at Askø (Skaarup 1973, 128), Sølager and Fårevejle (Skaarup 1973, 127–128). On all these sites – distributed over the whole of Denmark – the transition from Ertebølle – to Early Funnel Beaker Culture (and thus from the Mesolithic the Neolithic) – corresponds to a abrupt change from midden levels characterised by oysters to levels dominated by cockles (figs. 12 and 23).

It is in this connection essential to underline that in no case Ertebølle horizon(s) have been found on top of Funnel Beaker layers. There are no stratigraphic support for arguments of contemporaneity between the two phases as put forward by K. Jennbert (1984).

Fireplaces

In the Ertebølle layers we have found five fireplaces of two types. The most common are stone built fireplaces c. 1 m in diameter of which three were documented in the grey ash horizon beneath the midden (fig. 8b). These hearths were found along the prehistoric beach at intervals of 5–7 m, but it is impossible to tell whether they are contemporaneous – and thereby reflect a regular division of the settlement into areas centered around such hearths, or if their spacing reflects a gradual movement of the settlement along the old coastline.

In two areas we see another type of fireplace, i.e. areas where the subsoil has been coloured reddish-yellow by the heating from fireplaces; around these places we also find more charcoal, burned bone-splinters, fragments of "heath-cracked" stones, etc.

The difference in type may represent differences in function or degree of permanence, but this problem has not yet been analysed. In one case we see a stratigraphic sequence of three fireplaces – an observation which indicates a fixed position of the hearths through time. An identical observation was made at Ertebølle (S. H. Andersen and E. Johansen 1987, 48).

With few exceptions all the hearths have been found in the ash layer underneath the kitchenmidden – thereby indicating that habitation had taken place in these areas before periods of shell accumulation. However, it is impossible to tell whether this horizon constitutes an older and different settlement type than does the kitchenmidden; it is more reasonable to assume that this lower horizon represents traces of settlement activities connected with the oldest occupation of the site, so that both smaller shell heaps and flint debris have been deposited close by and around the fireplaces. As the habitation gradually moved along the beach and the shell layer(s) grew in height, these activity areas were slowly covered by later shell layers.

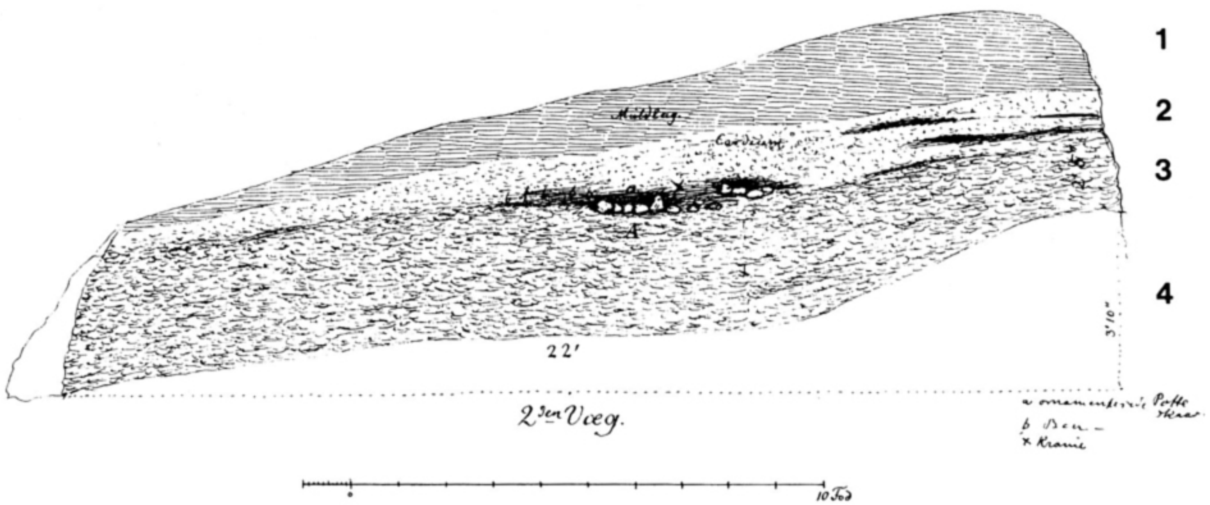

Fig. 12. Section of the køkkenmødding Krabbesholm in Northern Jutland (drawn in 1896, after drawing in the archives of the National Museum, Copenhagen. Legend: 1) Sandy humus. 2) Køkkenmødding with cockles, ashlayers, and horizons of cooking-stones (Early Neolithic). 3) Køkkenmødding with oysters (Mesolithic). 4) Subsoil.

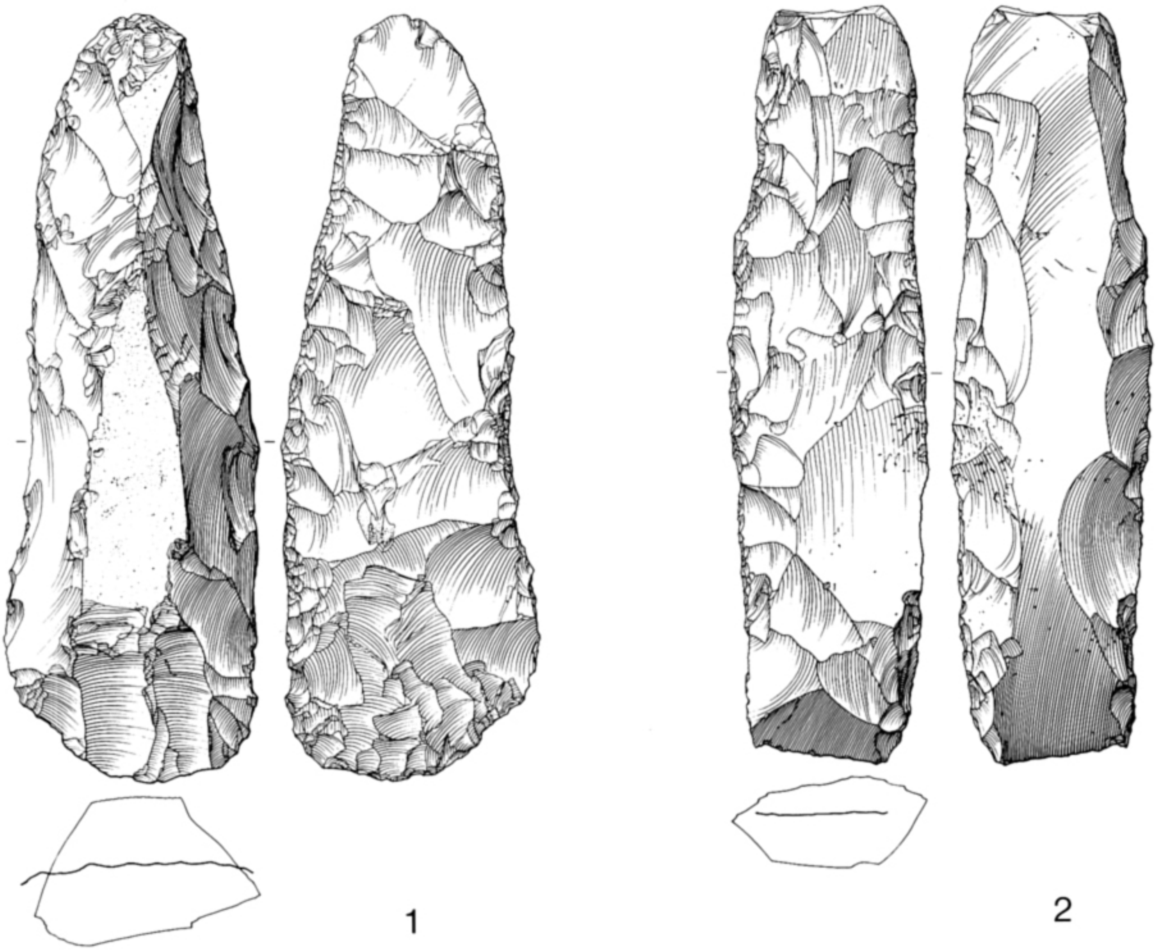

Fig. 13. Flint tools of Younger Ertebølle types. 1) Core adze, 2-3) Flake adzes, 4-7) Transverse arrowheads, 8) Flake borer, 9) Blade borer, 10) Truncated blade, 11) Saw, 12) Blade scraper, and 13) Burin on a break. Scale 3:4. O. Svendsen *del.*

Activity areas

Around the Ertebølle-fireplaces are concentrations of flint debitage, flint tools, fishbones, and pottery – clear indications that these areas have been centres of activity i.e. production and use of tools and consumption of food. An analysis of the size of the flint debitage indicates that a substantial part of the flint waste consists of small splinters (micro debitage less than 1 cm in length) which proves that flint knapping took place on the midden.

There are also distinct areas of concentrated fishbones (fig. 8b). These areas are localised, and found in association with the fireplaces. Fishbones is also found in a c. 3–5 cm thick grey horizon in the middle layer of the midden. These concentrations may reflect periods of intense fishing or a systematic use of specific areas of the midden for fish processing.

Anthropological evidence

In the Ertebølle shell-layer some scattered human cranium fragments (Homo s. sapiens.) were found – probably the vestiges of one or several graves.

This was confirmed by the occurrence of a disturbed grave (unfortunately without grave goods). The grave, a shallow pit dug into the subsoil, contained the remains of a woman c. 25–30 years old, with the head facing SW.[7] The dating was later confirmed by a C-14 analysis giving

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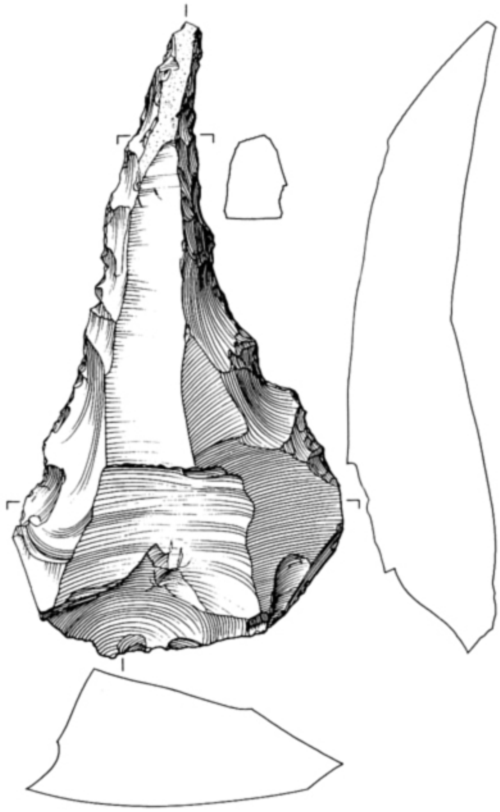

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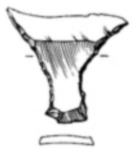

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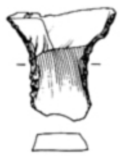

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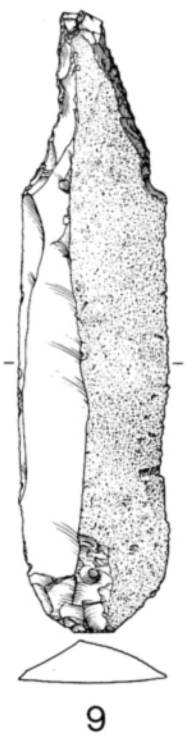

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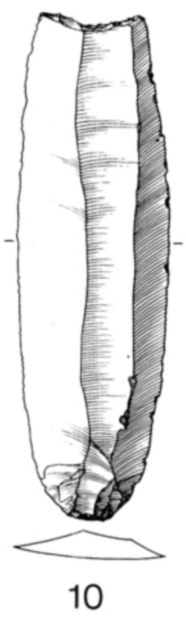

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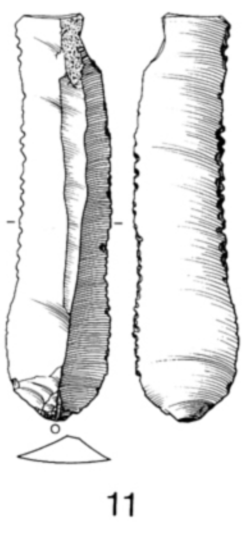

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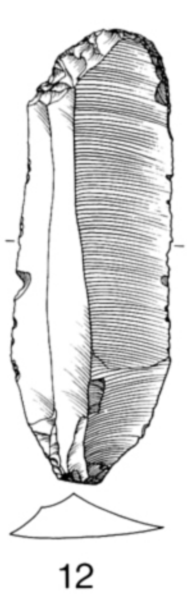

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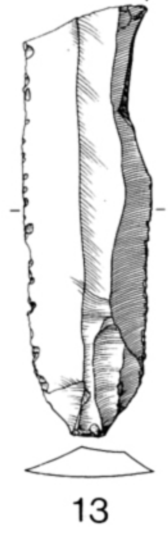

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Fig. 14. Red deer antler-axes. Bottom: Older type with the shafthole near the burr. Top: Younger type – so-called T-axe with the shafthole bored through a sawed off tine (Scale 1:3). Photo: Moesgård.

Fig. 15. Rim sherd and bottom of typical pointed-bottom vessels of the Ertebølle Culture. E. Koch *del.* Scale 1:2.

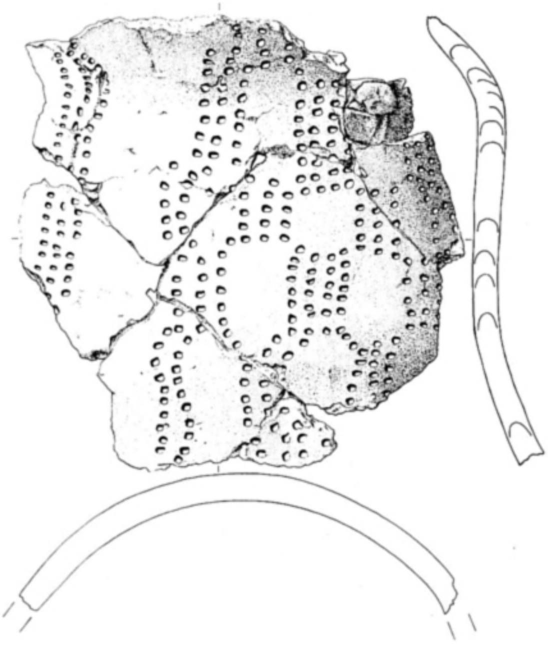


Fig. 16. Thinwalled, pointed bottom vessel ornamented with series of small dots in a net-design. O. Svendsen *del.* Scale 1:2.

Fig. 17. Sawed off tines of red deer used for pressure flaking. Top: Late Mesolithic. Bottom: Early Neolithic. Scale 1:2. Photo: Moesgård.

a date of c. 3.400 b.c. (K-5199). Analysis of the stabile isotope 13.C from two of the cranium fragments indicates that the food mainly was composed of a marine diet, i.e. fish, seals, shell food, etc. (Tauber 1981).

Other features

No pits or house floors were recorded within the Ertebølle or Funnel Beaker midden during the excavation. Also, no traces of structural remains were found in the subsoil under or to the rear of the midden. However, it was observed that no "natural" boulders were found on the old surface within a distance of c. 3–4 m around the stone-built fireplaces of the Ertebølle period. This may reflect a "clearing" of stones from these areas to make them more suited for the different settlement activities which took place around the hearths.

CHRONOLOGY

Thirty-three C-14 dates have been analysed in connection with the Norsminde excavation. Of these, 26 are based on oyster shells (*Ostrea sp.*), five on cockle shells (*Cerastoderma sp.*) and one on bone (see the list page 39). The position of each sample was taken in stratigraphic context and in direct contact with well defined archaeological types in order to date the different sections and layers. The C-14 analysis support the stratigraphic observations, and demonstrate that the whole midden accumulated over a period of 700–800 C-14 years; not as a gradual and continuous process, but rather a series of more or less intense depositions.

The Ertebølle-midden

Twenty-one C-14 dates have been investigated from this part of the midden; sixteen are from oyster shells (*Ostrea sp.*) and two from cockles (*Cerastoderma sp.*) (see list page 39). The lowermost part of the Ertebølle-midden is dated to 3820 ± 100 b.c. (K-2187), while the top horizon belong to 3090 ± 90 b.c. (K-2663).

Apart from one date (on cockles, K-2187: 3820 ± 100 b.c.) all the samples from the "oyster-midden" are concentrated in the period 3.500–3.100 b.c. It is essential to note that all samples taken from layers with an archaeologically well defined artefact inventory of Late Mesolithic type also have dates within the range known from other Late Mesolithic sites i.e. Ertebølle (S. H. Andersen and E. Johansen 1987, 49–50). The datings are in nice accordance with the artefact inventory and suggest that the central part of the midden is the oldest and that it grew along the coastline. Furthermore, the dates support our stratigraphic observations that this part of the midden has been made up by very few depositions within a short time-span of 200–300 years – mainly in the younger or youngest Ertebølle period.

The TBK midden

We have 10 C-14 dates from this level; six are from oysters (*Ostrea sp.*) and four from cockles (*Cerastoderma sp.*). The results are spaced in the period 3010 ± 100 b.c. (K-2192) – 2530 ± 85 b.c. (K-2665); the mean is 2880–2860 b.c.

The main part of the Neolithic midden is dated to 3.000–2.800 b.c., hereby placing it in a very Early Neolithic context. The youngest dates of this midden are 2650 ± 85 b.c. (K-2664) and 2530 ± 85 b.c. (K-2665). Since these two dates differ from the rest and since they both come from the most eastern part of the midden, it is reasonable to assume that they represent a younger and individual occupational episode on the site.

Finally we have one C-14 date from "The black layer": 2450 ± 100 b.c. (K-2188) (*Ostrea sp.*). This date corresponds nicely with the ceramic inventory in this horizon (MN I a).

ARTEFACTS FROM THE ERTEBØLLE LAYER

The finds from the Ertebølle midden reflect a broad range of types of flint, bone, antler and ceramics. All types are within the range known from other contemporary Ertebølle sites. Based on the range and relative number of artefacts this site should be characterised as a "base-camp".

All artefacts belong to the Younger Ertebølle Culture, and occur throughout the midden. Both the horizontal and vertical distribution of artefacts show areas of concentration. In terms of the horizontal distribution, the material around the fireplaces is highly concentrated – not only tools, but also debris and animal bones. As for the vertical distribution, there is a high concentration on the surface of the subsoil.

We can observe only very few changes in the artefact inventory in relation to the stratigraphy; an indication of a short occupation period. There is a change in the type of the red deer antler axes from axes with the shafthole near the burr of the tine (at the bottom of the layers), to antler axes with the shafthole further up the stem where a tine has been sawed off – the so-called T-axes – in the top layers (fig. 14).

The flint tools are very regular and well made. The blades are long, wide, regular and made by "soft technique"; they form the basic blanks for tools, such as blade scrapers (few), different types of borers (several), burins,

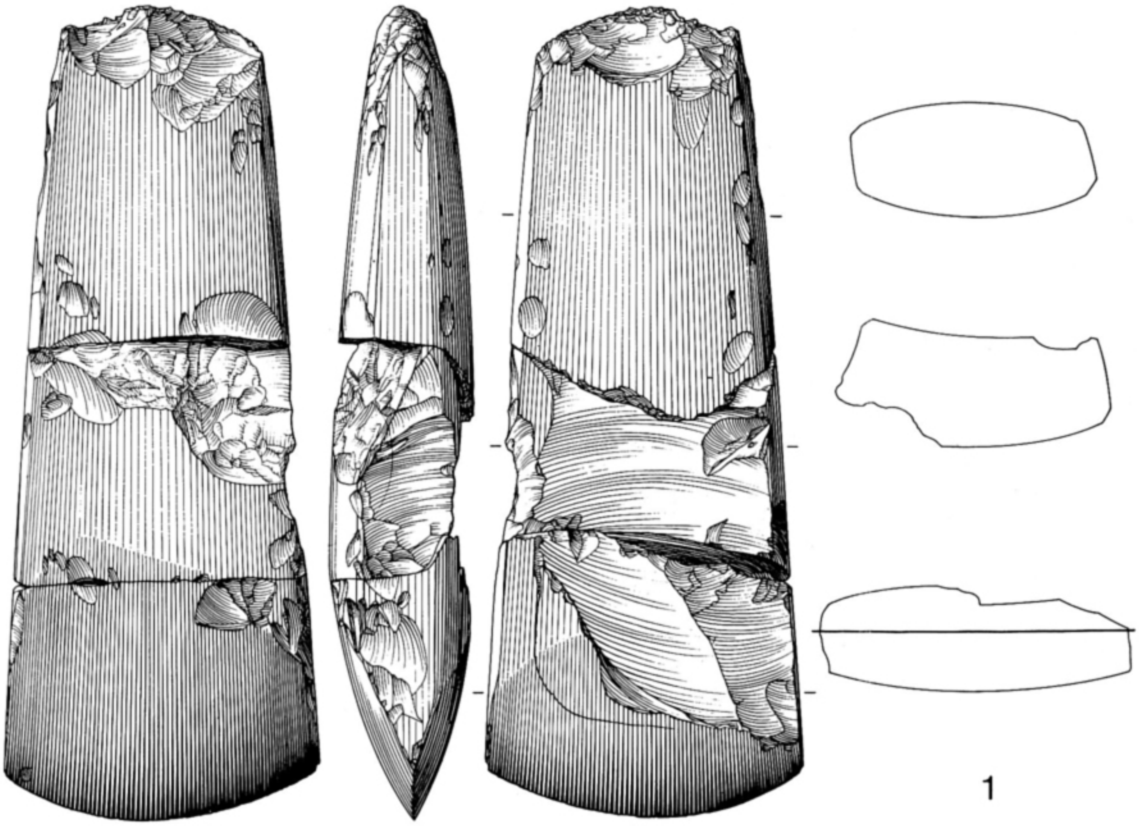


Fig. 18. 1) Polished thinbutted axe, 2-3, 6) Scrapers, 4) Truncated blade, 5) Flake adze, 7-8) Needle - shaped drills, 9-12) Transverse arrowheads. Scale 3:4. O. Svendsen *del.*

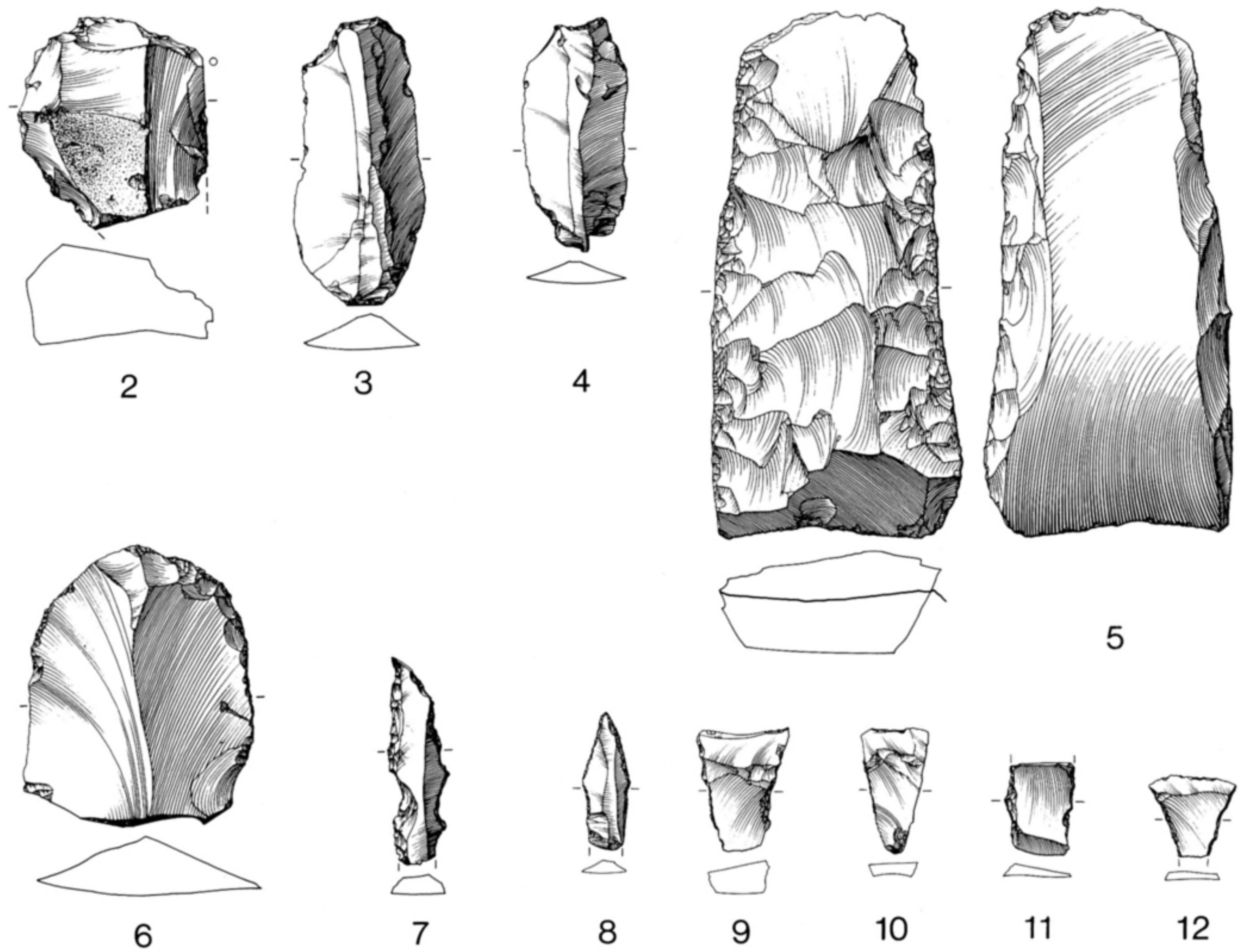
concave truncations, and other truncated pieces (numerous). These types occur together with transverse arrowheads and flake-, core-, and green stone (diabase) axes. In all layers, there is a heavy dominance of beautifully shaped flat flaked flake axes – very often with expanding edge corners. The core axe is rare, but occurs normally as very symmetrical with specially trimmed edges (fig. 13:1).

A concentration of blades and blade scrapers found around the stone built fireplace in the squares 32–34/31 have been analysed for traces of use wear.[8]. The investigation showed that a majority of the scrapers were used for scraping dry hide, but scrapers for fresh hide were also recorded. All in all, these data clearly demonstrate the presence of a well defined "work area" for skin preparation just beside the fireplace. The use-wear analysis proves that the shell midden is the settlement proper – not only an area for sporadic activities, but rather more basic and time consuming activities.

Tools of bone and antler of the Ertebølle tradition were also found: Most numerous are simple bone points, red deer antler axes of the two above mentioned types, and sawed off tines for pressure flaking (fig. 17).

Ertebølle pottery occurs in all layers of the midden. The material comes from the both thick- and thin-walled pointed-bottom vessels – both larger and small pots are present, but on this site the thin-walled ware is the dominant. No sherds of the so-called "lamps" were recorded. The rim sherds display finger impressions on the edge (fig. 15).

A fragment of a small Ertebølle vessel is ornamented. The design is an elaborate net pattern made by a series of rows of small dots (fig. 16) – a technique and motif well-known from the contemporary inland Ertebølle site Ringkloster (S. H. Andersen 1975, 62–63).



FINDS FROM THE TBK MIDDEN

The flint artefacts from the TBK-level are distinctly different from those in the Mesolithic horizons. Technologically this level is characterised by flake technique, while blades are vere few; nearly all tools are made on flakes. As we are dealing with the same site there is no reason to suppose that this difference has anything to do with access to raw material, it must, indeed, be a change in "style". Typologically, we generally find the same types as before, but in other relative frequencies.

Only a few axe types are documented from this level. Core- and greenstone-axes are completely absent and only a few flake axes are found. The dominant axe type is now the polished, thinbutted axe of type IV (eventually also type I) (fig. 18) (P. O. Nielsen 1977, 72–74 and 77–78, 106). Transverse arrowheads are numerous, but occur in other shapes than in the Ertebølle culture; the Neolithic arrows have slightly convex sides and a pointed back (fig. 18:9-12). In addition, we have several round flake scrapers, many borers and knives, while burins and truncated pieces are few (fig. 18:2-4, 6-8).

To summarise: The flint artefacts demonstrate type-continuity between the youngest Mesolithic and the oldest Neolithic period, while the technique is markedly different; finally we can observe a change in the relative frequencies among the types.

Tools of bone and antler are very few in number; only some simple bone points and sawed off tines for pressure flaking are present (fig. 17).

The most numerous artefact group is ceramics; c. 150

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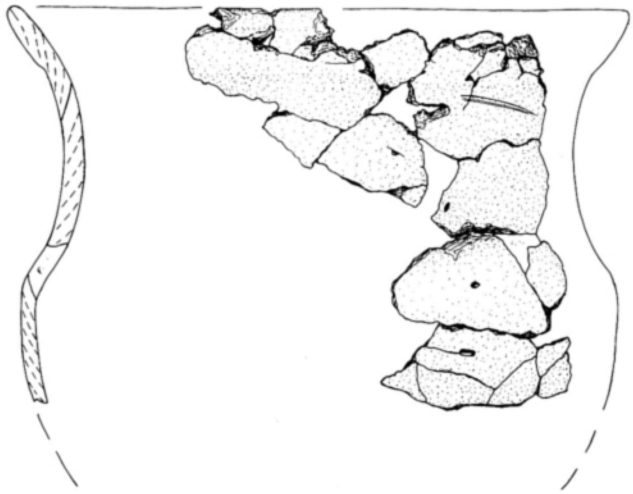

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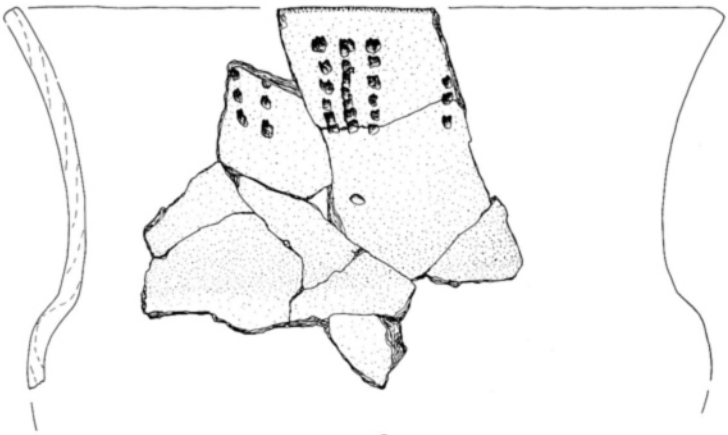

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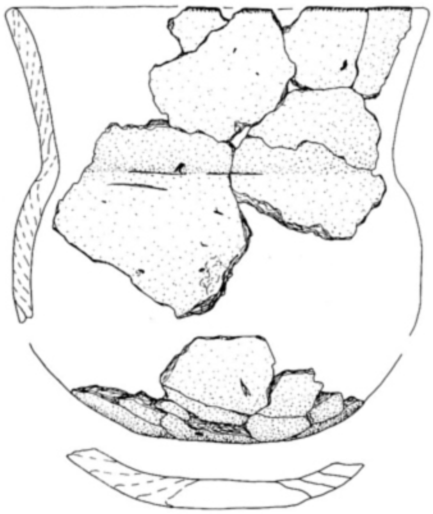

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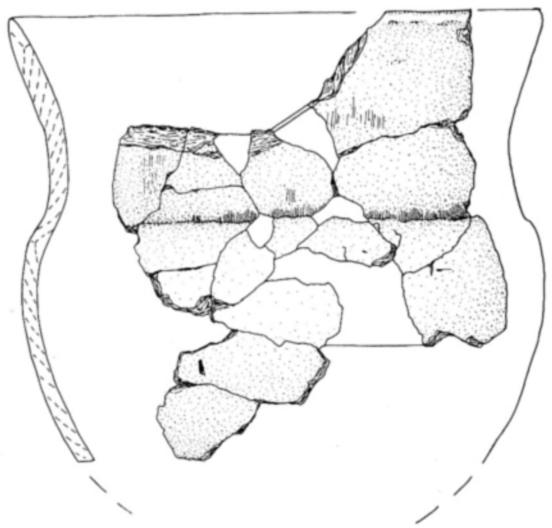

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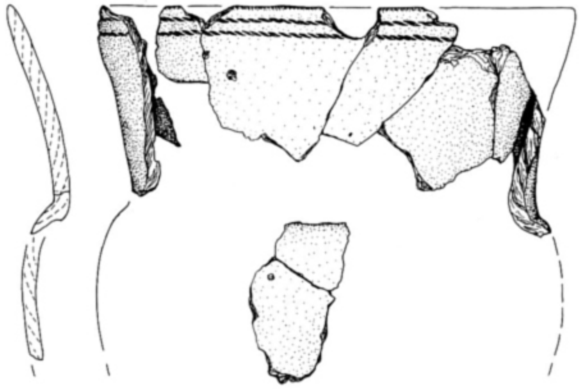

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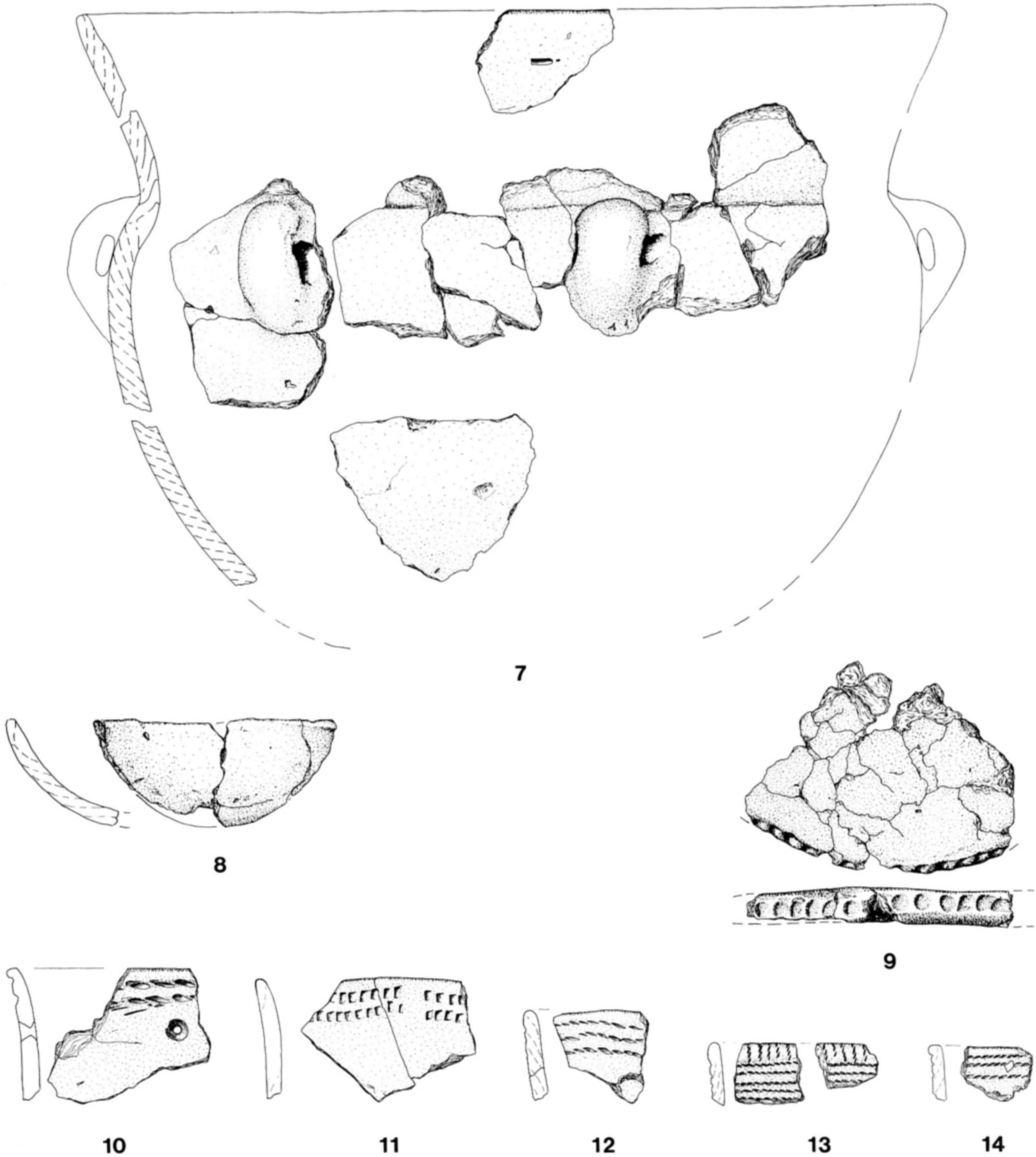


Fig. 19. 1-6) Funnel beakers of the Volling type. 7) Lugged beaker, 8) small bowl and 9) clay disc. 10-14) Types of ornaments. Scale 3:4. E. Koch *del.*

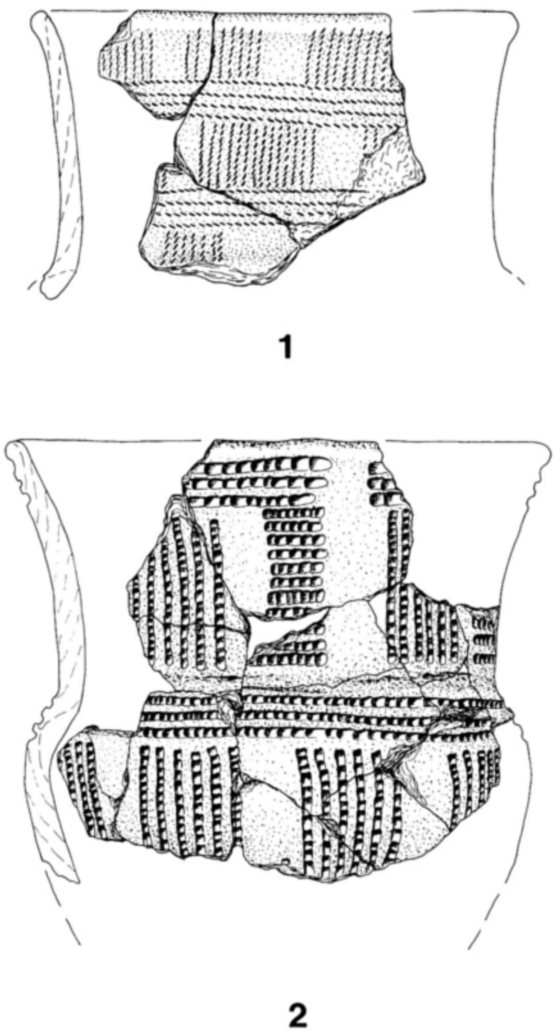


Fig. 20. Funnel beakers of Volling type with fully decorated neck and belly. Scale 3:4. E. Koch *del.*

different vessels are recorded, of which c. 1/3 is decorated. Normally the ceramics are found in large fragments – very often in the ash- and stone layers. In comparison to the Ertebølle level it is obvious that ceramics – as a type – play a more important role in the inventory than earlier. Not only the shapes, techniques and ornaments, but also the number and type-inventory are fundamentally different. It is essential that "hybrid"-forms between the ETBK- or TBK-ceramics have not been found.

The ceramic inventory is simple funnel-necked beakers, lugged beakers, lugged jars, small bowls, and clay disks. The dominant form is simple funnel-necked beakers, which are present in two size-groups: The largest group is made up by rather small vessels with a height of c. 15–20 cm and a smaller group of larger pots of c. 30–40 cm in height (fig. 19). The majority of the vessels display a very characteristic profile with a relative high, concave neck, separated from the convex belly by a distinct angle from neck to body (figs. 19:1-6). The base is always round or rounded. The pottery is generally without ornamentation. If decoration is found, it is usually confined to just below the rim. Out of c. 129 pots of this type, c. 40 are decorated on the rim – normally with 1–6 horizontal impressions of twisted cord . The most frequent ornament is two horizontal cord impressions on the rim (fig. 19:6). Some vessels also display single or double rows of horizontal stabs or short strokes (figs. 19:3).

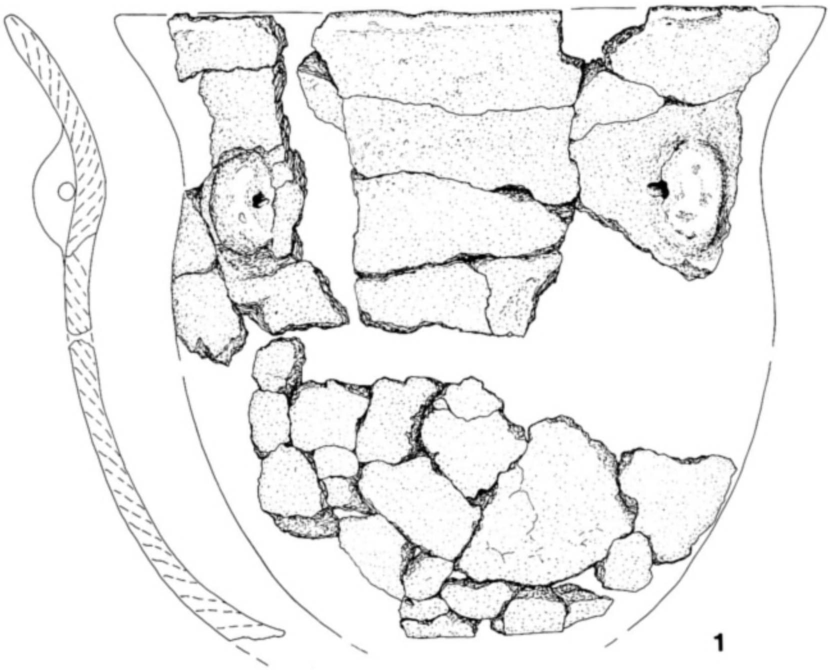
Within this ceramic group a small number are different from the rest by the fact that they are of a "finer ware", i.e. thinner and that the entire surface is covered with decoration in a chequer composition (fig. 20). The clay disks are decorated with finger impressions on the edge (fig. 19:9). Finally, we have three undecorated beakers of slightly different type with a short, straight neck (fig. 21).

The large group of funnel beakers corresponds the so-called B-beakers, while the "finer" vessels belong to the "non-megalithic C-group" (Becker 1947). Both groups have recently been incorporated in the so-called "Volling group" (Madsen and Petersen 1984). The stratigraphical observations clearly testify that the two types of funnel beakers are contemporary in eastern Jutland, and this type of inventory should be dated to c. 3,000–2,800 b.c.

From an archaeological-typological point of view the upper shellmidden at Norsminde must be dated to the beginning of the Early Neolithic Funnel Beaker Culture – a dating which is also supported by the stratigraphy and C-14 dates.

The Norsminde settlement has, probably, provided one of the largest samples of Early Neolithic pottery and it, therefore, gives a good impression of the ceramical type inventory and range of variation of the Oldest Funnel Beaker culture in this region.

As mentioned before we have three vessels of a slightly different form (fig. 21) which from a typological point of view show clear affinities to the "A-group" (Becker 1947). A preliminary investigation of the stratigraphical position of these pots shows, that they all belong to the oldest "Neolithic" horizon – just above the Ertebølle layer. They could either define an occupation older than the "Volling-group", or be a part of the oldest "Volling".



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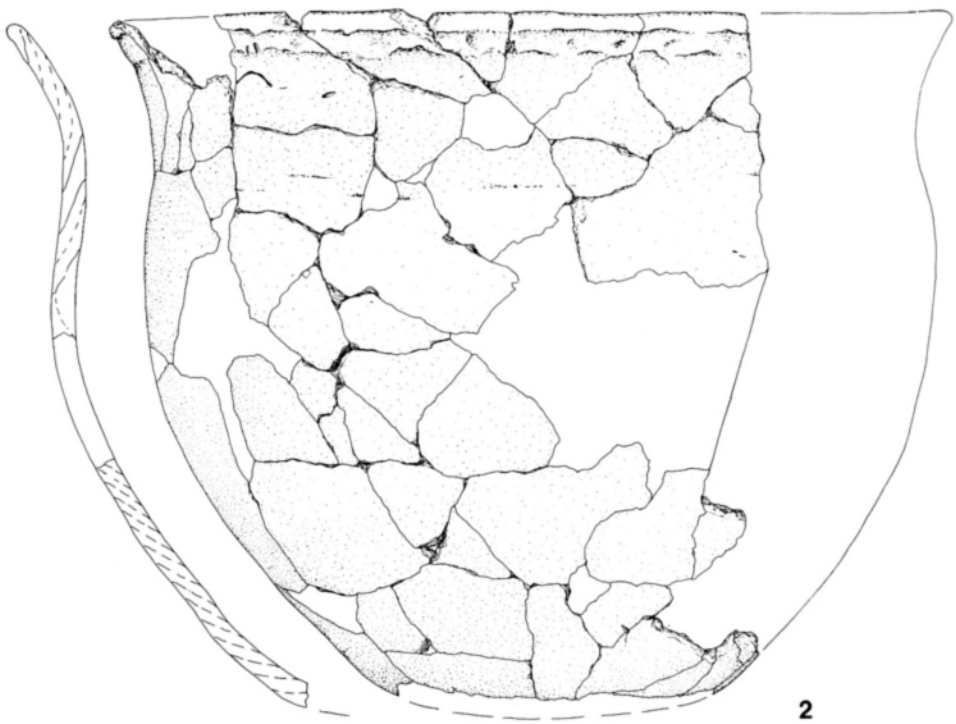

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Fig. 21. Funnel beaker, lugged beaker and bowl with a short, straight neck. Scale 3:4. E. Koch *del.*

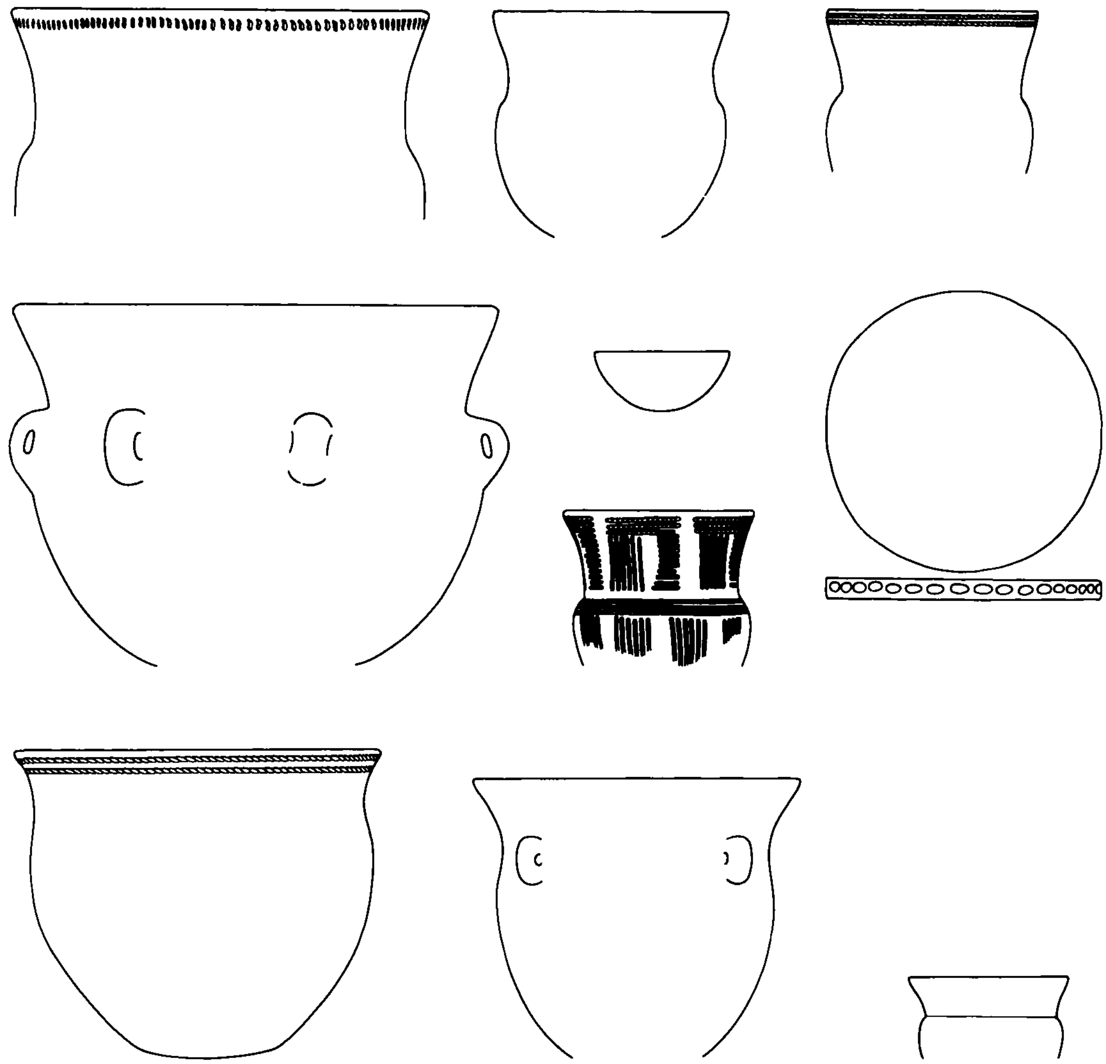

Fig. 22. Type table of Early Neolithic pottery forms from the Norsminde settlement. The three beakers in the bottom row are found in a stratigraphic position *below* the others. Scale 1:4. O. Svendsen *del.*

SUBSISTENCE

The economy of the Ertebølle levels has been based on hunting, fishing and gathering. This is well documented by the types of artefacts found associated with the large numbers of animal bones and shellfish. The list of species display a wide range of mammals, fish, and some birds. The only domesticated animal is the dog. A few bones of Man were also recorded – probably coming from (a) grave(s) destroyed by later activities. As it is usually the case in "køkkenmøddinger" the bones are very small and fragmented – either a result of many different taphonomic factors or because they have been crushed for cooking purposes, i.e. for soup (Binford 1985, 157). The distribution of animal bones follow the same patterns as described for the flint debitage, i.e. there is a strong correlation between the ash horizons around the fireplaces and the higher concentrations of bones.

The bones from mammals and birds are in most cases found scattered in the shell matrix, while fishbones either occur in layers or as concentrations close to the fireplaces. Among the larger animals, the red deer (*Cervus elaphus*), wild pig (*Sus scrofa*), and roe deer (*Capreolus capreolus*) were the most common species; aurochs (*Bos primigenius*) is represented by only a few bones.

Animals such as wild cat (*Felis silvestris*), beaver (*Castor fiber*), and wolf (*Canis lupus*) were huntet for their furs.

Grey seal (*Halichoerus grypus*) as well as large whale (*Cetacea*) were hunted at sea and along the coast. Also swans (*Cygnus sp.*) and ducks were captured.

The fact that fishing has been of great importance in the subsistence is confirmed by the many fishbones (both concentrations and horizons), the wide range of species, the technological items used for this activity and the 13.C-analysis of human bones (see page 28 and Inge B. Enghoff, this volume). The dominant species are flatfish (*Platichthys, Psetta/Scophthalmus*), cod (*Gadus*), and eel (*Anguilla*).

All species present are marine; not a single bone of freshwater fish has been found. The fish species, combined with their relatively small size, indicate fishing close to the beach – probably conducted by means of fish traps, i.e. Tybrind Vig (S. H. Andersen 1986, 61). Gathering is documented by the many shells of oysters (*Ostrea sp.*), mussels (*Mytilus sp.*), cockles (*Cerastoderma sp.*), and periwinkle (*Littorina littorea*).

Some information on seasonality is available. Fishing has taken place in the summertime and the cockles have been gathered between May and October. The fur-bearing animals were most probably hunted during the winter. This is also the case with the swans and some species of ducks. At present it is possible to state that summer, autumn, and winter indicators were found, but it would be premature to argue for a permanent year round occupation.

The subsistence of the TBK-levels has been based on a mixture of hunting, farming and gathering. Wild game is represented by seal (Phoca sp.), wild boar (*Sus scrofa*), fox (*Vulpes vulpes*) and red deer (*Cervus elaphus*). Domesticated animals are pig (*Sus dom.*), cattle (*Bos t. domesticus*) and sheep/goat (*Ovies aries, Capra hircus*). Also, the presence of dog (*Canis fam.*) and Man (*Homo sp. sp.*) must be mentioned.

It is essential that no traces of fishing has been recorded from this horizon (for further discussion of this: see I. Bødker Enghoff 1991, this volume).

The Neolithic subsistence is further documented by grain-impressions in the vessels, by charred grains of Emmerwheat (*Triticum dicoccum*) and of Naked barley (*Hordeum vulgare*), but grains are very few in number.

Gathering is documented by the many shells of cockle (Cerastoderma ed.), and mussels (Mytilus sp.), periwinkle (*Littorina lit.*), and oysters (*Ostrea ed.*). Also shells of hazel nuts (*Corylus av.*) are found. Analysis of the "year-rings" of the cockles indicate that they were collected in the spring- and summertime.[9]

Although the economy of this habitation reflects exploitation of several different biotopes, it is remarkable that fishing is not documented. Also, the change from oysters to cockles as the focus of gathering is interesting. This may be explained in several ways i.e. as a result of "overcollecting", but it is more reasonable to suppose that it reflects a general change in the (marine) biotope as the cockles are more resistant to environmental alterations in temperature, salinity in the sea, than is the oyster. This does not necessarily need to have had any economic importance in itself, but may just indicate alteration(s) in the (marine) environment, which may have resulted in a change in the available (marine) resources. The stratigraphic information and the C-14 dates demonstrate that this environmental change took place c. 3.000 b.c., and it is, therefore, contemporary with the transition from pollenzone VII to zone VIII (Atlantic-Subboreal) – and form the Late Mesolithic Ertebølle culture to the Early Neolithic Funnel Beaker culture (fig. 23). This observation is also recorded at other coastal sites with stratigraphic sequences covering this period, i.e. Krabbesholm, Bjørnsholm etc. (see page 24-25).

CONCLUSION

The Norsminde site is a "køkkenmødding" with two different occupation layers from the Late Mesolithic and Early Neolithic periods. The oldest habitation belongs to the Ertebølle culture, while the Neolithic one represents the Funnel Beaker culture. The occupation may very well have been continuous – and thereby also covered the Meso-/Neo-transition, but such an assumption is impossible to prove.

No traces of occupation outside the midden area have been documented from the Ertebølle period. All finds reflect basic home base activities of production and consumption without any trace of specialisation. In the

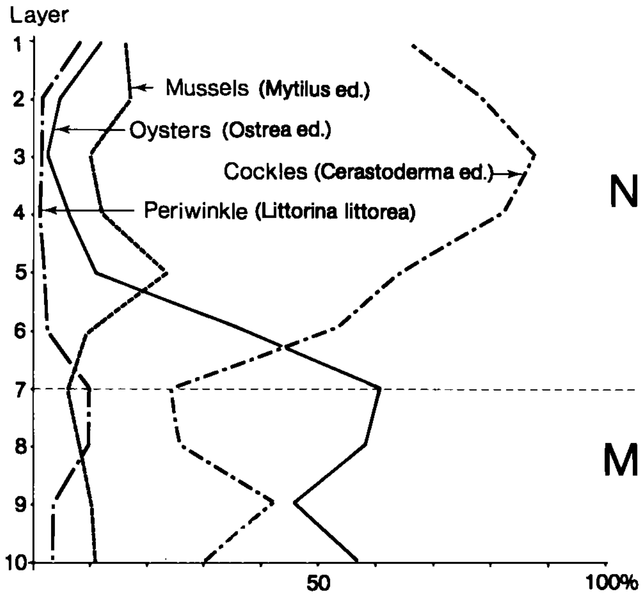

Fig. 23. Percentages of the different species of molluscs in the layers of the Norsminde "Køkkenmødding"

subsistence the fishing of flounder, cod and eel seem to have been of special importance (see I. Bødker Enghoff, this volume).

The Mesolithic horizon is characterised by oysters, while the Neolithic one is dominated by cockles. This change from oyster to cockle may reflect a change in the (marine) environment, an observation which seems to be of a general order and is contemporary with the transition from pollenzone VII to VIII (Atlantic-Subboreal). This change in the biotope is also contemporary with the transition from the Mesolithic to the Neolithic in Denmark (fig. 23).

The number of artefacts is much more restricted in the Neolithic than in the Mesolithic horizon. However, it is generally the same type groups which are present in the two periods. This reflects more or less the same activities in those two periods. Indeed, the TBK-midden bears all indications of being a real midden or dump – most probably belonging to the habitation-area on the hillside to the rear of the midden area.

The transition from the Late Mesolithic to the Early Neolithic is most sharply reflected in the ceramics: New types, techniques, and ornamental motifs appear, but it is also reflected in the flint tool inventory – not only in the presence/absence of types and relative numbers of type groups, but also – and very distinctly – in the style; from a dominance of regular blades in the Mesolithic to a similar dominance of flakes in the Neolithic. Apart from this we can also observe a series of 'constants' in the type inventory between the two main horizons in the midden. Of special importance is the disappearance of the core axe and greenstone axe, which apparently are replaced by the polished thin butted axe.

The ceramical material from Norsminde is one of our largest Early Neolithic materials from eastern Jutland and is thereby essential in defining the range and variation within such an assemblage. Of special importance is the observation that two ceramic groups, which previously were thought to define and belong to two different geographical and chronological groups (simple, roundbottomed vessels only decorated by cordimpression on the rim and a 'finer' type of ceramics which is fully ornamented on the surface), are found together in the same levels.

The subsistence in the Neolithic levels is documented by the presence of domesticated animals and a few finds of wheat and barley. It is also important that fishing seems to have stopped or at least lost importance.

While the shift in technology and material culture seems to have been very rapid and abrupt – within c. 100 C-14 years, this does not seem to be the fact with the site location and subsistence; people continued to live on the same spot, hunting and gathering continued, and the new subsistence activities (farming and agriculture) were rather supplements than substitutes to the "old" Mesolithic ones, i.e. hunting, (fishing) and gathering. The economic transition seems to have been much more gradual, which is also supported by the fact that there was habitation on the same location – a clear indication of stability in the resource potential and stability in the subsistence basis of the population.

Søren H. Andersen, Institute of Prehistoric Archaeology, University of Aarhus, Moesgård, DK-8270 Højbjerg.

NOTES

1. The site has been recorded in the Forhistorisk Museum, j.nr. 1734. Norsminde, Malling s., Ning h., Århus amt.
2. The project has been sponsored by the Danish Research Council for the Humanities, Aarhus Universitets Forskningsfond and Ny Kredits Fond. Prof. C. J. Becker is thanked for support during the initial stage of the project.

3. During the excavation, one complete column sample measuring 1x1 m was taken in the central part of the midden and brought to the Institute of Archaeology and Ethnography at Cambridge for further analysis.
4. Fragment of cranium of Homo sp. sp. (a young individual) from the deepest part of the shelllayer. Sample no. 1734 NHG. K-385. 13.C = -14.9% O. The sample itself was too small for C-14 dating.
5. Report in the archives of the National Museum.
6. The Bjørnsholm Køkkenmødding was partly excavated by the National Museum in 1931 (H. C. Broholm). Report in the National Museum, j.nr. 361/31. This report is unpublished, but the main results have been mentioned by Th. Mathiassen in 1940 and 1942.
   In 1985 a new large scale investigation at the site was resumed by the author in collaboration with E. Johansen, Aalborg Historiske Museum.
7. Preliminary analysis of the skeleton has been performed by H. C. Petersen, Dept. of Genetics and Ecology, University of Aarhus.
8. The blades have been analysed by Peter Rasmussen, the National Museum, Copenhagen.
9. Analysis have been carried out by Miss G. Fromm in Cambridge at the Dept. of Archaeology and Ethnography – under the supervision of Geoff. Bailey.

List of C-14 dates

1734 DHK	K - 2505 Ostrea ed. ETBK	3230 ± 95 b.c.
1734 DHM	K - 2506 Ostrea ed. ETBK	3200 ± 70 b.c.
1734 NEO	K - 2447 Ostrea ed. ETBK	3520 ± 100 b.c.
1734 RH	K - 2186 Ostrea ed. ETBK	3450 ± 100 b.c.
1734 RJ	K - 2187 Cardium ed. ETBK	3820 ± 100 b.c.
1734 RK	K - 2193 Ostrea ed. ETBK	3420 ± 100 b.c.
1734 RL	K - 2194 Cardium ed. ETBK	3550 ± 100 b.c.
1734 PAC	K - 2663 Ostrea ed. ETBK	3090 ± 90 b.c.
1734 PAH	K - 2666 Ostrea ed. ETBK	3220 ± 90 b.c.
1734 TNN	K - 3141 Ostrea ed. ETBK	3370 ± 65 b.c.
1734 TNO	K - 3142 Ostrea ed. ETBK	3430 ± 95 b.c.
1734 TNP	K - 3143 Ostrea ed. ETBK	3450 ± 95 b.c.
1734 TNR	K - 3144 Ostrea ed. ETBK	3430 ± 95 b.c.
1734 AESM	K - 4035 Ostrea ed. ETBK	3310 ± 65 b.c.
1734 AESK	K - 4036 Ostrea ed. ETBK	3530 ± 95 b.c.
1734 AESN	K - 4037 Ostrea ed. ETBK	3130 ± 90 b.c.
1734 AESJ	K - 4038 Ostrea ed. ETBK	3180 ± 90 b.c.
1734 AESH	K - 4039 Ostrea ed. ETBK	3540 ± 95 b.c.
1734 RM	K - 2191 Ostrea ed. EN TBK	2790 ± 100 b.c.
1734 RN	K - 2192 Cardium ed. EN TBK	3010 ± 100 b.c.
1734 RO	K - 2190 Ostrea ed. EN TBK	2800 ± 100 b.c.
1734 RP	K - 2189 Cardium ed. EN TBK	2760 ± 100 b.c.
1734 PAD	K - 2664 Ostrea ed. EN TBK	2650 ± 85 b.c.
1734 PAE	K - 2665 Ostrea ed. EN TBK	2530 ± 85 b.c.
1734 PBO	K - 2668 Ostrea ed. EN TBK	2910 ± 85 b.c.
1734 DHJ	K - 2669 Ostrea ed. EN TBK	2940 ± 85 b.c.
1734 TNX	K - 3145 Cardium ed. EN TBK	2880 ± 85 b.c.
1734 UKD	K - 4034 Cardium ed. EN TBK	2830 ± 65 b.c.
1734 RQ	K - 2188 Ostrea MN 1a-b	2450 ± 100 b.c.
1734 BMNB	K - 5199 Bone (Homo sp.) ETBK	3840 ± 95 b.c.
1734 BSFO	K - 5300 Ostrea ed. ETBK	3420 ± 90 b.c.
1734 BSFP	K - 5301 Ostrea ed. ETBK	3410 ± 95 b.c.
1734 BSFQ	K - 5302 Ostrea ed. EN TBK	2590 ± 85 b.c.

Preliminary List of Species

Mammals (Mammalia) (Det U. Møhl & P. Rowley-Conwy):

Mesolithic.

- Reed deer. (*Cervus elaphus*)
- Roe deer. (*Capeolus capreolus*)
- Wild pig. (*Sus scrofa*)
- Grey seal. (*Halichoerus grypus*)
- Large Whale. (*Cetacea*)
- Dog. (*Canis familiaris*)
- Wolf. (*Canis lupus*)
- Aurochs. (*Bos primigenius*)
- Oxen. (*Bos sp.*)
- Beaver. (*Castor fiber*)
- Wild cat. (*Felis silvestris*)
- Water vole. (*Arvicola terrestris*)
- Man. (*Homo sapiens sp.*)

Neolithic

- Red deer. (*Cervus elaphus*)
- Wild pig. (*Sus scorfa*)
- Sheep. (*Ovis aries*)
- Seal sp. (*Phoca sp.*)
- Pig sp. (*Sus sp.*)
- Dog. (*Canis familiaris*)
- Cattle. (*Bos taurus*)
- Oxen. (*Bos sp.*)
- Aurochs. (*Bos primigenius*)
- Wild cat. (*Felis silvestris*)
- Otter. (*Lutra lutra*)
- Fox. (*Vulpes vulpes*)
- Man. (*Homo sapiens sp.*)

Birds (Aves sp.):

Mesolithic

- Razorbill/Guillemot. (*Alca torda/Uria aalge*)
- Duck. (*Anas sp.*)
- Swan. (*Cygnus sp.*)

Neolithic.

- Duck. (*Anas sp.*)

Fishes (Pisces) (Det. I. Bødker Enghoff):

Mesolithic.

- Flounder. (*Platichthys flesus*)
- Turbot/Brill. (*Psetta maxima/Scopthalmus rhombus*)
- Plaice/Flounder/Dab. (*Pleuronectes platessa/Platichthys flesus/Limanda limanda*)
- Flatfish. (*Heterosomata*)
- Cod. (*Gadus morhua*)
- Saithe. (*Pollachius virens*)

Gadids. (*Gadidae*)
Eel. (*Anguilla anguilla*)
Herring. (*Clupea harengus*)
Macherel. (*Scomber scrombus*)
Grey Gurnard. (*Eutrigla gurnardus*)
Greater Weaver. (*Trachinus draco*)
Bullhead. (*Acanthocottus scorpius*)
Salmon/Trout. (*Salmo sp.*)
Eelpout. (*Zoarces viviparus*)
Dragonet. (*Callionymus lyra*)
Three-spined stickleback. (*Gasterosteus aculeatus*)
Sand-eel. (*Hyperoplus/Ammodytes sp.*)
Gobiid. (*Gobiidae*)
Pipefish. (*Syngnathidae sp.*)
Spurdog. (*Squalus acanthias*)

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Journal of Danish Archaeology vol. 8, 1989, pp 41–50

Fishing from the Stone Age Settlement Norsminde

by INGE BØDKER ENGHOFF

INTRODUCTION

The Norsminde settlement was situated on the north coast of the Norsminde inlet, near the mouth of the inlet into Kattegat, about 20 km south of Århus, Denmark.

During the Atlantic period the inlet was considerably larger than today: it was about 10 km long, and the largest width was 2.7 - 3 km. The mouth was originally about 500 m across but gradually decreased in width; today the mouth is 40-50 m. The water depth was also greater than today. The stream channel running along the north coast had a maximum depth of 9 m, and Kysing Fjord (which is now reclaimed) was a large shallow-water area (fig 1). The settlement was placed at a small spring, but there were no major watercourses or lakes in the neighbourhood.

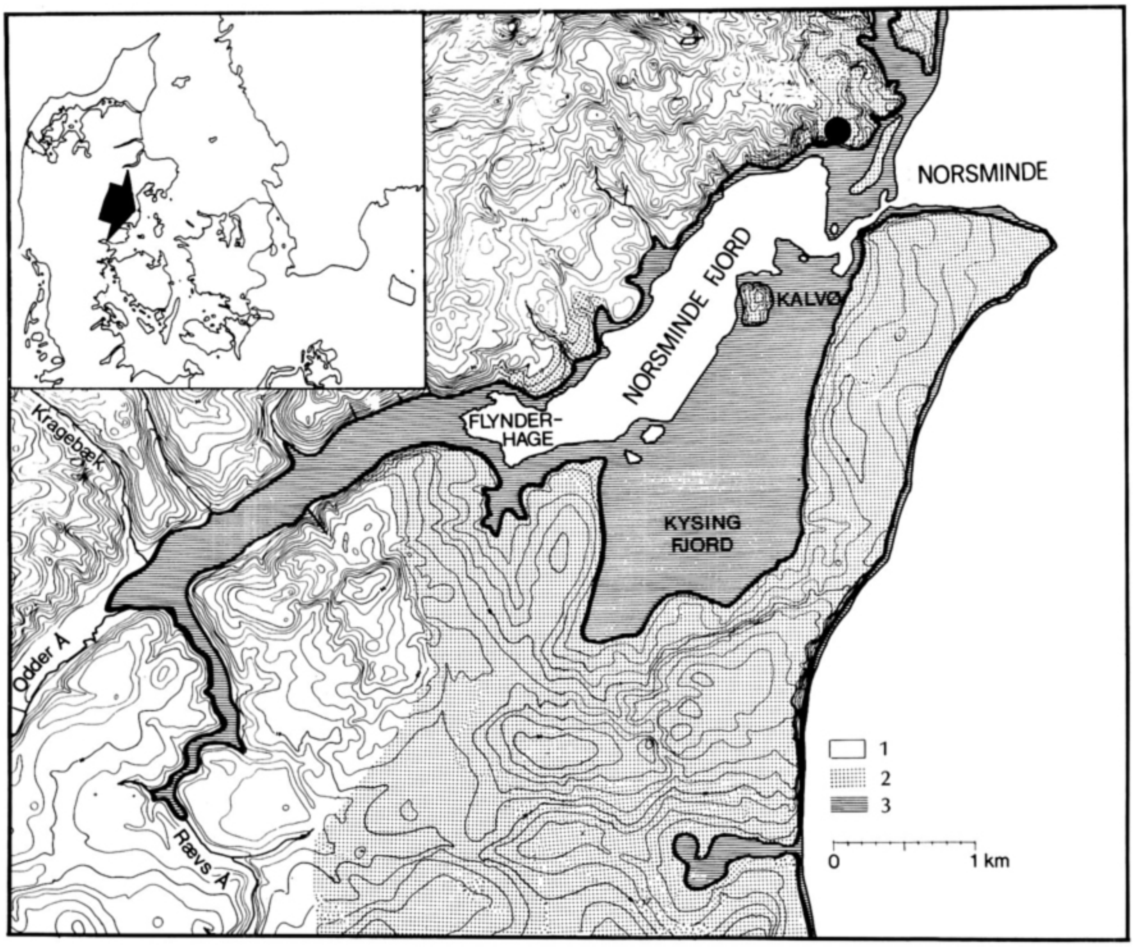

Fig. 1: Map showing the situation of the shell midden at Norsminde (black dot). – 1: clay, 2: sand, 3: ancient seafloor.

MATERIAL

The Norsminde shell midden is about 30 m long (east-west) and about 12 m wide (north-south) at the widest place (eastern part). The maximum depth of the deposits is 1.5 m (in the eastern part); the western deposits are 40-60 cm deep. The shell midden has been excavated since 1972 under supervision of S.H. Andersen, Institute of Prehistoric Archaeology, University of Århus (see Andersen 1991, this volume). The deposits include three layers: In the bottom there is a shell midden from the Ertebølle culture phase, directly overlaid by a midden from the early Neolithic Funnel Beaker Culture. The uppermost blackish layer contains artifacts from various Neolithic periods. Horizontally the shell midden appears to be divided into three parts, in accordance with the local topography. A fireplace was found in the bottom of each part.

C_{14}-datings of the Ertebølle layer from all over the midden cover the interval ca. 3500-3100 B.C. (conventional C_{14}-years). This indicates a comparatively short period of inhabitation within the late Ertebølle culture phase. The early Neolithic layer has been dated to 3000-2500 B.C. (conventional C_{14}-years), most datings lying within the interval 2900-2800 B.C. The Neolithic period of inhabitation thus also appears to have been quite short.

The shell midden was systematically excavated and may in fact be rated as totally excavated. The soil was not sieved in the field, but fish bones and other objects were collected as they were observed during the excavation. This means that many fish bones have been overlooked. However, bulk samples were sieved in the laboratory, in part through a 0.5 mm mesh screen (e.g., samples from the "fish layers" mentioned below), and numerous fish bones were recovered in this way. Equal numbers of randomly selected bulk samples were sieved from Mesolithic and Neolithic layers, respectively.

The distribution of fish bones in the midden was uneven: Some bones were scattered throughout, some occurred in large concentrations ("fish layers").

The state of preservation of the fish bones is highly variable. Many of them are badly preserved, probably due to heavy percolation of rain and ground water. Other fish bones, however, are well preserved.

Part of the southern area of the midden has been removed by the sea (presumably after 3000 B.C.; water-worn flint in the upper, blackish layers indicate inundation of the settlement, probably during the sub-boreal transgression). However, archaeological studies, including numerous profiles, show that the preserved part of the Ertebølle layer has not been secondarily disturbed. Also, the main part of the early Neolithic layer seems undisturbed by the sea.

The fish bone material is kept in the Zoological Museum, University of Copenhagen.

	No. of bones	%
Flounder (*Platichthys flesus*)	190*	2.13
Turbot/Brill (*Psetta maxima/ Scophthalmus rhombus*)	10	0.11
Plaice/Flounder/Dab (*Pleuronectes platessa/Platichthys flesus/ Limanda limanda*)	4599	51.55
Flatfish (Heterosomata) unspecified	271	3.03
Flatfish (Heterosomata) total	5070	56.83
Cod (*Gadus morhua*)	194	2.17
Saithe (*Pollachius virens*)	2	0.02
Gadids (Gadidae) unspecified	2418	27.10
Gadids (Gadidae) total	2614	29.30
Eel (*Anguilla anguilla*)	770	8.63
Herring (*Clupea harengus*)	272	3.05
Mackerel (*Scomber scombrus*)	43	0.48
Grey Gurnard (*Eutrigla gurnardus*)	43	0.48
Greater Weaver (*Trachinus draco*)	32	0.36
Bullhead (*Acanthocuttus scorpius*)	32	0.36
Salmon/Trout (*Salmo* sp.)	23	0.26
Eelpout (*Zoarces viviparus*)	13	0.15
Dragonet (*Callionymus lyra*)	3	0.03
Three-spined Stickleback (*Gasterosteus aculeatus*)	2	0.02
Sand-eel (*Hyperoplus/Ammodytes* sp.)	1	0.01
Gobiid (Gobiidae)	1	0.01
Pipefish (Syngnathidae sp.)	1	0.01
Spurdog (*Squalus acanthias*)	1	0.01
Total	8921	99.99

* Plus 237 dermal denticles.

Table 1. The species of fish in the Norsminde material, numbers of bones from each species (or higher category), and percentual occurrences.

SPECIES OF FISH AND THEIR RELATIVE FREQUENCIES IN THE MATERIAL

The fish bones were identified by comparison with recent, identified skeletons.

The entire fish bone material from Norsminde was analyzed with the exception of a few samples from layers

	Platichthys	*Psetta/Scophthalmus*	*Pleuronectes/Platichthys/Limanda*	Heterosomata unspecified	*Gadus*	*Pollachius*	Gadidae unspecified	Anguilla	*Clupea*	*Scomber*	*Eutrigla*	*Trachinus*	*Acanthocottus*	*Salmo*	*Zoarces*	*Callionymus*	*Gasterosteus*	*Hyperoplus/Ammodytes*	Gobiidae	Syngnathidae	*Squalus*
HEAD BONES																					
Para sphenoideum			3	1	28		1				1										
Vomer			46		14		1	6													
Mesethmoideum							3														
Frontale	1							1													
Exoccipitale			1	3																	
Basioccipitale			92				25	8			1		1								
Prooticum									3												
Opisthoticum			5																		
Pteroticum	54																				
Otolithi				58			164														
Neurocranium unspecified	122										8										
Praemaxillare			37		24		9			1											
Maxillare			47		16		7	4													
Dentale			18		13	1	3	10													
Articulare			16	1			25	1													
Quadratum			53	4			28	2													
Palatinum			13	15			8														
Pterygoidea		1	63				9														
Praeoperculare			5													1					
Interoperculare							2														
Operculare			4	2			4						1								
Symplecticum							2														
Hyomandibulare			30	4			8	3													
Hypohyale			2																		
Keratohyale			22	2			2	7													
Epihyale			15	1			2	5													
Urohyale	13		37					1													
Branchialia			82				6														
SHOULDER GIRDLE																					
Posttemporale							22														
Supracleithrale			48	3			17														
Cleithrum			40	4			2	5													
Postcleithrale			50																		
PELVIC GIRDLE																					
Basipterygium			8														2				
VERTEBRAE		9	3756	173	99	1	2068	717	269	42	33	32	30	23	13	2		1	1	1	1
OTHERS																					
Os anale			106																		
Dermal denticles	237																				
Total	190 +237	10	4599	271	194	2	2418	770	272	43	43	32	32	23	13	3	2	1	1	1	1

Table 2. Specification of the identified fish bones, in total 8921 (excluding 237 dermal denticles of *Platichthys*).

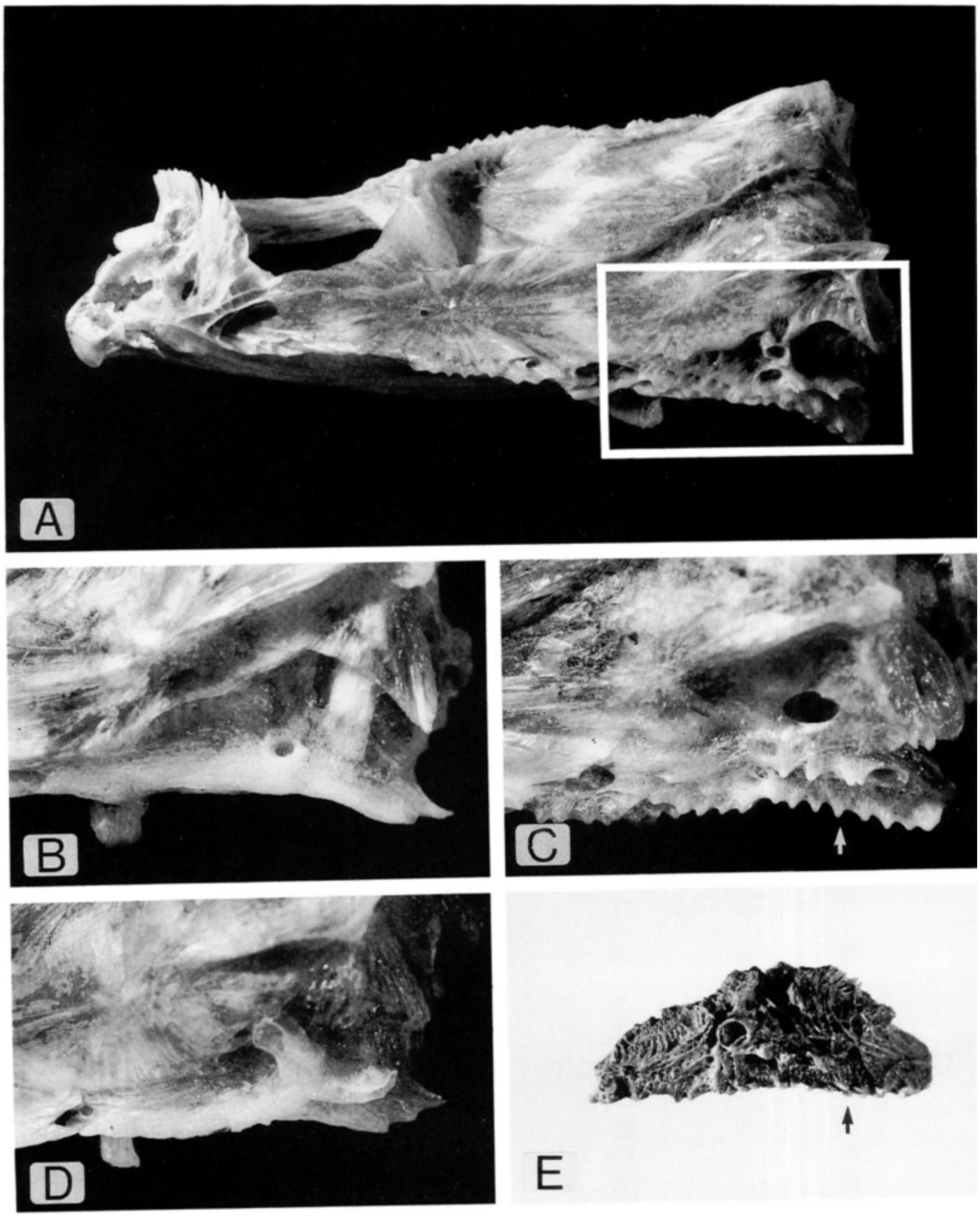

Fig. 2: Identification of subfossil *Platichthys*. – A: Neurocranium of recent *Platichthys* with position of pteroticum indicated. B-D: Pteroticum of recent *Pleuronectes* (B), *Platichthys* (C), and *Limanda* (D). E: Pteroticum (length 13.1 mm) of subfossil *Platichthys*. The arrows in C and E show the nodose-serrated margin.

with a high concentration of fish bones, from which representative sub-samples were extracted and analyzed.

Table 1 shows the species of fish found, the number of bones from each species, and the percentage occurrence of each species. The percentages are based on 8921 identified bones. The list includes 18 species of fish, in the following referred to by their Latin generic names.

The flatfish (including *Platichthys* and *Psetta/Scophthalmus*), completely dominate the material and constitute 57% of the bones. They are followed by gadids (including *Gadus* and *Pollachius*) with 29%, *Anguilla* (9%), and *Clupea* (3%). The remaining species: *Scomber*, *Eutrigla*, *Trachinus, Acanthocottus, Salmo, Zoarces, Callionymus, Gasterosteus, Hyperoplus/Ammodytes,* Gobiidae, Syngnathidae, and *Squalus,* amount to 2%.

It should be added here that the percentages must not be taken too literally. The fish species have different numbers of bones and different chances of preservation in the soil (Enghoff 1987 and references therein).

All species which are abundant in the material, are represented by bones from all body regions (Table 2).

All species on the list are marine. They include species demanding high salinity, e.g., *Pollachius, Eutrigla,* and *Callionymus,* as well as species frequenting brackish water, e.g., *Platichthys* and *Zoarces.*

All species on the list are common in Danish waters today.

Callionymus, Hyperoplus/Ammodytes, and Syngnathidae are new to the Danish subfossil fauna.

NOTES TO THE IDENTIFICATIONS

Flatfish bones are difficult, and in many cases even impossible to identify to species. The flatfish bones in the present material can be divided into two groups, viz., the *Psetta/Scophthalmus* group and the *Pleuronectes/Platichthys/ Limanda* group. Within the former group, to which only 10 bones were referred, further identification was impossible.

The latter group included no less than 4789 bones, of which 190 could be identified as *Platichthys,* whereas *Pleuronectes* and *Limanda* could not be detected. In connection with an analysis of fish bones from the Iron Age settlement Sejlflod, I was able to demonstrate (unpublished report) that the head bone urohyale may be used for distinguishing these three species. The Norsminde material included 50 flatfish urohyales of which 13 could be identified as *Platichthys* – the others were too fragmented for further identification. In connection with the present analysis I further found that several bones (chiefly the pteroticum) in the neurocranium of *Platichthys* have a characteristic nodose-serrated lateral margin which is absent in *Pleuronectes* and *Limanda* (Fig. 2). The Norsminde material contained 176 of these neurocranium bones, all with the *Platichthys* structure - corresponding bones from *Pleuronectes* and *Limanda* were not recognized. In addition the material contained 237 dermal denticles diagnostic of *Platichthys* (Enghoff 1987).

With this background I believe that the *Pleuronectes/Platichthys/Limanda* group in Norsminde is predominantly represented by *Platichthys.* Concerning the problems of flatfish bone identification, see further Heinrich (1987) and Lepiksaar & Heinrich (1977).

The identification of gadid bones was based on 7 species-specific bones: praemaxillare, maxillare, dentale, vomer, parasphenoideum, first vertebra, and second vertebra. An attempt was made to identify these bones to species; remaining gadid bones were then considered to derive, with corresponding frequencies, from the same species. Apart from 2 bones from *Pollachius,* all identified gadid bones derived from *Gadus.* The gadid material thus consists almost exclusively of *Gadus.*

DISTRIBUTION OF FISH BONES IN THE SHELL MIDDEN

The most striking aspect of bone distribution is that all bones except one were found in Mesolithic layers. This phenomenon was observed in the field during the excavation, and the field observations were supported by the results of sieving in the laboratory. Froom (1979) also noticed this in her column sample from Norsminde, which was sieved through 2 and 1 mm mesh screens. In order to check the absence of fish bones from Neolithic layers personally I sieved several samples of these layers and examined the retained material meticulously with a stereo microscope, without finding more than the single, abovementioned bone (a gadid vertebra). All other Neolithic samples lacked fish remains.

The majority of fish bones (90%) derive from a smaller, welldelimited area in the middle part of the midden (squares 31/24, 31-32/25, 31-32/26, and 31-32/28). This area was correspondingly denoted as the "fish layer" during excavation. A fireplace is situated 1-2 m west of the fish layer. The other parts of the midden are mainly represented by scattered finds of fish bones. The 4 most frequent species: *Platichthys, Gadus, Anguilla* and *Clupea,* occur all over the excavated area (to the extent that fish bones are present at all). However, *Platichthys* dominates in the above-mentioned "fish layer", whereas *Gadus* appears to dominate in other areas. (Of 854 fish bones found outside the "fish layer" 783 are from gadids.) The rarer species of fish (in total: 2% of the bones) were found only in the "fish layer" (except for 4 bones).

As to the vertical distribution of fish bones in the Mesolithic layers, regular column samples which might have elucidated this aspect were not available. In order to get

Sample no.	level	layer	No. of fish bones							
			Heterosomata	Gadidae	*Anguilla*	*Clupea*	*Scomber*	*Trachinus*	*Salmo*	*Zoarces*
BHSF	272	?	1	6	1	2				
VTA	278–80	E	1	14						
BHSD	283–86	?	2	12		3		1		
XFM	296	?	19	9		3	1		1	1
WTY	304	E	10	7	2					
ZRC	309	E	10							
ZXD	311	E	3	1						
ZXQ	313	E	14	1						
ZRA	314	E	2	1						
AAAF	314	E	13	4	1		1			
ABTB	329	?		11						

Table 3. Vertical distribution of fish bones from square 31/28. Level difference: 57 cm. E = Ertebølle layer.

an impression of the vertical distribution the squares 31/28 and 32/28 were examined more closely. These squares contained numerous fish bones from many different levels. Samples from square 31/28 span a vertical difference of 57 cm. All samples are Mesolithic and indicate uniform fishing throughout the period represented (Table 3). The same is true of the samples from square 32/28 (Table 4). No C_{14}-datings are available from these two squares. But a series of C_{14}-datings from an area close by (within a few meters) indicates ages from 3450±95 B.C. to 3370±65 B.C. (conventional C_{14}-years) and are thus largely contemporaneous.

SIZE OF THE FISH

The *Pleuronectes/Platichthys/Limanda* group (henceforward referred to as *Platichthys*, cf. above) and *Gadus* were represented by so many bones that construction of size-frequency diagrams was warranted. The lengths of subfossil *Platichthys* and *Gadus* were estimated by means of regression formulae based on large recent materials.

Flounder - *Platichthys flesus*

Among Platichthys bones suitable for measuring the first vertebra was most abundant in the Norsminde material. Therefore, corresponding values of diameter of first vertebra and total length were measured on 27 recent *Platichthys*. The relation between these values is given by the regression equation:

$$TL = 69.7268 \times W^{0.9068}$$

(the correlation coefficient r = 0.9525, n = 27), where: TL = total length of fish in mm, and W = largest width of posterior face of first vertebra in mm.

(The correlation between TL and W is identical in *Platichthys* and *Pleuronectes*, whereas *Limanda* has a slightly lower value of W at correponding TL.)

Sample no.	level	layer	No. of fish bones								
			Heterosomata	Gadidae	*Anguilla*	*Clupea*	*Scomber*	*Eutrigla*	*Salmo*	*Zoarces*	*Callionymus*
VKM	272	E		9		1					
VSZ	282	E	8	24		2		1	2	1	
VLW	289	E	4	9	1						
VZY	290	E	23	5	3						
WXX	292	E	303	53	8	1		1			
WTZ	296	E	201	33	1	3	1		2		3
ZUU	299	E	1								
ZRH	300	E	15	5			1				
AACF	302	E	2	5							
ABEZ	304	E	12	4							
ZRD-G	305	E	33	7	1					6	
ZUN	310	E	1								

Table 4. Vertical distribution of fish bones from square 32/28. Level difference: 38 cm. E = Ertebølle layer.

Measurements of the first vertebra of subfossil *Platichthys* (n = 85) were substituted in the equation. The resulting size-frequency diagram is shown in Fig. 3. The diagram shows that the *Platichthys* from Norsminde were between 15 and 37 cm long, the majority (71 out of 85) between 22 and 30 cm.

Cod - *Gadus morhua*
The lengths of subfossil *Gadus* were estimated in the same way as with *Platichthys*. I chose to measure the diamater of the second vertebra which is abundant in the material.

The regression equation is:

$$TL = 86.1390 \times W^{0.8162}$$

(the correlation coefficient r = 0.9972, n = 55), where: TL = total length of fish in mm, and W = largest width of posterior face of second vertebra in mm.

The resulting size-frequency diagram is shown in Fig. 4. The length of the Norsminde *Gadus* varies from 16 to 38 cm.

Other species
The length of the subfossil *Anguilla* was estimated by means of regression equations based on measurements of cleithrum, keratohyale, dentale, and first vertebra (see Enghoff, 1987). The Norsminde material contained only 19 measurable bones of these kinds, so a size-frequency diagram was not made. The length of Norsminde *Anguilla* varies from 32 to 93 cm; most specimens lie in the lower range.

Regarding the remaining species from Norsminde they are generally small fish - either small species (e.g., *Gasterosteus* and *Hyperoplus/Ammodytes*) or small individuals of species which may grow large (e.g. *Salmo*). Here, *Scomber* is an exception, being represented by individuals of a good size.

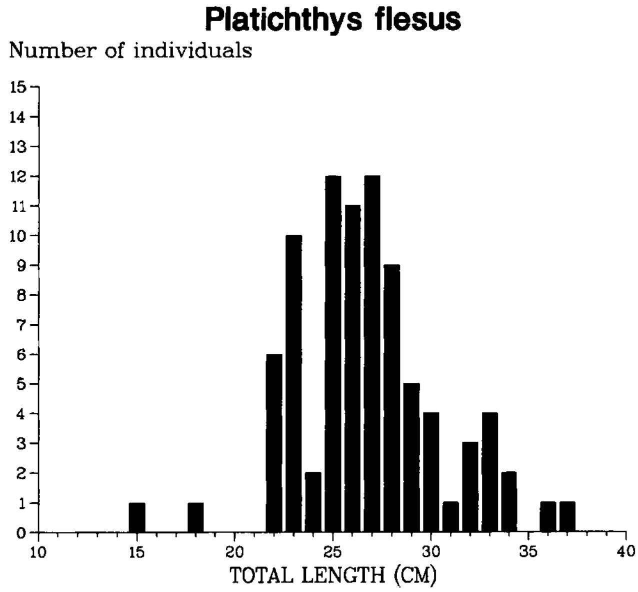

Fig. 3: Size-frequency diagram of flounder *(Platichthys flesus)* from Norsminde. Total length estimated on the basis of measurements of first vertebra. N = 85.

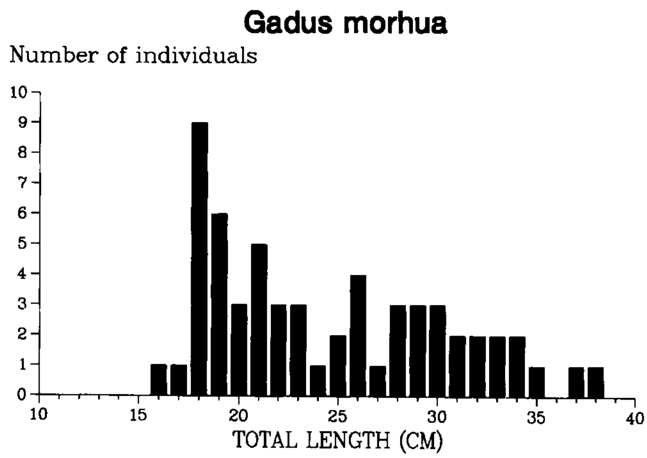

Fig. 4: Size-frequency diagram of cod *(Gadus morhua)* from Norsminde. Total length estimated on the basis of measurements of second vertebra. N = 59.

FISH BONES ASSOCIATED WITH LARGE COCKLE AND OYSTER SHELLS

Many large shells of cockle (*Cerastoderma edule*) and oyster (*Ostrea edulis*) in the Norsminde shell midden contained a firmly cemented mass of sediment, fish bones etc. In order to find out whether each shell contained a random medley of bones, or bones referable to one individual fish I examined 14 of the largest shells from the "fish layer": 12 from square 32/25 and 2 from square 31/25.

Seven of the shells contained bones which appeared to belong together. One contained a bone from the ear region (pteroticum) plus an otolith. The others contained 2-10 vertebrae of the same size and from the same region of the vertebral column. The species of fish were *Platichthys* (7 shells), *Gadus* (1 shell), and *Anguilla* (1 shell) (2 shells each contained 2 associations of bones). The remaining shells contained randomly mixed bones from several species of fish.

DISCUSSION

The Norsminde settlement was located on the shore of a marine inlet near its mouth into the Kattegat. Off the settlement there was a natural oyster bed. Since the lowest salinity tolerated by the oyster (*Ostrea edulis*) is 23‰ (Younge 1960), the salinity in this end of the inlet must have been above this level.

No major watercourses or lakes were present in the vicinity of the settlement. Accordingly, the list of fish species includes only marine species. Not a single bone of a freshwater fish has been found. Further, a C_{13}-analysis of a human skull fragment found in the Ertebølle layer of the shell midden indicated that the diet of this person was strongly dominated by sea-food.

The dominating species of fish in the shell midden is *Platichthys* (57% of the bones derive from flatfishes, cf. above). Since flatfish bones dominate the Norsminde material in spite of their high fat contents (and consequently poor chances of preservation), the importance of flatfishes must have been great. This is not surprising: *Platichthys* prefers to assemble in lagoons and inlet mouths during the summer, and the shallow Kysing Fjord must have been ideal for *Platichthys* fry. The *Platichthys* bones from Norsminde derive from fairly large individuals. Today *Platichthys* rarely grows longer than 30 cm [c. 1 kg], maximal length is 50 cm. The deep water close to the north coast of the inlet may have housed large *Platichthys*.

The second most frequent species in the Norsminde material is *Gadus* (29% of the bones). Unlike *Platichthys*, the Norsminde *Gadus* are small, even smaller than *Gadus* from the Vedbæk settlement (Enghoff 1983). *Gadus* of such small size occur close to the beach.

Several of the species on the list are common in brackish water, e.g., *Platichthys*, but also *Acanthocottus*, *Zoarces*, gobiids, *Gasterosteus*, and *Anguilla*. But taken as a whole, the species list does not indicate brackish water - the truly marine element is too large: e.g., *Pollachius*, *Eutrigla*, *Trachinus*, and *Callionymus*. In accordance with this, the inlet cannot have been all brackish, as mentioned above. However, it cannot be excluded that the Mesolithic inhabitants of the settlement have conducted fishing from the nearby coast of Kattegat proper.

A most intriguing aspect of the Norsminde fishbone material is the almost complete absense of bones from the Neolithic layers, compared with the abundance of them in the Mesolithic layers.

The consistent absence of fish bones from Neolithic layers appears strange. It is true that the Neolithic layers lie closer to the surface, where conditions of preservation are poorest, but on the other hand, bones from other vertebrates have been preserved, albeit poorly. It is hard to imagine that the Neolithic people, who did collect cockles (*Cerastoderma*) and hunt seals (*Phoca*), did not exploit the fish, which could be caught without much trouble, for instance by means of fish traps. It is generally thought that the transition from the Mesolithic to the Neolithic period was accompanied by profound environmental changes. It is true that the oyster declined strongly at that time. But even if there were changes in temperature and salinity, and even if the mouth of the inlet became narrower, there must have been fish available, although perhaps other species or other relative frequencies. Today *Platichthys* and *Anguilla* are among the commonest species of fish in Danish estuaries, e.g., Norsminde (=Kysing) Fjord (Muus 1967: 174). An over-exploitation of fish resources during the Mesolithic period is unthinkable - the available fishing tools cannot have been efficient enough for this.

Negative evidence is always difficult to explain. The possibility that the Neolithic people left their fish bones outside the shell midden always remains. But then why not the mammal bones?

Within the Mesolithic part of the shell midden the fishing appears to have been uniform: The 4 commonest species, *Platichthys*, *Gadus*, *Anguilla*, and *Clupea*, are represented in all parts of the midden where fish bones have been recovered at all. This is not surprising, since the Mesolithic part represents a comparatively short period of sedimentation within the late Ertebølle culture phase: about 400 years (see above). Furthermore, 90% of the bones derive from a discrete area, a few meters square in the central part of the shell midden, where C_{14}-datings are largely concordant, see above. The analysis of the contents of large bivalve shells, several of which contained associated bones, also indicates rapid sedimentation within this area.

However, the horizontal distribution of fish bones is not entirely uniform. In the above-mentioned delimited area in the central part, where fish bones were most plentiful, *Platichthys* bones predominate. In other parts of the excavated area where fishbones have been found (scattered finds, mostly of a few bones each), *Gadus* bones are actually in the majority. In agreement with this, Froom (1979) stated that the fish bones she examined from the eastern part of the midden were all from *Gadus*. P. Rowley-Conwy (pers. comm.) also studied fish bones from the eastern part of the midden and found almost exclusively *Gadus*. Since the various parts of the shell midden are regarded as largely contemporaneous (S.H. Andersen, pers. comm.) the difference regarding the dominating species of fish cannot be interpreted as reflecting different fisheries during different periods. Rather, the difference results from taphonomic factors: according to experience, gadid bones have high probabilities of preservation in the soil, compared to most other fish bones. Thus, gadid bones may have been preserved in those parts of the Norsminde shell midden, where fish bones are relatively scarce, and from where bones of other fishes may have disappeared. The conditions of preservation in the Norsminde midden are generally bad, but in the small area in the central part of the midden, conditions of preservation appear to have been good. Many fish bones have been preserved here (90% of the material), and in addition to the many flatfish bones, this area alone contained bones of several other species having a low resistance, such as *Scomber*, *Salmo*, and *Squalus*. Of course it cannot be entirely excluded that the high concentration of fish bones in the small area has nothing to do with taphonomy, and that it represents a period of particularly intense fishing. In any case, the Norsminde fish bone material as a whole is strongly dominated by *Platichthys*.

During the Mesolithic period, fishing appears to have taken place during the summer half of the year. The presence of the seasonal fish *Scomber* indicates this. Most of the other species caught, in the relevant sizes, e.g., small *Gadus*, would also be most easy to catch during the summer season, when they frequent coastal waters. This interpretation of the fishing agrees with results of growth ring analyses of *Gadus* otoliths from Norsminde (Froom 1979).

Neither fishhooks nor other definite fishing tools have been found in the Norsminde midden. Some bone points found may, however, have been used for fish spears (S.H. Andersen, pers. comm.).

The fish on the species list, combined with their small size, indicate fishing close to land. Such fishing would have been conducted most easily and with minimum performance by means of fish traps which are known from the Mesolithic period (Becker & Troels-Smith 1941), perhaps supplemented with weirs. Trap fishing is also indicated by the varied and uncritical selection of species caught. However, the relatively large size of the *Platichthys* is puzzling in this respect. Small flatfishes are almost absent altogether, although they must have been numerous in shallow water. *Platichthys* may be speared, but this method is less efficient than trapping.

A large number of settlements are situated at Norsminde Fjord, including several which have been contemporaneous with the Norsminde settlement: Frederiks Odde, Store Nor, Flynderhage, Norslund Syd, Smedensborg, and Kalvø (Andersen 1976). From none of these do we have analyzed fish bone material of any importance, so it is not possible to say whether the fishing pattern shown by the Norsminde material is of general validity for the area during the period in question.

In comparison with contemporaneous settlements from where analyses of large fish bone materials are available, Norsminde is distinguished by the dominance of *Platichthys* bones. This is explained in terms of the topographic situation of the settlement. It is also noteworthy that not a single bone from a freshwater fish has been found - in this respect Norsminde resembles the Tybrind Vig settlement (Trolle-Lassen 1984). The classial settlement at Ertebølle on the contrary, is dominated by freshwater fishes, in spite of its marine situation. This apparent paradox has been interpreted as a specialization in fishing for *Anguilla* (Enghoff 1987). The fish bone material from the shell midden at Bjørnsholm, dominated by *Anguilla* bones, can be interpreted in the same way (Enghoff unpublished). The fish bones recovered from the settlements at Vedbæk include a large proportion of *Gadus* bones (Aaris-Sørensen 1980), but subsequent studies have shown that flatfishes have also played an important role here (Enghoff unpublished).

In summary, fish bones from Danish Ertebølle settlements differ widely with regard to species composition and frequencies. This may be primarily due to differences in availability of the various fish species in the local fishing waters. However, part of the divergencies may be attributable to local specializations in the exploitation of particular phenomena in the habits of the fishes, e.g., the autumnal migrations of *Anguilla*.

Information on the Norsminde shell midden and its excavation has been extracted from Andersen (1991, this volume) unless otherwise stated.

Acknowledgements
The material was put at my disposal by S.H. Andersen (Institute of Prehistoric Archaeology, University of Århus) who also adviced and informed me throughout the analysis. Unpublished information was supplied by P. Rowley-Conwy (University of Cambridge). Photographs were prepared by G. Brovad, and diagrams by B.W. Rasmussen (both Zoological Museum, University of Copenhagen). The English text was reviewed by H. Read. I extend my sincere thanks to these persons. Furthermore I am grateful to the Danish Research Council for the Humanities for funding of the work.

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Leaf-foddering of Livestock in the Neolithic: Archaeobotanical Evidence from Weier, Switzerland

by PETER RASMUSSEN

INTRODUCTION

The question of feeding leaves and branches to livestock in the Neolithic has been discussed on the basis of palynological evidence for over 40 years. Numerous pollen analysts and archaeologists have claimed and discussed the occurrence of leaf-foddering in the Neolithic over the greater part of Europe. In this debate one thing has consistently been absent: Firm archaeological evidence.

The theory of leaf-foddering was originally formulated by Rolf Nordhagen, but first put into print by Knut Fægri (1940, 1944). Fægri proposed that the elm decline, which today has been demonstrated across a large part of Europe and has been dated to the centuries around 3000 b.c.,[1] was the result of neolithic farmers lopping branches and leaves from trees for use as fodder. In this way the potential of elm trees to flower and produce pollen would have been greatly reduced. The leaf-foddering theory, along with Firbas' work from 1937 and Johs. Iversen's from 1941, is one of the first examples of a palynologically-demonstrated vegetational change being interpreted as a consequence of cultural activity. Troels-Smith (1953, 1955, 1960) through his research in Denmark and Switzerland was able to expand and develop the leaf-foddering theory. In particular, the palynological investigations associated with waterlogged Swiss settlements suggested that this practice took place. One locality central to Troels-Smith's work is the neolithic settlement Weier, which lies in N.E. Switzerland in Cantone Schaffhausen. During the archaeological excavation of the site two heaps of leaf-bearing twigs were found. These comprised twigs of elm (*Ulmus*), birch (*Betula*), oak (*Quercus*), lime (*Tilia*), maple (*Acer*) and ash (*Fraxinus*) (Guyan 1955). In addition, in some of the buildings thick layers containing animal dung were found. The latter shows that livestock had been kept confined in the settlement and the heaps of twigs suggest that they were fed on leaf fodder. The result of the palynological and archaeological investigations at Weier form, without doubt, the strongest evidence we have to date for leaf-foddering in the Neolithic.

One of the events which plays a crucial role in Troels-Smith's arguments concerning leaf-foddering is the neolithic elm decline. In the concluding remarks in his thesis (1955) he writes:

"It is reasonable to suppose that the animals were foddered in the byre and in primitive systems this is characterized by leaf-foddering, particularly with elm, but also with ash, lime, poplar etc. Consistent with this interpretation is the very marked decline in elm, the tree which since time immemorial has been the most prized for animal fodder" (translated from Danish).

Since Troels-Smith's investigations a vigorous debate has developed concerning the cause or causes of the elm decline. In addition to leaf-foddering, other factors proposed, either singly or collectively, include climatic change, soil deterioration and an elm-specific disease (Iversen 1960, 1973; Smith 1961; Watts 1961; Heybroek 1963; Tauber 1965; Rackham 1980; Groenman-van Waateringe 1983; Huntley and Birks 1983; Göransson 1984; Aaby 1986 *inter alia*).

Discussions concerning possible leaf-foddering in the Neolithic and the cause of the elm decline are thus closely linked. With time however, the associated cultural phenomena, pollarding and leaf-foddering, have also been incorporated into explanations of other vegetational changes demonstrated in pollen diagrams from the Neolithic (Andersen 1978; Aaby 1986; Behre and Kučan 1986; Kalis 1988 *inter alia*). Some pollen analysts have, furthermore, interpreted palynologically-demonstrated vegetational changes in terms of a particular form of tree management (i.e. shredding – see later) (Aaby 1983; Andersen 1985). In the archaeological world, pollarding of trees and leaf-foddering have also been incorporated into descriptions of the prehistoric economy as a more or less accepted fact (Clark 1952; Lüning 1982; Madsen 1982; Poulsen 1983; Kristiansen 1988 *inter alia*).

Ever since Johs. Iversen first demonstrated in 1941 that the neolithic population was capable of changing its environment, it has been difficult to integrate palynolo-

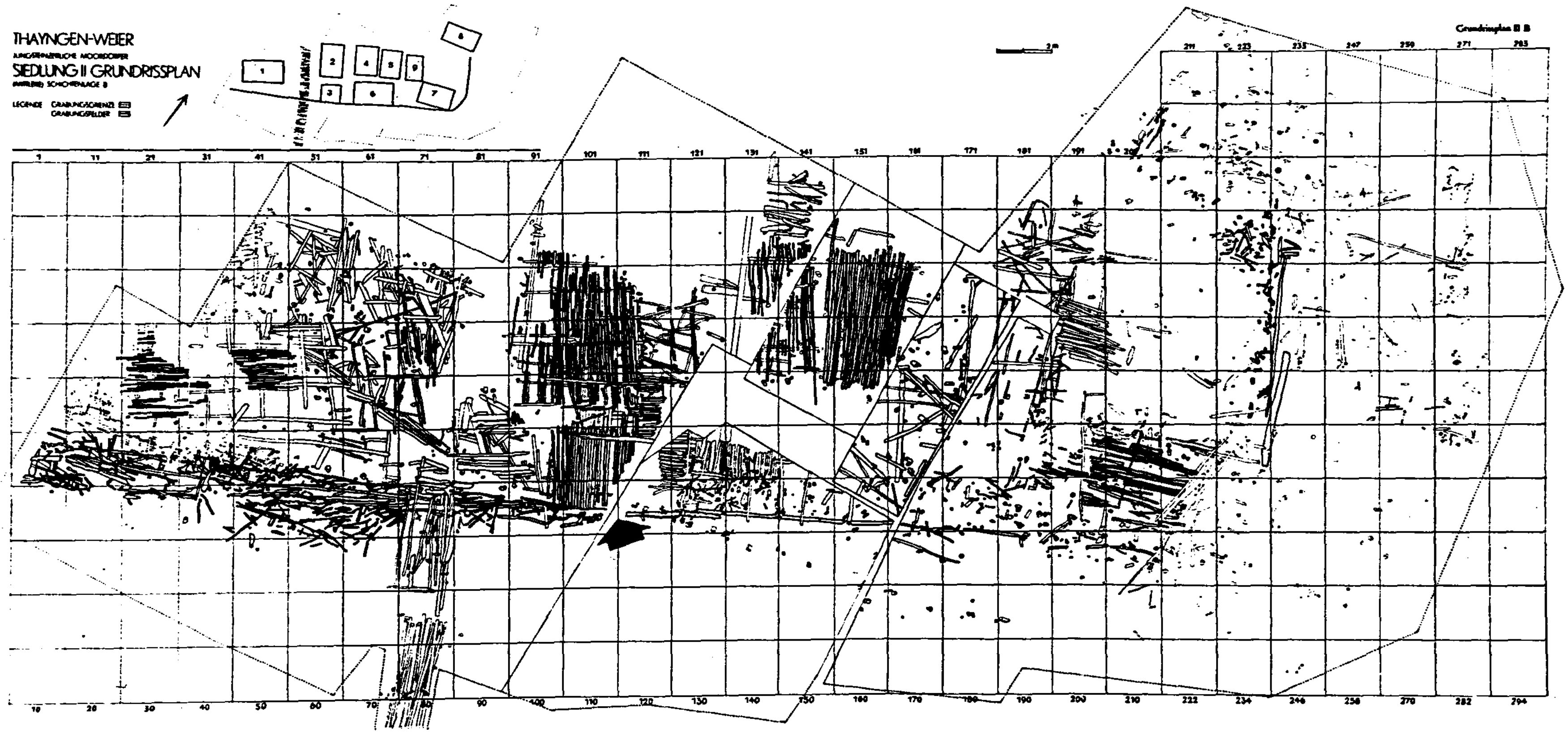

Fig. 1. Excavation plan of the Weier settlement (Weier II) (after Guyan 1967).
Building 1: House with hearth; at the western end of the house there was an extension which contained a thick layer of goat/sheep faeces.
Building 2: House with hearth.
Building 3: Byre containing dung layers which were identified via their content of thousands of house fly puparia (*Musca domestica* L).
Building 4: No hearth; building's function unknown.
Building 5: No hearth; two heaps of leaf-bearing twigs (elm, birch, oak, maple and ash) were found in this building.
Building 6: House with hearth.
Building 7: No hearth; fly puparia present.
Building 8: No hearth; fly puparia were present in the western end of this building.
Building 9: No hearth; building's function unknown.
A wooden trackway runs between building 1 and buildings 2 and 3.

gically-based cultural-historical interpretations with the archaeological evidence. This also applies to a great extent to the leaf-foddering theory, which is built up almost completely around palynological evidence. Firm archaeological evidence for leaf-foddering is rare and there is no doubt that demonstrating this phenomenon by palynological evidence alone is exceedingly difficult, if not impossible. The more one is able to involve and compare both the palynological and archaeological evidence, the better the possibilities for evaluating the theory. In this article the first clear example of leaf-foddering of livestock in the European Neolithic is presented. The results of these analyses and the perspectives which they open up are of relevance not just at Weier but everywhere that leaf-foddering and the character of neolithic agriculture are discussed.

THE WEIER SITE

As mentioned earlier the results of the palynological and archaeological investigations at Weier comprise the strongest evidence to date for leaf-foddering in the European Neolithic. The site also lends itself to a closer archaeobotanical examination of the leaf-foddering theory in two particular ways:

1. There is palynological evidence suggestive of leaf-foddering, in addition to archaeological evidence in the form of the remains of harvested leaves and twigs.
2. There are well-preserved byre layers containing dung of domesticated animals.

The latter are something very rarely found in sites of neolithic age and they represent a very special opportunity to investigate the question of leaf-foddering; by analysing the dung layers it is possible to say, with a great deal of certainty, what the animals were fed on.

Earlier archaeological, botanical and zoological investigations at Weier have been dealt with in a long series of publications. For this reason only a brief description will be entered into here: The site was constructed around 3100 b.c. on a small dried-out gyttja island in a shallow lake on the Weier valley floor. The lake measured c. 100 x 500 metres and the site was surrounded by water and marshland. In its three phases the site covered in total between 6000 and 9000 m^2 and it was enclosed by a wooden fence or palisade (fig. 1). Three settlement phases can be recognized at the site (Weier I–III) all of which belong to the Pfyner Culture (Guyan 1967; Winiger 1971). The oldest phase, Weier I, originally comprised 8–10 buildings, Weier II comprised 10–15 buildings and Weier III c. 30 buildings (Guyan 1967). The three phases are dated to 3106 b.c. (Weier I), 3026 b.c. (Weier II) and 2810 b.c. (Weier III) respectively (Troels-Smith 1981). The site is one of the classical archaeological localities in Switzerland which earlier went by the name of "Pile Dwellings". Cultivation at the site involved first and foremost wheat, barley, flax and opium poppy (Troels-

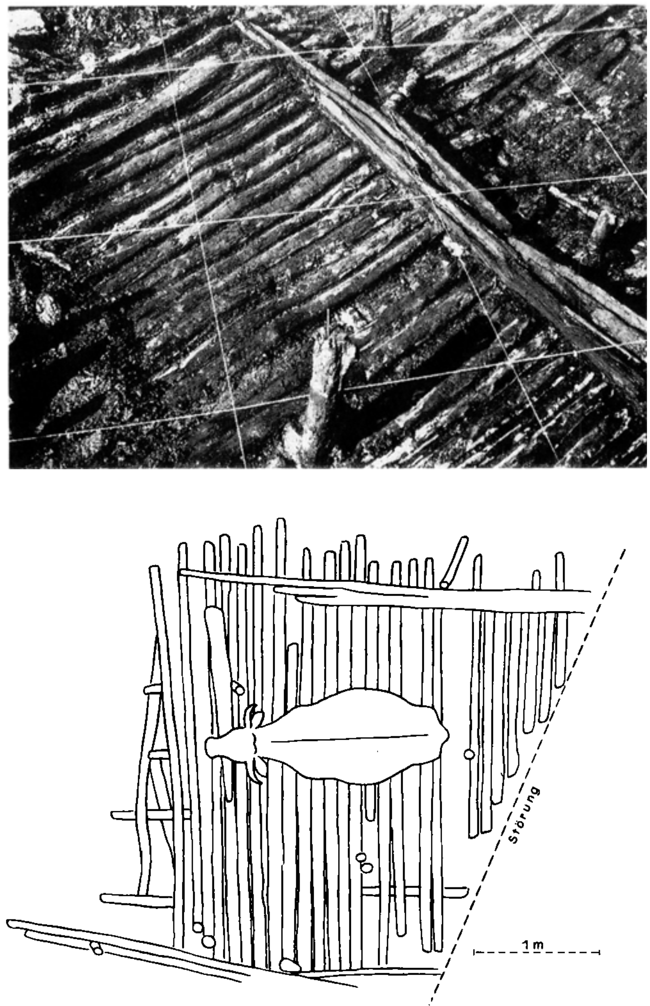

Fig. 2. Above: Excavation photograph of the byre, which is marked with an arrow on figure 1 (building 3). The building's wooden floor can be seen to the left of the picture together with the remains of a presumed wall. To the right is the wooden trackway which runs parallel to the byre.
Below: Drawing of the byre (after Guyan 1967).

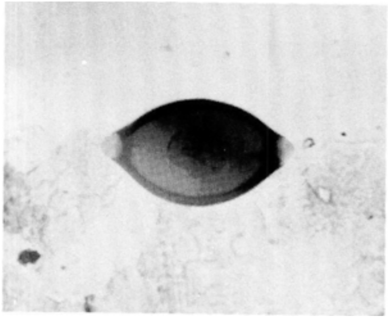

Fig. 3. Ovum (egg) of the parasite whipworm (*Trichuris spp.*) found in dung from the byre at Weier. The egg measures 52 x 24 µm. (Photo: P. Nansen).

Fig. 4. Ovum (egg) of the parasite liver fluke (*Fasciola hepatica* L.) found in dung from the byre at Weier. The egg measures 155 x 70 µm. (Photo: P. Nansen).

Fig. 5. House fly puparia (*Musca domestica* L.) found in dung from the byre at Weier; seven puparia can be seen on the picture. (Magnification approximately x 4.5). (Photo: L. Larsen, National Museum).

Smith 1955, 1981, 1984; Jørgensen 1975; Fredskild 1978; Robinson and Rasmussen 1989). Livestock at the site was dominated by cattle, with pig, goat and sheep being of lesser importance (Soergel 1969).

The Dung Layers

The finding of compact layers containing animal dung shows that, at certain times of the year at least, livestock were kept confined within the settlement. One of the areas where the animals stood is that referred to by the excavator, W. U. Guyan, as "*Rinderstall*" or "*Rinderstandplatz*" (fig. 2). The fact that the structure was used by animals is confirmed by the presence of ova of the internal parasites whipworm (*Trichuris spp.*) and liver fluke (*Fasciola hepatica L.*) (figs. 3 and 4). Two samples from the dung layers, each 50 g in weight, were subjected to flotation and sedimentation. One sample (Wh 87) yielded 25 *Trichuris* ova, the other (Wh 84) yielded 25 *Trichuris* ova and 7 *Fasciola hepatica* ova (Nansen 1984, 1987). These ova are shed in faeces and show therefore that the layers in the building are, to some extent, composed of dung. The identification of fossil ova of whipworm to species is difficult and accordingly the identity of the host animal cannot be determined with certainty. The *Trichuris* genus has a broad host spectrum which includes cattle, sheep, goat, pig, dog, cat and man, all of which, with the exception of cat, could have been present at Weier. On the other hand, the liver fluke, as a consequence of its life cycle, is specific to ruminants. The presence of liver fluke ova shows therefore that the layers contain ruminant dung. The layers can hardly consist entirely of dung however, rather a mixture of dung from the byre floor and other material brought, intentionally or by accident, into the byre as a result of human and animal activity. The size of the dung component is difficult to estimate. The concentration of parasite ova is low, but this does not necessarily mean that only a small amount of dung is present. We do not know the extent of the parasite burden which the animals carried neither do we know to what extent these parasite ova survive in such ancient material.

In the byre layers there are also large numbers of house fly puparia (*Musca domestica* L.) (fig. 5) which together with the parasite ova serve to confirm the material's faecal origins. Dung heaps or middens are the most important breeding grounds for this species (Blædel/Troels-Smith 1956; Guyan 1981; Overgaard Nielsen 1989; Troels-Smith 1984).

As only 3 goat/sheep faeces were found in the dung layers and given liver fluke's host specificity, it seems fairly safe to conclude that the dung present in the layers is primarily from cattle.

The composition of the dung layers

Figure 6 shows part of a section through the byre and the dung layers. Three floor layers are present in the byre, each constructed of whole and split tree trunks. Between each of the floors was up to 30 cm of dung and other organic material. The dung layers must have been thicker in the past, perhaps double so thick, but due to compaction over the millennia, their thickness has been much reduced. They contain a wide range of macrofossils of which twig and leaf fragments are the most abundant (figs. 7 and 8). The volume of twigs contained in the layers is given in table 1. As can be seen from the table, the quantities of twigs are large. If the quantities of leaf fragments are also considered then it is clear that large quantities of leaf-bearing twigs must have been brought in to the animals. On the basis of the samples which were analysed it can be estimated that the dung layers in the byre all in all contain in the region of 53000 twig fragments. These vary in size from under 1 mm up to pieces over 7 cm in length and 1.3 cm in diameter. The majority of

Layer no	Twigs %
g	25.0
h	≤12.5
i	12.5
k	50.0
l	50.0
m	25.0
n	≤12.5

Table 1. The estimated volume occupied by twigs in the dung layers. (det. by J. Troels-Smith and Svend Jørgensen in 1956).

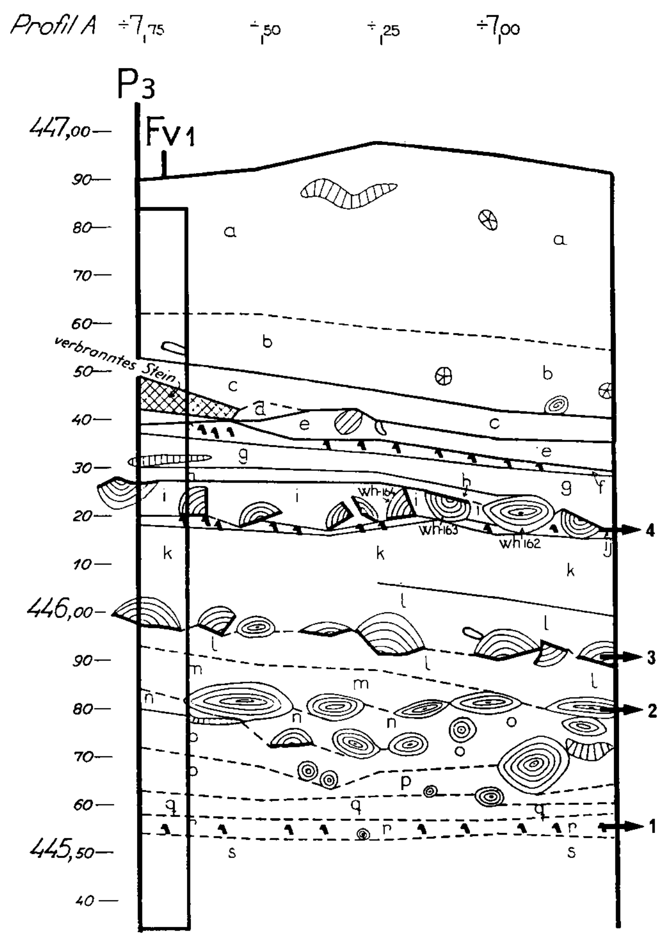

Fig. 6. Part of the section through the byre and dung layers. Three floor levels can be seen in the section, each made of whole and split tree trunks (arrows 4, 3 and 2) (cf. fig. 2). Arrow 1 marks the position of a charcoal-rich layer, which is the oldest archaeological layer in this section. The four layers have been radiocarbon dated as follows:

4: 2760 ± 60 b.c. (K-4928) Mean: 2805 b.c.
2850 ± 65 b.c. (K-4929)
3: 2920 ± 65 b.c. (K-4930) Mean: 2940 b.c.
2960 ± 65 b.c. (K-4931)
2: 2870 ± 135 b.c. (Ua-1009) Mean: 2870 b.c.
2870 ± 135 b.c. (Ua-1010)
1: 2820 ± 135 b.c. (Ua-1011) Mean: 2820 b.c.

The narrow range of the dates shows that the floor levels in the byre were established over a relatively short period of time. On the basis of archaeological/stratigraphical evidence, one of the layers is assigned by the excavator to phase II at the Weier site. Unfortunately the identity of the floor level is not specified (Guyan 1967). The new radiocarbon dates are consistent with the interpretation that all three floor levels belong to the Weier II phase. The section was measured and drawn by J. Troels-Smith and S. Jørgensen in 1956.

The dung samples which were analysed were taken from layers g-n in the column marked Fv1.

Fig. 7. The larger twig fragments (a total of 77) in sample of 200 cm^3 from the dung layers. They include fragments of the following species: Ash (48), willow (19), oak (4), hazel (3), ivy (1), alder (1), birch/alder (1). (Photo: L. Larsen, National Museum).

Fig. 8. The leaf fragments in a sample of 200 cm^3 from the dung layers. (Photo: L. Larsen, National Museum).

these fragments have not been through the animals digestive systems but was left behind after the leaves and smaller twigs had been eaten. It is the thousands of small wood fragments (2–3 mm or less) and the many small leaf fragments which have passed through the animals. The partially-digested and undigested material was thoroughly mixed together and the formation of the dung layers can perhaps best be illustrated by way of a series of photographs taken of a modern experiment involving feeding leaf hay to cattle (figs. 9–11). The experiments were carried out under the auspices of the Historical-Archaeological Experimental Centre at Lejre.

Tree species used for fodder

22 samples, each of 200 cm^3, were analysed from the dung layers. These samples yielded 1610 twig fragments. 11 woody species were represented (table 2). The figures given in the table should be treated with a certain measure of caution as it is not certain here (and in all analyses of this nature) how representative the analysed samples are of the material as a whole. One thing is clear however and that is that leaves and branches from a wide range of tree species were gathered and brought in as livestock fodder. If we compare the species present here with those exploited in historical times, there is a great measure of similarity, both in Switzerland and other countries where leaf-foddering was practised (Brockmann-Jerosch 1918, 1936). Austad (1985) writing about Norway, where leaf-foddering is still practised today, states that: "All accessible deciduous trees were exploited for fodder but various districts had differing views as to the value of each species of tree" (translated from Norwegian). So, despite the fact that all available trees were exploited for fodder, there were some species which were considered to be better than others. In Brockmann-Jerosch's (1918, 1936) ac-

		Weight (g)	%	Number	%
Ash	(Fraxinus)	114.3	27	339	21
Lime	(Tilia)	81.5	19	285	18
Willow	(Salix)	71.8	17	308	19
Alder	(Alnus)	40.1	9	217	13
Ivy	(Hedera)	28.7	7	186	12
Clematis	(Clematis)	28.6	7	69	4
Hazel	(Corylus)	27.5	6	64	4
Oak	(Quercus)	15.1	4	68	4
Elm	(Ulmus)	14.5	3	45	3
Misteltoe	(Viscum)	0.3	0.07	5	0.3
Honeysuckle/Privet	(Lonicera/Ligustrum)	0.16	0.04	3	0.2
Birch/Alder	(Betula/Alnus)	1.0	0.2	18	1
Poplar/Willow	(Populus/Salix)	0.4	0.09	3	0.2
Σ		423.96		1610	

Table 2. All the twig fragments identified from the dung layers arranged according to species. The percentages for the various species are calculated on the basis of the total weight and the total number of twigs.

counts of leaf-foddering in Switzerland in historical times it was generally ash which was considered to be the best deciduous tree for animal fodder. If we consider the collective picture from Weier, over 25% of the material is ash, showing that it must have been one of the preferred species. Lime is the next most abundant with 19% and as lime grows on drier soils it must have been gathered at some distance from the site. Willow, alder, hazel and oak also make up a significant proportion of the material. They too have been used for fodder during historical times although without their being attributed particular significance. On the contrary elm, which in the past has been considered a particularly valuable fodder tree (Troels-Smith 1960), makes up only a very modest proportion (3%) of the material present. Ivy and clematis, conversely, are present in surprisingly large quantities – 7% in each case. In a number of countries, including Switzerland, ivy has a history of being used as fodder for cattle, sheep and goats. It is an evergreen and was often collected in winter when it could be a problem collecting other kinds of fodder (Brockmann-Jerosch 1936; Troels-Smith 1960; Rackham 1980). Clematis on the contrary is not particularly known as animal fodder in historical times. As both ivy and clematis are creepers, growing up trunks and out along branches, it is possible that they were brought in unintentionally along with branches and twigs of other species. The quantities of both species present in the dung tend however, to suggest that this was not the case. With regard to ivy, it should also be mentioned that pollen analyses from the culture-layers at several neolithic settlement sites in Switzerland and Germany show unusually high values of ivy pollen, which is also consistent with the intentional collection of this plant (Troels-Smith 1960; Welten 1967; Schütrumpf 1968; Leroi-Gourhan and Girard 1971; Heitz-Weniger 1978; Liese-Kleiber 1985). Indisputable evidence for the selective gathering of ivy was found at the Pfyner settlement of Feldmeilen-Vorderfeld (on Lake Zürich in Cantone Zürich), where 18% of the twig fragments examined were of ivy (Bräker 1979). Furthermore at the Egolzwil 3 settlement in Wauwilermoos, Cantone Luzern (Egolzwiler Culture) 3% of the twigs in samples containing goat faeces were ivy (Rasmussen in prep.).

Mistletoe, which is present very occasionally in the

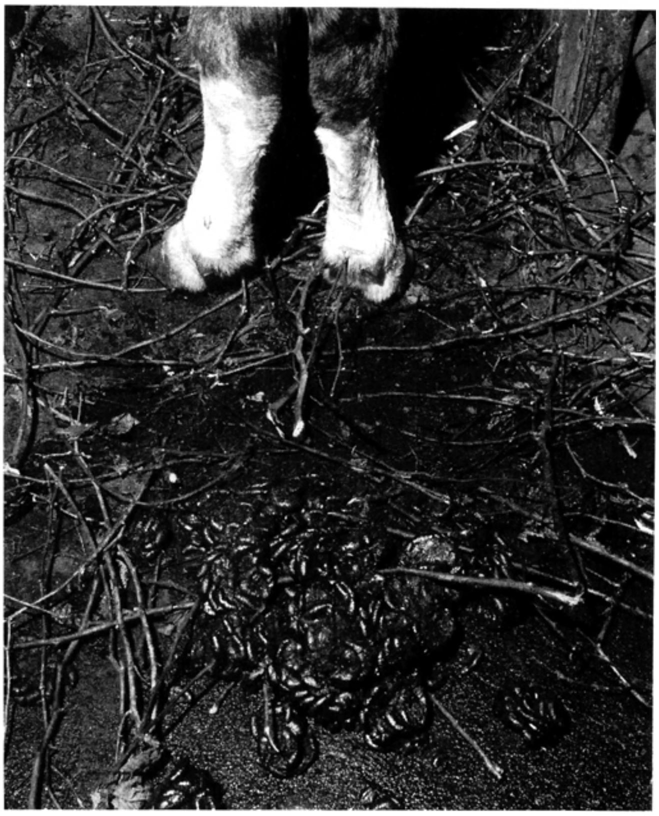

Fig. 9 (above). A modern leaf-foddering experiment: The cow is fed with dried ash leaves and twigs. It pulls the twigs through the bars and eats the leaves and the smaller twigs. (Photo: H. Rasmussen, Historical-Archaeological Experimental Centre, Lejre).

Fig. 10 (above, right). The larger twigs are not eaten by the cow and together with some leaves which are wasted they accumulate at the rear of the cow where they become mixed with dung. If the dung is allowed to lie for any length of time the cow tramples the twigs into small pieces and twigs, leaves and dung are mixed together producing something very similar to that found in the dung layers from Weier. The leaf-foddering experiment revealed that the quantities of larger twigs eaten depends on how hungry the animals are. Analysis of the modern dung also showed that leaves and twigs are not completely digested by the animals. Identifiable twig fragments up to 2.5 cm in length and with a diameter of 0.3 cm, and leaf fragments measuring 1.1 x 1.0 cm passed through the animals digestive systems. (Photo: H. Rasmussen, Historical-Archaeological Experimental Centre, Lejre).

Fig. 11 (below, right). Cow fed on elm leaves – cf. caption to figure 10. (Photo: H. Rasmussen, Historical-Archaeological Experimental Centre, Lejre).

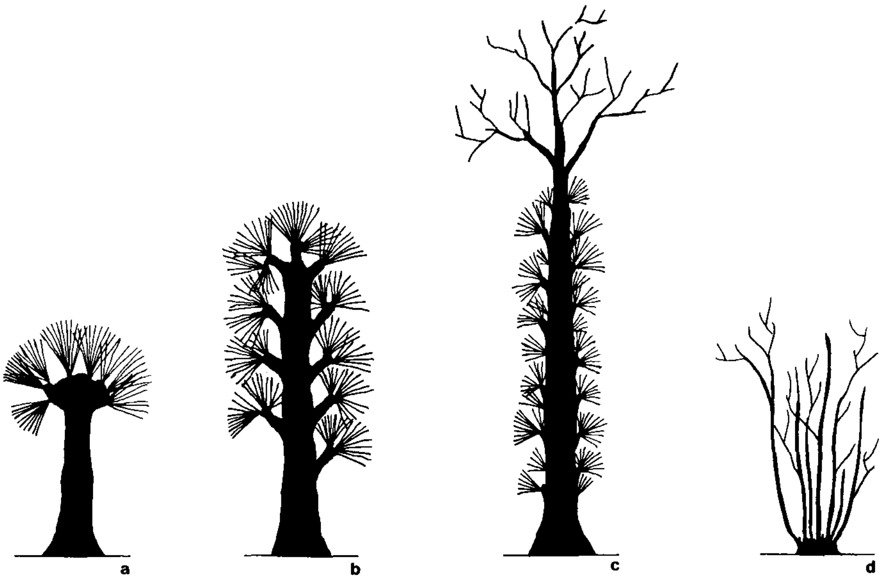

Fig. 12. Schematic representation of methods of tree management known from Europe during historical times. (Peter Rasmussen del.).
a: Pollarding b: "Pollarding" with the trunk intact c: Shredding d: Coppicing

Weier dung layers, has been used as a fodder plant in historical times in Central Europe in time of shortage, for example by farmers in the Vosges (Brockmann-Jerosch 1936). It grows parasitically on various tree species (primarily lime) and as there were so few fragments in the dung layers it seems likely that it was brought in unintentionally in association with branches of other tree species. The possibility cannot be excluded however, that it was gathered intentionally. A convincing example of the selective gathering of mistletoe is known from the late-neolithic settlement of Auvernier La Saunerie (on Lake Neuenburg, Cantone Neuenburg) where mistletoe makes up 3.6% (59 fragments) of the 1596 twig fragments which were examined (Schweingruber 1976). In Denmark recent palynological studies strongly suggest that both mistletoe and ivy were collected by the earliest farmers at the transition between the Atlantic and Sub-Boreal Periods (Andersen 1984; cf. Troels-Smith 1960). A sound basis for the interpretation of the Danish pollen diagrams is thus to be found in the archaeological evidence from the Swiss sites which shows unequivocally that neolithic farmers gathered both of these species.

THE MANAGEMENT OF TREES TO PRODUCE LEAF FODDER

Leaf-foddering in historical times was closely associated with particular methods of harvesting and lopping trees. According to Rackham (1976, 1980), this management can be divided into two main types: Pollarding and shredding. Pollarding consists of cutting off the top of the tree at a height of between 1.5 and 5 metres and harvesting the shoots which arise from the cut surface (fig. 12a). In a variation on this, not mentioned by Rackham, the trunk is left intact and the branches are cut at some distance from the trunk. The shoots which arise from the cut branches are then harvested (fig. 12b). In shredding the trunk and crown are left intact and the side branches are removed. The new shoots which are formed along the trunk are then harvested (fig. 12c). These management practices serve at least 3 main purposes:

1. They increase the production of leaf fodder.
2. They make the practical work of harvesting the leaf fodder easier.
3. The leaves are rendered inaccessible to freely-grazing animals.

From historical times and up into the recent past, various methods are known by which the fodder was harvested from the trees. In Norway for example, there are distinctions between "*rising*", "*risping*" and "*lauving*" (Austad *et al.* 1985). "*Ris*" means branches without leaves, which were collected in the winter and early spring and used particularly as cattle fodder. "*Risping*" entails ripping off the leaves from the branches either for use im-

Age of twigs in years	Willow (Salix)	Elm (Ulmus)	Ash (Fraxinus)	Oak (Quercus)	Hazel (Corylus)	Alder (Alnus)	Lime (Tilia)
	% (W)	% (W)	% (W)	% (W)	% (W)	% (W)	% (W)
1	50		6	4	8	6	0.2
2	8	5	14	33	8	16	4
3	16	46	23	36	12	30	16
4	13		23	4	2	13	14
5	4	7	9	7	5	5	11
6	4	0.3	16		20	13	15
7	3	6	2	11	35	12	15
8	2	9	2		8	5	9
9		18	0.4	5	1		3
10		3	1				5
11			1				
12		0.6	0.1		0.4		0.3
13			1				1
14							1
15			0.6				2
16							
17		3					0.7
18		2					0.3
19							2
Σ	73.75	14.36	113.01	15.04	25.31	38.16	76.46

Table 3. The age distribution of twigs found in the dung layers, arranged after species. The percentages are calculated on the basis of the total weight (g) of each individual tree species.

mediately in fresh state, or dried for later use. By far the most important of fodder-gathering activities in all areas was "*lauving*". Branches were harvested in a leafy state in July/August and after drying were stored for use as winter fodder. In "*lauving*" individual trees are harvested at 2–4 year intervals, although this varies to some extent depending on local conditions; in some areas the tree was harvested every year, in others up to 7 years could elapse between the harvesting of each individual tree.

Apart from pollarding and shredding there is a third important form of tree management, that of coppicing. This involves cutting through the tree trunk close to the ground, something which promotes the formation of a vigorous growth of shoots from the remaining stump (fig. 12d). With a few exceptions (see Petrovič 1936) coppicing has rarely been used to produce animal fodder in historical times. The primary aim was always to produce long straight rods or poles for use for example in fencing, house construction and for fuel (Worsøe 1979; Rackham 1980). A consequence of this is that the trees were not cut as often as they were with pollarding and shredding. The normal coppicing interval lay somewhere between 10

Age of twigs in years	Number	%
1		
2	18	64
3	3	11
4	3	11
5	2	7
6	1	4
7	1	4

Table 4. Frequency and age distribution of cut twigs from two ash branches which were lopped at 2-year intervals between 1964 and 1968. Lötschental, Switzerland.

and 20 years, although woods are known from Eastern England with a coppicing interval in the Middle Ages as short as 4–8 years (Rackham 1980).

So far it has been difficult to determine to what extent the gathering of leaf fodder at the Weier site was linked to any of the above activities. Counting the annual rings of the twigs from the dung layers and determining their age distribution at harvest can give a certain amount of information (table 3). However before the age distribution of the twigs can be evaluated in terms of a possible organized harvesting, it is important to know the expected age distribution of twigs that have been harvested on a formal basis i.e. via a system of pollarding or shredding. The analyses of two branches from two modern pollarded trees from Lötschental, Switzerland are helpful in this respect. The branches were collected in 1968 (by J. Troels-Smith), at which time the trees were still being pollarded by local farmers with the aim of producing leaf fodder. A dendrological analysis of the branches (Bartholin 1970), shows that one ash branch was lopped three times, in 1968, 1966 and 1964, and that the cut twigs had the following age distribution:

1968: 5 2-year old twigs
1 4-year old twig
1 7-year old twig
1966: 5 2-year old twigs
1964: 2 3-year old twigs

The second ash branch had been lopped 5 times, in 1968, 1966, 1964, 1958 and 1956, and the twigs cut in these years had the following age distribution:

1968: 7 2-year old twigs
1966: 1 4-year old twig
1 5-year old twig
1964: 1 6-year old twig
1958: 1 4-year old twig
1 5-year old twig
1956: 1 2-year old twig
1 3-year old twig

The investigations shows that since 1964 the two branches had been lopped at 2-yearly intervals, but this does not mean that all the twigs harvested were 2-years old. Not all the twigs were removed at each harvest, some of them remained to be cut at a later harvest hence the distribution seen above. 2-year old twigs are however very much in the majority (table 4).

This modern example illustrates the difficulties in trying to link the age distribution of twigs with a particular management practice carried out on a particular tree. It does however show that it is possible to demonstrate a connection between the dominant age category of twigs and the time interval at which the tree has been harvested. On the basis of this it is possible to evaluate the fossil twig material from the dung layers. There are however some factors regarding the dung material which make comparison difficult. For example, the proportion of the branches which the animals have eaten, how fragmented the twigs are and, not least, the extent to which the analysed material is representative are all unknown. If a comparison is attempted despite these reservations then the following is found to be the case: With regard to elm and willow there is good agreement with the modern material in that one age category is dominant. In the case of willow it is the 1-year old twigs (comprising 50% of the material), with elm it is the 3-year old twigs (comprising 46% of the material (table 3). With regard to the other tree species the picture is rather more diffuse, although there is a tendency for age categories comprising two consequtive years to dominate. In ash it is the 3- and 4-year old twigs, making up almost 50% of the material. Amongst oak twigs, it is the 2-and 3-year old twigs which are the most abundant, comprising almost 70% of the material. In hazel, 6- and 7-year old twigs are the most abundant, forming over 50% of the total and in alder it

Age in years	Number	Weight g	%	%
1	266	49.1	14	
2	197	38.4	11	
3	218	76.2	21	
4	177	52.9	15	
5	106	27.1	8	
				69
6	88	42.8	12	
7	59	32.6	9	
8	32	15.7	4	
9	20	6.5	2	
10	15	5.1	1	
				28
11	2	1.3	0.4	
12	5	0.5	0.1	
13	3	2.0	0.6	
14	4	0.7	0.2	
15	4	2.0	0.6	
				1.9
16	-	-	-	
17	2	1.0	0.3	
18	2	0.5	0.1	
19	1	1.7	0.5	
				0.9
Σ	1201	356.1		

Table 5. Age distribution of all the twigs examined from the dung layers. The percentages for the various age groups are calculated on the basis of the total weight of twigs. (In the case of 409 twigs it was not possible to determine the age).

is the 2-and 3-year old twigs which together make up 46% of the total. Lime deviates from this pattern in that there is an even distribution across the age categories.

On the basis of the age categories alone, it is not possible to determine to what extent the leaf fodder was harvested from formally-lopped trees. Much suggests however, that the different tree species were treated in different ways. The problem of demonstrating tree management in the Neolithic has also been approached by way of tree-ring analysis. The results of this research are described in detail in Rasmussen (1990).

On the whole the twigs from the dung layer were harvested at an early age: 69% fall in the 1–5 year old category and 97% are under 10 years old (table 5). This distribution is very suggestive of selective harvesting with the aims of:

a: obtaining the highest possible amount of leafy material combined with the lowest possible amount of woody material.
b: producing woody material which the animals were able to chew.

Measurements of twig diameter suggests that the latter consideration played an important role in determining which branches were harvested. All the older twigs (i.e. those in the range 10–19 years old) have a diameter approximately equal to or less than those in the 1–10-year age category (table 6). Normally twig diameter is directly proportional to age but this is not the case in the dung layers. It would appear therefore that older twigs are included in the fodder because their thickness is such that the animals were able to chew them.

LEAF FODDER AND ANIMAL HUSBANDRY

The housing of livestock in the settlement, either in byres or other enclosures, is not something unique to the Weier site. Several of the Swiss settlement sites have been found to contain either byres containing great concentrations of fly puparia: Egolzwil 4 (Cortaillod Culture) (Vogt 1969) or concentrations of goat and/or sheep faeces which can form layers up to several tens of centimetres thick: Egolzwil 3, (Egolzwiler Culture) (Vogt 1951), Egolzwil 2 (Cortaillod Culture) (Heierli and Scherer 1924), Robenhausen (Pfyner Culture) (Heer 1865), Thayngen-Weier (Pfyner Culture) (Guyan 1955), Niederwil (Pfyner Culture) (Clason 1966), Feldmeilen-Vorderfeld (Pfyner Culture) (Winiger and Joos 1976), Horgen "Dampfschiffsteg" (Pfyner Culture), Horgen Scheller (Horgen Culture), Zürich "Mozartstrasse" (Horgen Culture) and Saint Blaise (Lüscherz Culture).[2] Together,

Age in years	Number	Max. dia. cm	Min. dia. cm	Average dia. cm
1	266	1.15	0.10	0.34
2	197	0.9	0.15	0.35
3	218	1.0	0.15	0.45
4	177	0.95	0.10	0.42
5	106	0.77	0.15	0.40
6	88	1.07	0.17	0.51
7	59	1.35	0.17	0.51
8	32	1.05	0.2	0.47
9	20	0.67	0.25	0.45
10	15	0.72	0.35	0.50
11	2	0.55	0.5	0.52
12	5	0.65	0.27	0.40
13	3	0.65	0.27	0.50
14	4	0.52	0.3	0.38
15	4	0.75	0.4	0.53
16	-	-	-	-
17	2	0.62	0.47	0.55
18	2	0.62	0.45	0.53
19	1	0.7	0.7	0.7
Σ	1201			

Table 6. Diameter of the various age categories of twigs from the dung layers, given in the order: maximum, minimum and mean diameter.

these sites cover a period stretching from the oldest early Neolithic until the Corded Ware Culture; i.e. from 3400 b.c. until 1900 b.c. These are the sites where there is positive evidence for livestock being contained within the settlement. There are certain to be a large number of settlements where faeces and house fly puparia have been present without their being recognized as their detection demands of very special awareness during excavation. In the light of this one can assume that the practice of keeping livestock within the settlement was widespread. In contrast, questions as to why and at which time of year this occurred remain unanswered. Several possibilities exist, but the most likely of these is that livestock were kept confined for at least the duration of the winter; a time when food in the surrounding landscape was scarce and there was a need or desire to protect them from snow and frost, and perhaps, most importantly, to collect their dung for use as manure.

Winter and early spring has always been a difficult period in primitive agricultural societies due to the lack of food for both people and animals. In the book "*Vår Gamle Bonde-Kultur*" ("Our old farming culture") Visted and Stigum (1951) give a vivid description of conditions in Norway at the turn of the century. This description seems also in many ways appropriate to a prehistoric agricultural society:

"In this country livestock had to be foddered indoors for the greater part of the year. In some places in the coastal district sheep and goats could probably manage outside the whole year round; further inland this was not possible. Cows were able to find fodder outside for four months of the year, but in some places the grazing season was shorter. In others, such as on Sørlandet, it was slightly longer. In spring it was generally the sheep which were turned out before the cattle and they could also manage outside longer in the autumn... In the autumn it was necessary to decide how many animals it was possible to keep alive through the winter. It was desirable to have as many as possible and there was a tendency to keep too many animals relative to the amount of fodder available. This system is now often called the starvation feeding principle. This does not mean that livestock starved everywhere, although we can take it that the general level of winter fodder was lower than that which today would be considered either productive or defensible. There have been all possible variations in this relationship, and there are many accounts of suffering and hunger in the byre. In difficult years the cows starved to death in their stalls, and it was not unusual that they had to be helped outside in the spring. There are also accounts of bad years which affected the human population, neither was it unusual for people to die of deficiency diseases or directly of starvation" (translated from Norwegian).

It is difficult to determine with certainty the time of year at which the livestock in the Swiss Neolithic were confined in the settlement but there are indications from several localities which suggest that is was during the winter months (see also Rasmussen in prep.). As mentioned earlier, pollen analyses from culture-layers at several neolithic sites have revealed very high values of ivy pollen (table 7). As ivy flowers in the period October/Novem-

Culture	Locality	Hedera %	Author
Cortaillod	Kleiner Hafner 1	12.9	Heitz-Weniger 1978
Cortaillod	Kleiner Hafner 3	14.3	Heitz-Weniger 1978
Cortaillod	Burgäschisee-Süd	46.0	Welten 1955, 1967
Cortaillod	Baulmes "abri de la Cure"	22.0	Leroi-Gourhan & Girard 1971
Pfyner	Hornstaad-Hörnle I	12.6	Liese-Kleiber 1985
Michelsberg	Ehrenstein	33.0	Schütrumpf 1968
Horgen	Kleiner Hafner	9.0	Heitz-Weniger 1978

Table 7. Examples of neolithic settlements in Switzerland and southern Germany with high pollen percentages of ivy (*Hedera*).

ber, this must indicate that flowering branches were brought into the sites at this time i.e. at the start of the winter. If this evidence is seen in the light of the investigations at Weier which show that ivy was brought in specifically as animal fodder and where one pollen sample from the dung layers contained no less than 43% ivy pollen (Rasmussen 1988), then it seems likely that the high ivy pollen percentages at the other sites also reflect the collection of ivy for fodder. It is reasonable to conclude therefore that the livestock was kept confined in the settlement during the winter months, this does not however exclude the possibility that the animals were also foddered inside during the summer – this is just harder to prove or disprove.

THE LEAF-FODDERING THEORY AND THE ELM DECLINE

At Weier several pollen diagrams show a marked elm decline which is contemporary with the settlement's oldest phase.[3] The elm decline in the Weier valley has played an important role in shaping the theory that the fall in the elm-pollen curve is a result of the selective harvesting of elm by neolithic farmers for use as animal fodder (Troels-Smith 1955, 1960). We now have a valuable opportunity at the Weier site to re-evaluate the relationship between leaf-foddering and the elm decline. We now know to some extent which trees were harvested to produce fodder and we know in some detail the extent of the exploitation of the surrounding woodland which accompanied the construction of the village.

Together the Weier settlement's three phases covered an area of between 6000 and 9000 m^2 and large quantities of timber went into the construction of houses, roads, fences and other structures. In addition it has been shown that there were arable plots in the valley which were contemporary with the settlement (Troels-Smith 1981, 1984). The establishment of these must have involved the clearance of a substantial area of woodland.

Topographically the Weier valley is small and elongated. It is surrounded on all sides by hills which, with the exception of a narrow opening toward the Fulach valley to the west, reach a height of between 40 and 80 m. The valley's longitudinal axis is orientated almost east-west and is just under 2 km in length. The distance across the valley, from hill-top to hill-top is approximately 800 metres. During the Atlantic and Sub-Boreal Periods there was a shallow lake *c.* 100 x 500 metres on the valley floor. The lake had an outlet to the Fulach river but no inlet. Given this relatively limited and isolated topography it is possible to compare what is known about the effect of the neolithic farmers on the woodland in the Weier valley with a pollen diagram from the Weier basin. The main question is whether the influence of the neolithic folk in the form of timber extraction, clearance for agriculture, leaf fodder harvesting etc. is reflected in the pollen diagram?

Table 8 is a summary of all the published wood identifications from the Weier settlement's three phases. It includes *c.* 4600 identifications ranging from small pieces of charcoal up to complete tree trunks.[4] This summary does not, of course, give a complete picture of how the woodland was exploited, but given the quantity of material analysed it is likely to give a reasonably representative picture of the relative quantities in which the various species were used. It is evident from the table that the timber

	Settlement		Field		Gyttja		Σ		Dung			
	n	%	n	%	n	%	n	%	W(g)	%	n	%
Quercus	896	37	102	25	66	47	1064	35	15.1	4	68	4
Fraxinus	628	26	62	15	19	13	709	24	114.3	27	339	21
Alnus	299	12	113	27	1	0.7	413	14	40.1	9	217	13
Salix & Populus	162	7	72	17	6	4	240	8	72.2	17	311	19
Betula	55	2	2	0.5			57	2				
Acer	37	1	15	4	9	6	61	2				
Tilia	120	5	23	5	14	10	157	5	81.5	19	285	18
Corylus	212	9	12	3	14	10	238	8	27.5	6	64	4
Sorbus	2	0.08	11	3	3	2	16	0.5				
Fagus	4	0.2	3	0.7	9	6	16	0.5				
Carpinus	7	0.3					7	0.2				
Malus	3	0.1					3	0.1				
Taxus	3	0.1					3	0.1				
Abies	3	0.1					3	0.1				
Prunus	2	0.08					2	0.07				
Cornus	2	0.08					2	0.07				
Rosaceae	1	0.04					1	0.03				
Ulmus	1	0.04			1	0.7	2	0.07	14.5	3	45	3
Hedera									28.7	7	186	12
Clematis									28.6	7	69	4
Viscum									0.3	0.07	5	0.3
Lonicera/Ligustrum									0.16	0.04	3	0.2
Betula/Alnus									1.0	0.2	18	1
Summa	2437		415		142		2994		423.96		1610	

Table 8. Summary of all wood identifications carried out in connection with the Weier settlement's three phases and comprising wood from the settlement, an arable field, a gyttja layer and dung layers from the settlement. (See note 4).

used in the construction of houses, fences, etc. is, in the main, oak (*Quercus*), ash (*Fraxinus*), alder (*Alnus*) and willow/poplar (*Salix/Populus*).[5] It is also largely these species which were cleared in connection with the establishment of the arable plots (cf. Troels-Smith 1981). The leaf fodder remains from the byre dung layers show a slightly different spectrum. Here there are relatively small quantities of oak (*Quercus*) but a great deal of lime (*Tilia*) and willow (*Salix*). In addition there are relatively large quantities of ivy (*Hedera*) and clematis (*Clematis*).

As mentioned above, table 8 gives an average picture of how the woodland around the Weier site was exploited by the neolithic farmers over a period of about 300 years, from 3100 b.c. to 2800 b.c. If this information is compa-

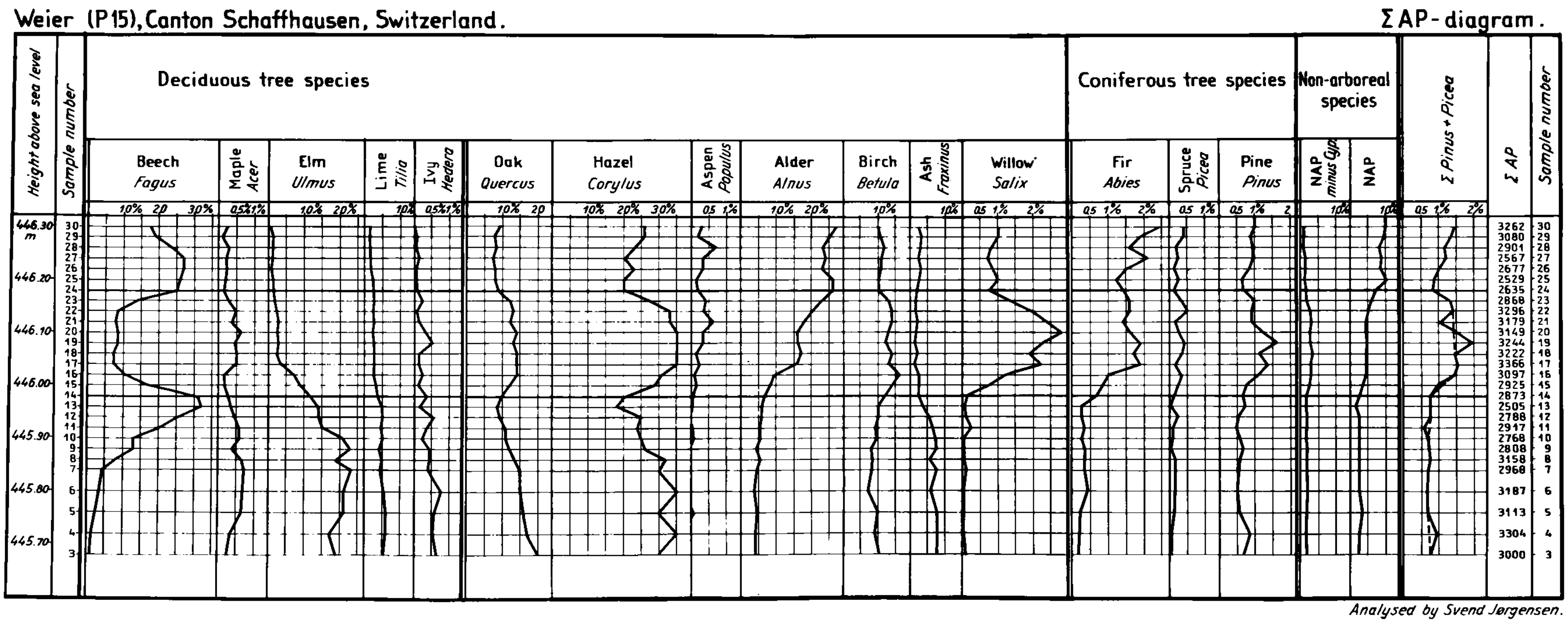

Fig. 13. Pollen diagram from the Weier basin (after Tauber 1965). The diagram is calculated on the basis of a pollen sum consisting of all arboreal species including hazel (Σ AP). Curves for less significant species (e.g. yew, rowan, elder, apple) are not shown. Σ NAP comprises Gramineae and Cyperaceae (Tauber 1965). The pollen samples were taken from an open section in gyttja, 12 metres from the Weier settlement. The investigation of the composition and stratigraphy of the profile and the collection of the pollen samples was carried out by J. Troels-Smith and Svend Jørgensen in 1958.

red with the pollen diagram (fig. 13) which covers the same period (from sample 14 to 24), it is clear that there are a number of events which cannot be explained on the premise that a fall in the pollen curve for a particular species is a result of felling or lopping that species. In this paper only the events relevant to the elm curve will be examined in detail (the situation with regard to beech (*Fagus*) has already been examined in detail by Troels-Smith (1981)).

Table 8 shows that on the whole elm was not used for house building and other construction work. One piece of elm was found in the oldest phase of the settlement (Weier I) and the species is also modestly represented in the dung layers (3% of the total). On this basis we can therefore conclude that only very limited use was made of elm in the settlement. If we then consider the theory that the elm decline was caused by human activity it is clear that the evidence from the wood identified from the settlement contrasts sharply with the evidence from the pollen diagram. In the latter the elm curve shows a marked decline which increases around 3100 b.c. (sample 14) the time at which the first farmers came to the Weier valley. From then onwards, throughout the 300 year existence of the settlement, there is a continued decline in the elm pollen curve. There is nothing in the wood identifications from Weier which suggests that the elm decline is the result of timber extraction. Similarly the analyses of the byre dung layers show that the lopping of elm for animal fodder can also be excluded as the main cause of the elm decline. These layers are dated to about 150–200 years later than the beginning of the elm decline and we do not know to what extent elm leaf fodder was gathered during that period. However the theory linking leaf-foddering and the elm decline states that after an initial marked fall, the elm curve maintains consistent low levels due to the persistent harvesting of leaf fodder which in turn prevented the elm trees from flowering (cf. Troels-Smith 1960 p. 24). For this to be the case, substantial quantities of elm twigs would be expected to be found in the byre layers even as long as 200 years after the initial decline; this is not the case.

The problem can also be approached from another angle. In so far as the elm decline is a result of leaf fodder collection then the elm trees must have been harvested selectively. This in turn means that large quantities of elm leaf fodder must have been brought in to the site. Historical accounts of leaf-foddering and modern leaf-foddering experiments both show that a herd of 10 cows (not an unrealistic figure for the Weier settlement) need 40 kg of fodder per day (4 kg per cow/day) (Rasmussen in press). If we assume that the animals were fed over a period of six months, this means that the requirement is a total of 7.2 tonnes of leaf fodder. If we also assume that a 10-cow herd was fed with elm leaf fodder over 50 winters, this would require 360 tonnes of elm leaf fodder. Even though we do not know with certainty how representative the wood identifications in table 8 are, it is clear that elm would have been much better represented had 360 tonnes of elm leaf fodder been brought into the settlement. On the basis of this evidence and the considerations presented here, the only conclusion possible is that no link can be found between the elm decline and the neolithic farmers exploitation of elm trees. Accordingly, the theory that the elm decline at Weier was caused by human activity can be dismissed.

What did cause the elm decline? The debate has been running for decades and in recent years several workers have argued the case strongly for the involvement of an elm-specific disease, similar to, or identical with, the present-day Dutch Elm Disease. The problem with this explanation is however, that it is particularly difficult to prove or disprove. At West Heath Spa, Hampstead Heath, London, fossil remains (two wingcases) of the elm bark beetle (*Scolytus scolytus* F.) were found in deposits approximately contemporary with the beginning of the elm decline (Girling and Greig 1985; Girling 1988). A piece of elm wood of approximately the same age was found in Åmosen, Denmark with galleries identified as being those of the elm bark beetle (*Scolytus Laevis* Chap.) (Stockmarr 1966; Fredskild 1968; Kolstrup 1988).The elm bark beetle is the main vector of the fungus *Ceratocystis ulmi*, which today causes Dutch Elm Disease. The beetle is however only responsible for transporting the fungal spores which cause the disease and its presence says nothing about the extent to which the fungus was present. In the few investigations which have been carried out into fungal spores in prehistoric deposits to date, it has not been possible to demonstrate the presence of *Ceratocystis ulmi* (van Geel 1978; van Geel, Dee and Bohncke 1981). The situation at present is therefore, that the presence of the elm disease vector at the time of the elm decline can be demonstrated, but that of the disease itself can not.

Despite the fact that there is no evidence for the elm decline at Weier being caused by elm disease, it is worth noting that there is evidence from the settlement for the presence of the disease vector; an elm trunk was found at the site which exhibited beetle galleries characteristic of the elm bark beetle (*Scolytus scolytus*) (Guyan 1955).

CONCLUSION

Discussions of neolithic leaf-foddering with their roots in the elm decline have almost become stereotyped. As the investigations at Weier show, the elm decline in pollen diagrams is misleading when it comes to evaluating the extent to which neolithic farmers fed their livestock with leaf fodder. The analyses of the dung layers from the Weier settlement show that we are dealing with a much more complex situation than has previously been appreciated. There is clear evidence for the use of a broad spectrum of tree species for fodder – something which has close parallels in more recent societies which practised leaf-foddering. The two species which dominate in the byre layers at Weier are ash and lime. Together they make up almost 50% of the material present. In addition to these two species, there are nine other species represented: willow, alder, ivy, clematis, hazel, oak, elm, mistletoe and honeysuckle/privet. Of these, ivy is remarkably abundant and several important facts are linked with its presence. At the transition from the Atlantic to the Sub-Boreal Periods many European pollen diagrams show a fall in the ivy pollen-curve. It has long been debated whether this decline is climatic or anthropogenic in origin. The analyses of the dung layers from Weier together with evidence from several other Swiss sites, provide incontrovertible evidence for the fact that neolithic farmers gathered ivy. The high pollen values for ivy in the dung layers show in addition that the ivy branches must have been collected during ivy's flowering period i.e. October/November, and this in turn means that the animals must have been fed during the winter. It cannot be determined with certainty whether the twigs from the dung layers were harvested from managed (pollarded/shredded) trees or not. Further analysis of twigs and branches from a number of sites, together with tree-ring analyses of tree trunks and branches are needed before further light can be shed on this problem.

As mentioned in the introduction it is particularly difficult to demonstrate leaf-foddering on the basis of palynological evidence alone. It is unknown to what extent, and in what way, leaf harvesting is reflected in a pollen diagram. It is often possible to see the effects of human influence in a pollen diagram, but to determine whether this influence is the result of leaf fodder harvesting appears to be almost impossible. An agricultural activity such as leaf fodder harvesting can not be demonstrated on the basis of fluctuations in pollen curves alone, it is particularly vital to also have firm archaeological evidence.

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NOTES

1. All datings are expressed in conventional C-14 years before Christ (b.c.).
2. Jürg Elmer, Landesmuseum in Zürich, kindly drew my attention to the unpublished find of goat/sheep faeces from the settlement site Horgen "Dampfschiffsteg". Together with Martin Dick, Botanical Institute, University of Basel, I have identified a small number of goat/sheep faeces from the site Zürich "Mozartstrasse". Goat/sheep faeces were identified by the author at the site of Horgen Scheller during an excavation in December 1989. Philippe Hadorn, Botanical Institute, University of Bern, has found goat/sheep faeces at the site of Saint Blaise (P. Hadorn personal communication).
3. Heitz-Weniger (1976) maintains that the elm decline is not contemporary with the Weier settlement, because the elm decline in a section from the site lies deeper than the culture-layer. This conclusion is based on a misconception as it is not certain that the culture-layer in this particular section belongs to the settlement's oldest phase (Weier I). If it belongs to the middle or youngest phase (Weier II and III) then the elm decline will be found at a lower level. Radiocarbon dating of the oldest phase of the settlement and the elm decline shows that the former are contemporary with the beginning of the latter.
4. The table is compiled from the results of the following investigations:

a. *Settlement*

Neuweiler 1925, p. 514, Table 1 (710 identifications; apart from the species identification, no other information is given about the nature of the sample, its location in the settlement etc.).

Neuweiler 1946, p. 122–136 (83 identifications; the samples consists of waterlogged wood. No further information about the samples is given).

Huber and Jazewitsch 1958, p. 448, Table 2 (260 identifications; waterlogged wood; the samples come exclusively from posts).

Huber; in Guyan 1967, p. 11 (1384 identifications; waterlogged wood; samples are partly from horizontally-orientated beams and boards and partly from vertical posts).

b. *Field*

Tellerup 1958; in Troels-Smith 1981, p. 102, Abb. 7 (303 identifications; apart from 108 uncarbonized twigs, the samples consist of charcoal).

Rasmussen 1984, Unpublished report, Natural Sciences Department of the Danish National Museum, NM VIII A3922 (92 identifications; all samples consist of charcoal).

Hauschild 1986, Unpublished report, Natural Sciences Department of the Danish National Museum, NM VIII A3922 (54 identifications; all samples consist of charcoal).

c. *Gyttja*

Tellerup 1958; in Troels-Smith 1981, p. 102, Abb. 7 (142 identifications; apart from one uncarbonized twig, all the samples consist of charcoal).

d. *Dung*

Present article.

5. It is normally possible to separate willow and poplar on the basis of wood anatomy, but as this was not done in the earlier analysis which are incorporated into table 8, records of these two species have been combined.

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Storgård IV

An Early Neolithic Long Barrow near Fjelsø, North Jutland

by INGE KJÆR KRISTENSEN

INTRODUCTION

Early Neolithic long barrows with wooden structures and graves built with wood and small stones were first recognized in Denmark at the beginning of the 1970's. Considerably more are now known as new discoveries are made nearly every year and old ones are being reassessed.

The barrows show much variation both in construction and in size, but there are certain elements which recur together or individually at the various sites. These are timber facades (usually placed at the eastern end of the mound and accompanied by deposits of pottery), rectangular or trapeziform palisade enclosures, and transverse partitioning of the barrow with rows of stakes.

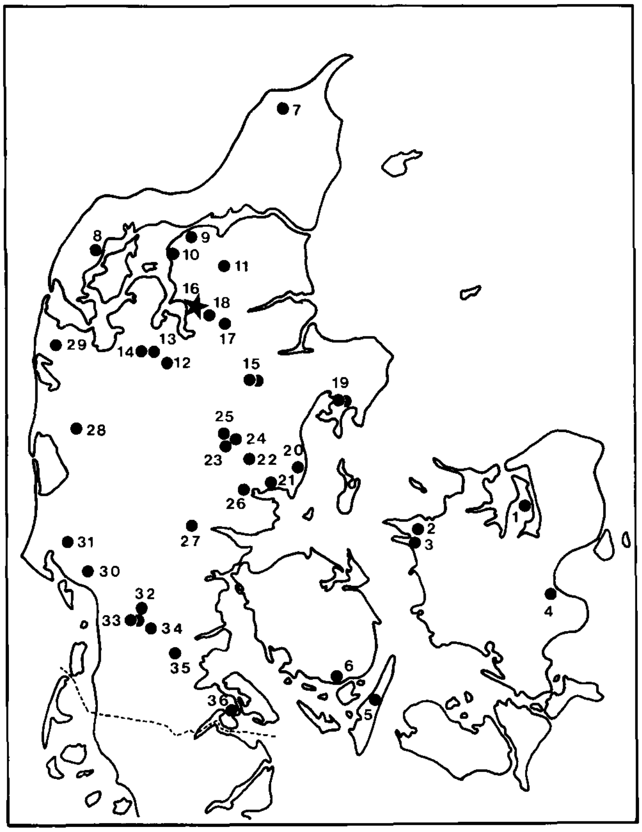


Fig. 1. Non-megalithic Early Neolithic long barrows in Denmark. Storgård IV is marked with a star.

In the great majority of cases one or more graves have been found, built of wood or of a combination of wood and stones. In Danish these have been termed "simple jordgrave". Like the barrows the graves are of very diverse construction and the amount of grave goods varies.

In Jutland there are known a further nearly 100 sites with simple graves. Unfortunately in most of these cases excavation was confined to the grave only, so it is not now possible to say whether they were covered by long barrows. There is much to suggest, however, that there existed graves under a level surface as well graves under barrows.

Including Storgård IV at least 39 non-megalithic long barrows are now known from 36 sites in Denmark (fig. 1, appendix).

THE EXCAVATION

In the early summer of 1986 Viborg Stiftsmuseum excavated the somewhat ploughed-down long barrow, Storgård IV[1] in preparation for the laying of the gas pipe from Lille Thorup to Ålborg. The site lay about 1.5 km from Simested watercourse, on a gentle slope, so that one end of the monument lay 1.35 m higher than the other. The natural subsoil was yellow to brownish-yellow silty sand. In some places, as near the facade, it contained coarser material.

When excavated the site lay in a cornfield, but until the turn of the century it had been heath. The course of wheel ruts over it showed that the mound had been low even at that time, and it was probably never very high.

The barrow

Storgård IV was found by field survey along the planned course of the pipeline, and showed as an oval, light-coloured, ploughed-up prominence. After removal of the

Fig. 2. The site during excavation from the SW.

topsoil it could be seen as a 50 m long and 5.5–12.25 m wide artificial mound, orientated NE to SW with the broad end in the highest part of the slope (fig. 2). The feature was clearly bounded by an outer row of closely-spaced small stones. The entire area was excavated, including a 4–5 m wide belt on all sites, so that the total excavated area amounted to 1200 m^2.

Storgård IV is one of the few fully excavated long barrows with timber graves, ditches, facade and palisades, which has not been disturbed by the later insertion of megalithic chambers.

It was built in at least two structural phases (fig. 3).

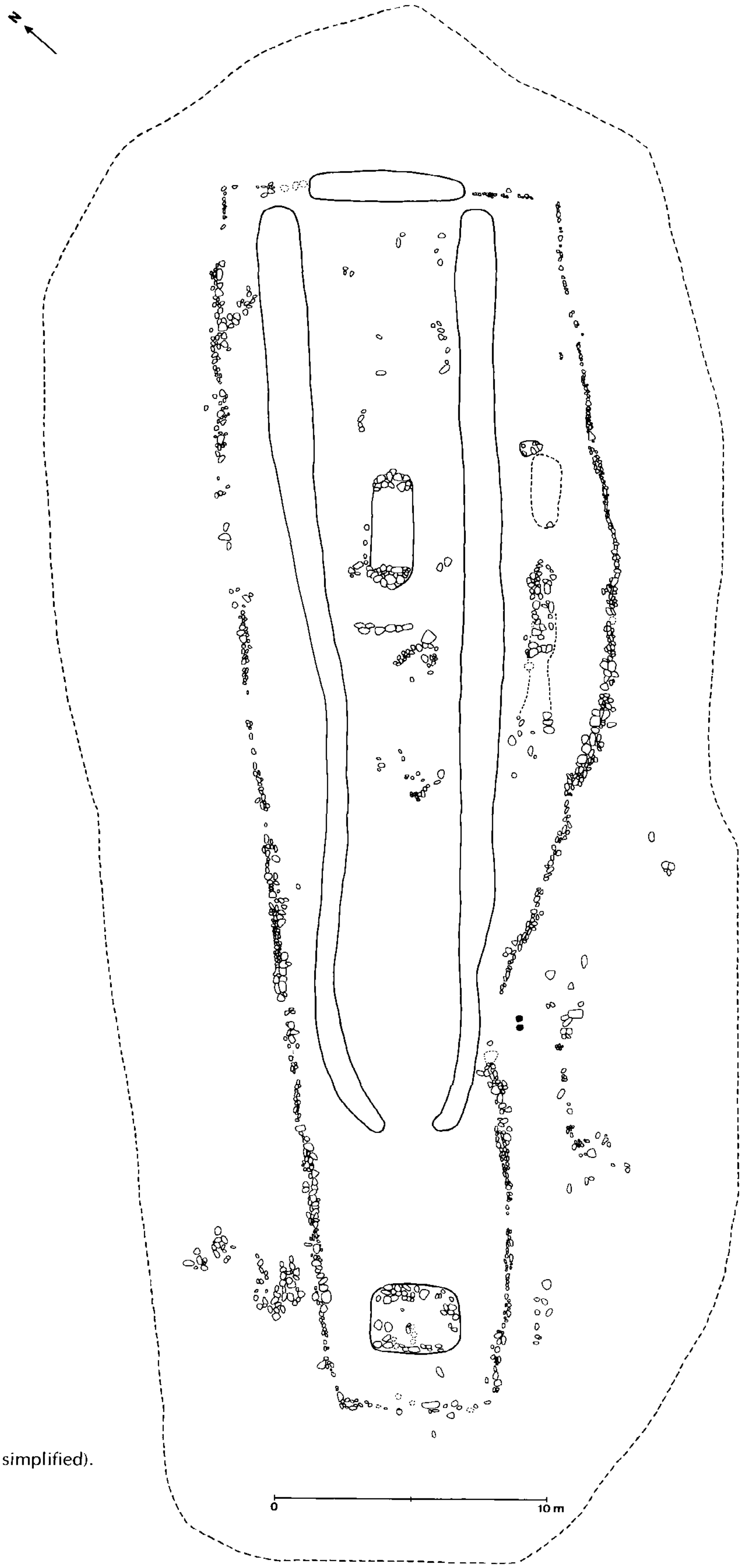


Fig. 3. Plan of the site (slightly simplified).

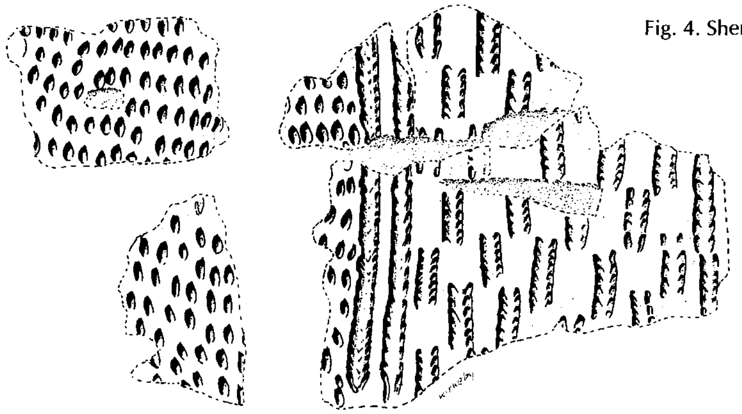


Fig. 4. Sherds from a large lugged beaker. J. Kirkeby del. 1:2.

The first phase

Earliest was a 39 m long and 3.6–8.5 m wide trapeziform structure, having at the NE end a facade built of four large posts. Two stone-free trenches ran from the outer posts of the facade down the slope, delimiting the barrow of this phase. The grave itself was axially placed 11 m from the facade.

In the area bounded by the trenches and palisade was the sod fill of the barrow, best preserved between the grave and the facade. Close to one another in the fill were found a few sherds from the neck of a large vessel, probably a lugged beaker (fig. 4). The decoration consists of pairs of short stab-and-drag lines arranged in a chequerboard pattern and rows of impressions divided up by vertical stab-and-drag lines so as to give a field pattern.

The original surface was several times observed below the barrow.

The facade. The timber facade showed as a 5.5 m long and 1.3 m wide feature with parallel sides and rounded ends, the fill of which was pale brown-grey sand with scattered charcoal.

At a depth of 0.3 m it became possible to distinguish four large stone-lined postholes (fig. 5). They were 1–1.2 m long and 0.5–0.7 m wide, and were dug down to a depth of 1.2 m from the surface. At the edge of each posthole inside the packing stones was observed a grey sand layer with scattered charcoal. The same material could be observed at the bottom of the postholes (fig. 6).

The elongated form of the holes and the arcs of substantial packing stones, intact for the three western holes, seemed to show that the posts were of split logs and had stood with the flat side towards the barrow.

A long and cross section shows the profiles of three postholes (fig. 6). The uppermost layer was 0.3 m thick and had been deliberately placed over the four postholes together with parts of the later palisade trench. This material had not subsided into the postholes and must be from a time when the facade was already cleared away, perhaps after standing for many years.

Below this layer the postholes can be seen as pockets

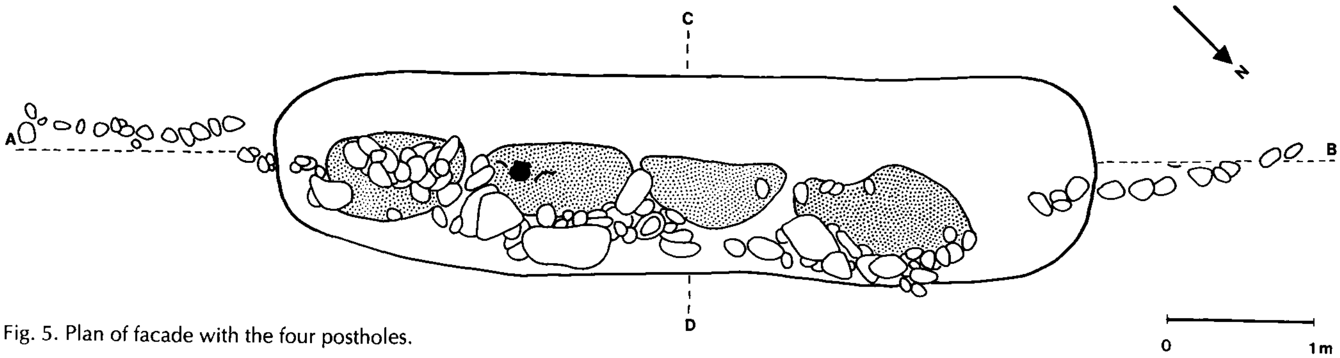


Fig. 5. Plan of facade with the four postholes.

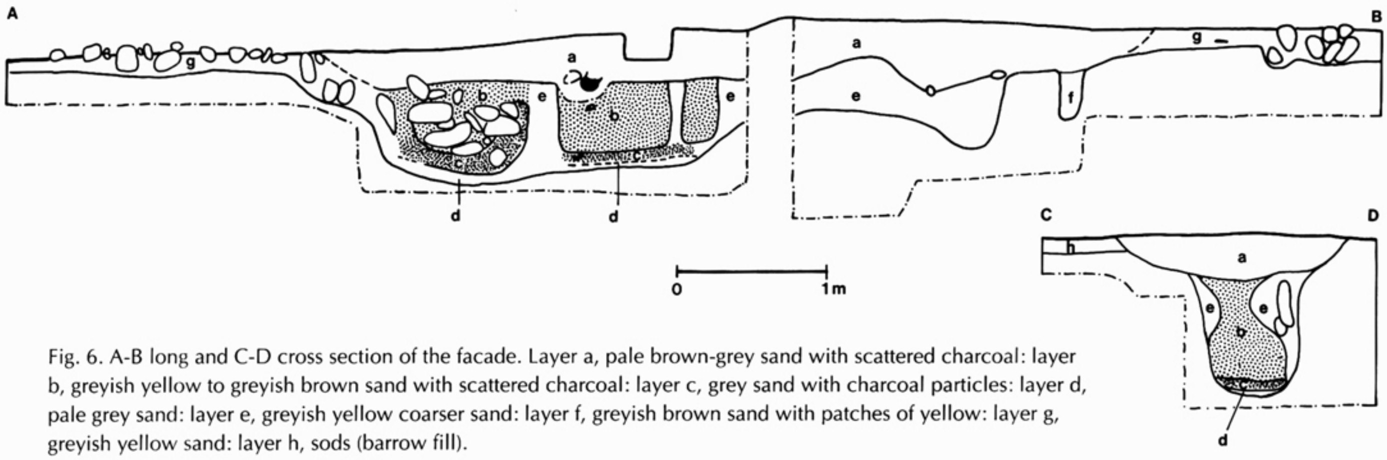


Fig. 6. A-B long and C-D cross section of the facade. Layer a, pale brown-grey sand with scattered charcoal: layer b, greyish yellow to greyish brown sand with scattered charcoal: layer c, grey sand with charcoal particles: layer d, pale grey sand: layer e, greyish yellow coarser sand: layer f, greyish brown sand with patches of yellow: layer g, greyish yellow sand: layer h, sods (barrow fill).

of variable yellow-grey earth with straight sides and flat bases. At the bottom under a 0.05–0.1 m thick layer containing charcoal can be seen a pale grey sand layer. In one of the postholes could be seen a 0.75 m wide area with grey-brown fill, probably the shadow of the post itself.

In a charcoal-rich layer at the top of the stone packing of this posthole lay the remains of three pots – a funnel beaker and one, perhaps two, lugged beakers (fig. 8).

The funnel beaker was 12 cm tall with cylindrical neck, slightly thickened rim, and round base and belly. The upper part of the body is decorated with a fringe of oblique stab-and-drag lines. Of one of the lugged beakers the body and part of the neck survive. It was very similar in shape to the funnel beaker. The body ornament consisted of a field pattern divided by sloping jab-and-drag lines under the lug and filled with horizontal rows of impressions. The body ornament was no doubt repeated on the neck. Only part of the body of the third pot survives. The ornament was carried out in horizontal rows of obliquely jabbed impressions. These pots from the facade belong to the Early Neolithic Volling group.[2]

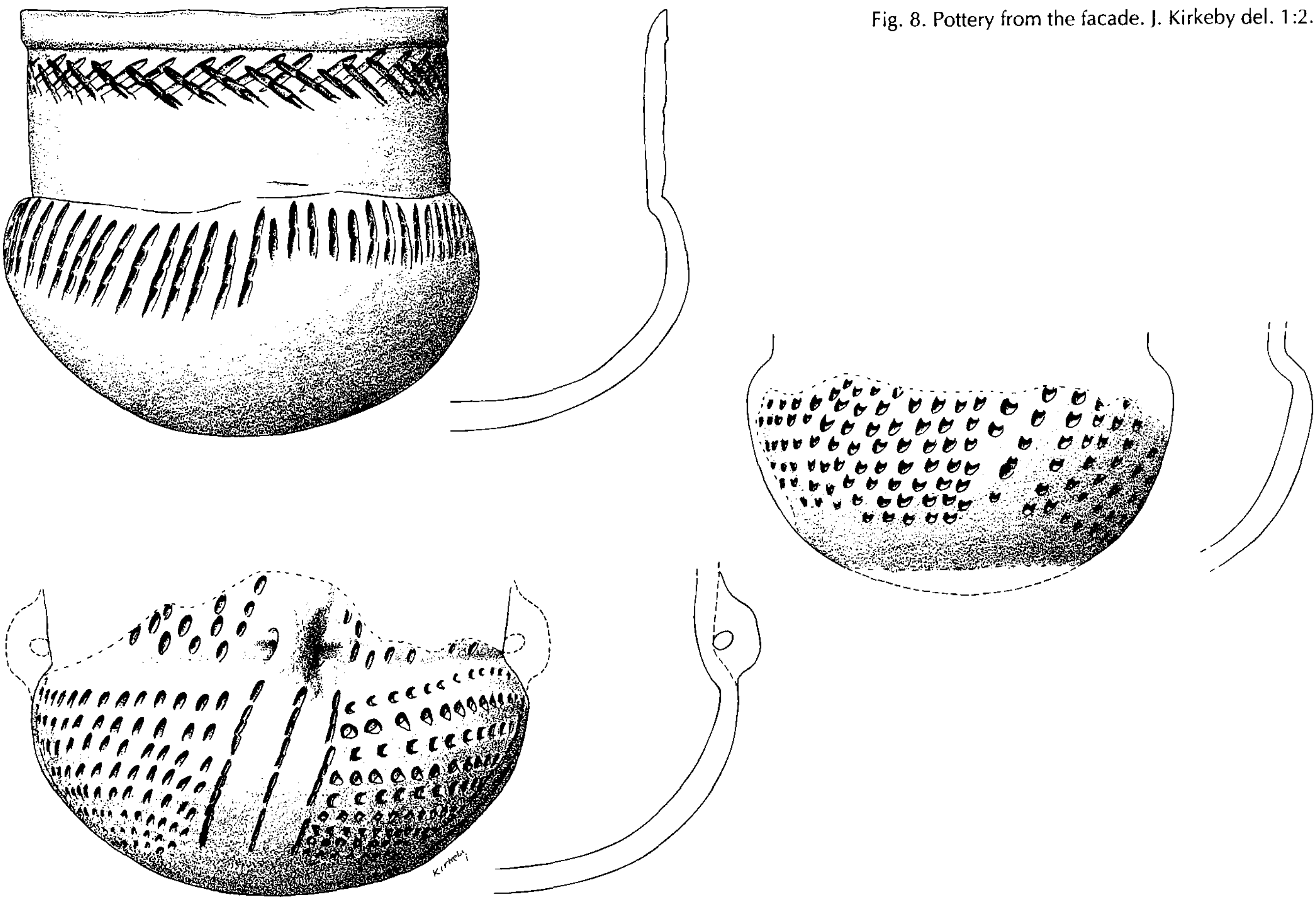
Fig. 7. Packing stones in facade postholes, seen from SE.

The facade seems not to have been deliberately burned down. Neither the stones, the earth, or the pots show marks of fire. Instead the charcoal in the postholes may have come from the deliberate surface charring of the timbers.

The stone-free ditches. These were 37.5 m long and 0.75–2.20 m wide, and followed similar courses down the hill. At the SW end they turned in towards each other without quite meeting. Sections through them (fig. 9) showed a gently rounded shape with maximum surviving depth of 0.4 m. In one place this feature was cut by the younger palisade. No finds or further details were observed in either of them. They had delimited the barrow of the first phase, and the material from them was not used to construct the barrow. There was scattered charcoal in the fill, which was taken for C14 dating.

The grave. This showed as a 4.8 m long and 1.6 m wide feature with parallel sides and stones at the ends (fig. 10). Even at the top of the grave it was possible to see thin charcoal lines from a planken cist (fig. 11), from which a sample of charcoal was taken. The fill of the grave was slumped sod fill. The heaps of stones at the ends survived

Fig. 8. Pottery from the facade. J. Kirkeby del. 1:2.



to a thickness of 0.5 m and consisted of about 35 not very large stones. There were no postholes under them, and they came to an end at the level of the grave floor. Some stones near the bottom of the heap at the SW end inclined inwards and may have supported a transverse plank.

On the floor of the grave SW of the middle lay a 26.8 cm long thin-butted axe (type IV of Nielsen, 1977) with blade pointing SW (figs. 12 and 13). Close west of this lay a transverse arrowhead (fig. 14) and close east of it a string of 30 amber beads of alternately cylindrical and prismatic shape (fig. 17). Close to the centre of the grave, probably at the waist of the corpse, lay a piece of amber with hole through the centre and 15 drilled pits along the edge. It measured 5.5 x 5 x 3 cm (fig. 15). A little west of this lay 17 smaller amber beads, probably forming a bracelet. At the NE end of the grave were found some cylindrical amber beads and a round piece with central perforation and pits around the edge (fig. 16).

Nothing remained of the corpse, but the grave goods show that a body had been buried with head at the SW end. None of the finds can be dated more closely within the Early Neolithic.

The second phase

In the following building phase there was erected a palisade, which together with the timber facade enclosed the entire monument. Within its enclosure was found at the extreme SW end a stone-lined feature measuring 2.8 x 3.3 m. There were no postholes or other details that could explain its purpose. It may have been another grave, in this case without grave goods, or a small mortuary building.

There was no sign of sod fill between the palisade and the trapezoidal feature. In fact the layers here were so thin that there was only a few centimeters to the natural subsoil. In the section could be seen a somewhat irregular layer of fill that might have been added in this phase.

The palisade. During excavation this appeared as a trench filled with field stones. Because of these the trench itself could not be seen in plan, but sectioning indicated an irregular excavation 0.15–0.7 m wide and 0.05–0.4 m deep.

There was no regular change in the feature's depth. If the tops of the posts were to be in horizontal line then the posts in the low-lying SW end would need to be taller than those in the NE, and would therefore be set more deeply in the ground. Another possibility is that the palisade's height over the ground was the same as it descended the slope. In an attempt to check the individual posts some areas were chosen for excavation in planes leaving long and cross sections. Fig. 18 shows a long section through one of the most stone-packed parts of the western palisade trench. Only a few posts could be confirmed. They were 0.2–0.3 m in diameter and up to 0.4 m deep. There was no sign of burning down or deliberate charring (fig. 19). The area enclosed by the palisade had three straight sides at right angles to each another. The NW side measured 49.5 m, the NE end 12.25 m, and the SW end 5.5 m.

The northern 34 meters of the SE side was bent somewhat outwards and enclosed also a stony area east of the grave and outside the stone-free trench. Here in a recent disturbance were found a number of undecorated sherds of Neolithic character. Nothing was observed that could explain the special purpose of this area.

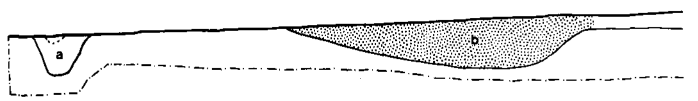


Fig. 9. Section across barrow SW of the grave. Layer a, greyish yellow sand with hand to head sized stones: layer b, pale grey sand with scattered crumbs of charcoal: layer c, sod fill: layer d, pale yellow-brown sand with coarse gravel.

Further south-west there was a gap in the trench, and outside the barrow here was found an 8 m long row of stones of various sizes running parallel with the trench. Two small postholes may together with the stones have formed part of an entrance feature.

The most southerly part of the footing trench consisted of three straight pieces giving the feature a square end.

Very little was found in the footing trench. At the NE end there were some undecorated Stone Age sherds that cannot be determined more closely.

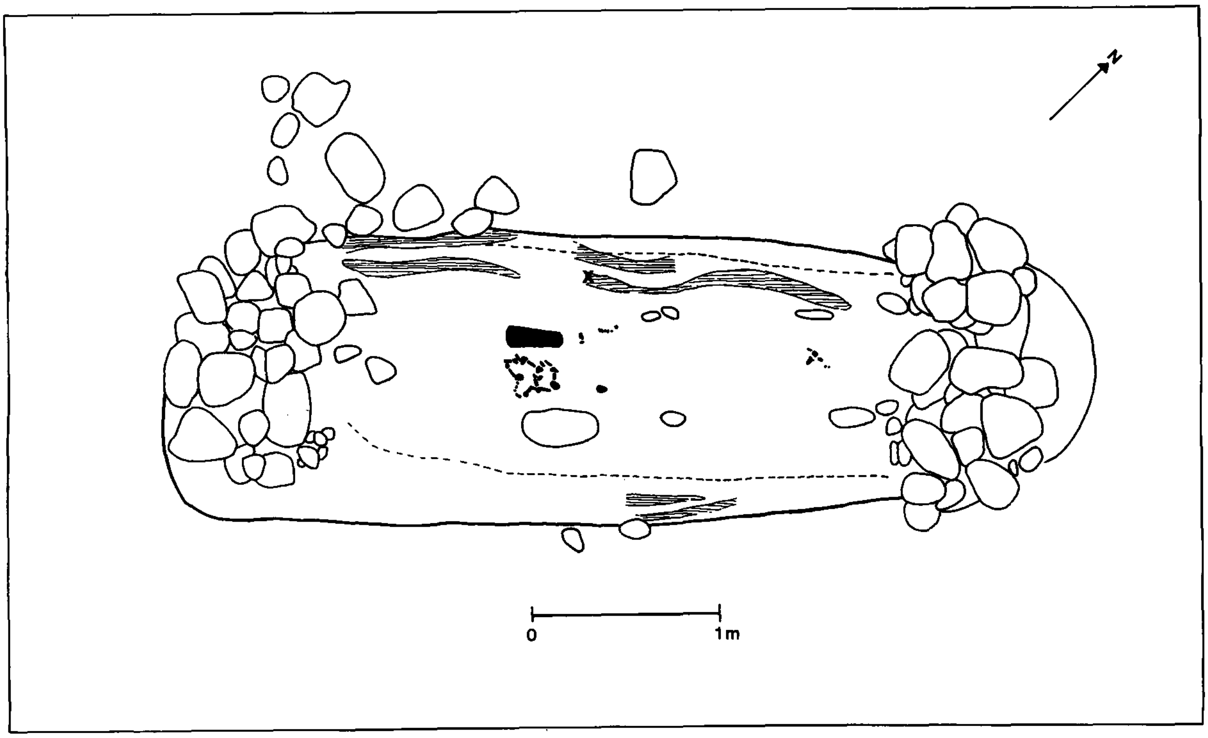
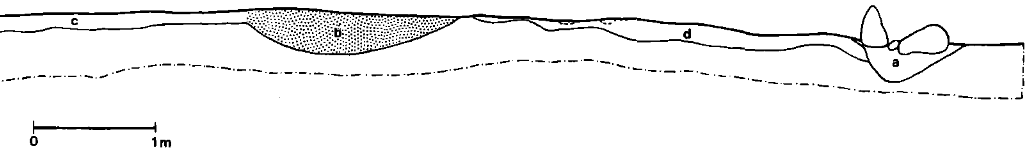


Fig. 10. Plan of grave with grave goods. The transverse arrowhead is shown by an 'x'. Traces of the wooden cist are hatched longitudinally.



Dating

From pottery found at the facade and in the fill the barrow can be assigned to the Jutland Early Neolithic local group called the Volling group. This is dated to the time bracket 3200 to 2800/2700 b.c. The small pieces of charcoal collected from the facade, the remains of the wooden cist, and in the stone-free ditches were not enough for a dating at the C14 laboratory in Copenhagen, and were sent instead for accelerator dating in Uppsala. The results were 2875 ± 140 b.c. for the sample from the stone-free ditches (UA-441), 2840 ± 115 for the sample from the facade (UA-443), and 2760 ± 115 b.c. for the sample from the grave (UA-442).

History of the monument

An attempt will be made to trace the course of events from the few stratigraphical clues.

The facade, stone-free ditches, and the grave give the impression of being on the whole synchronous, but differences in time cannot be ruled out. Here is a possible sequence.

A planken cist was inserted into the ground, and in it was placed a body with head to the SW, accompanied by personal equipment in the form of an amber necklace, amber at the belt, arrow and flint axe.

There stood or was later constructed a solid, high timber facade, at which pottery was placed as an offering.

The burial area was delimited by digging the two stone-free ditches, and the entire trapeziform area became the burial monument. Between the ditches and facade a low sod mound was raised over the grave.

Some time later, when the ditches had silted up, the palisade was raised. The little grave or building at the SW end could have been the reason for this enlargement. The NE facade had been higher than the palisade, which seems to have been built with stakes all equally high above ground.

After a time, perhaps only when the posts had rotted, there was dug near the facade and the area was cleared. The pottery that had been placed there earlier was upset and fell into the upper part of one of the postholes.

Fig. 11. Close-up of section through remains of the cist, seen from NE.

Fig. 12. The grave goods *in situ*.

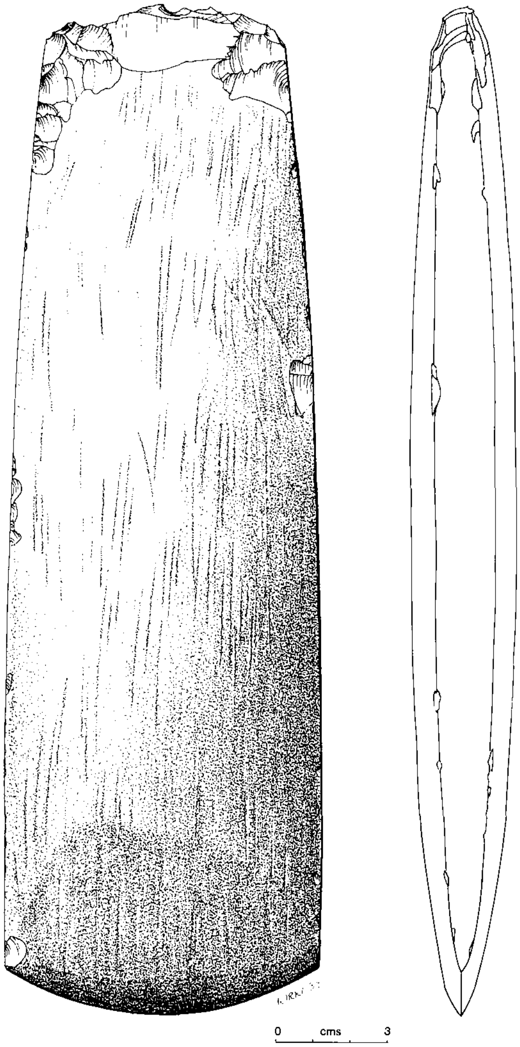


Fig. 13. Thin-butted axe. J. Kirkeby del. 1:2.

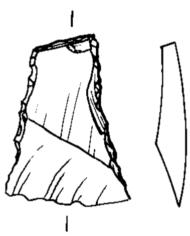


Fig. 14. Transverse arrowhead. J. Kirkeby del. 1:1.

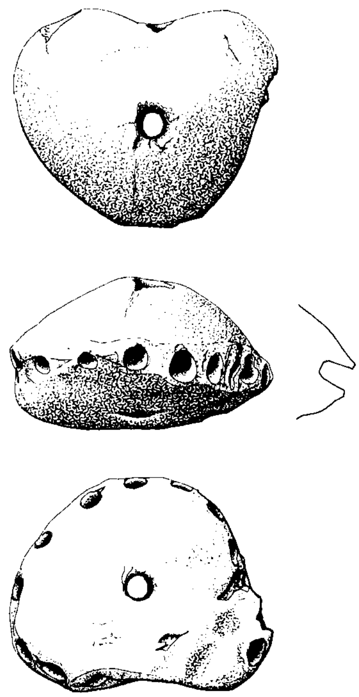


Fig. 15. Amber ornament with perforation in middle. J. Kirkeby del. 2:3.

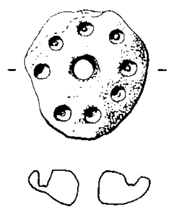


Fig. 16. The amber beads from the NE part of the grave. J. Kirkeby del. 2:3.

OTHER LONG BARROWS WITH TIMBER STRUCTURES

There is a whole series of Early Neolithic structures with features like timber facades and surrounding palisades. Those from Denmark were surveyed collectively by T. Madsen (1979).

Timber facades

Solid facades are known from 17 sites scattered over the whole country. In addition to the 14 described by F. Kaul (1988) attention should be called to Højtvedgård (no. 7) and two recently excavated facades in Thy (no. 8) and West Himmerland (no. 10).[3]

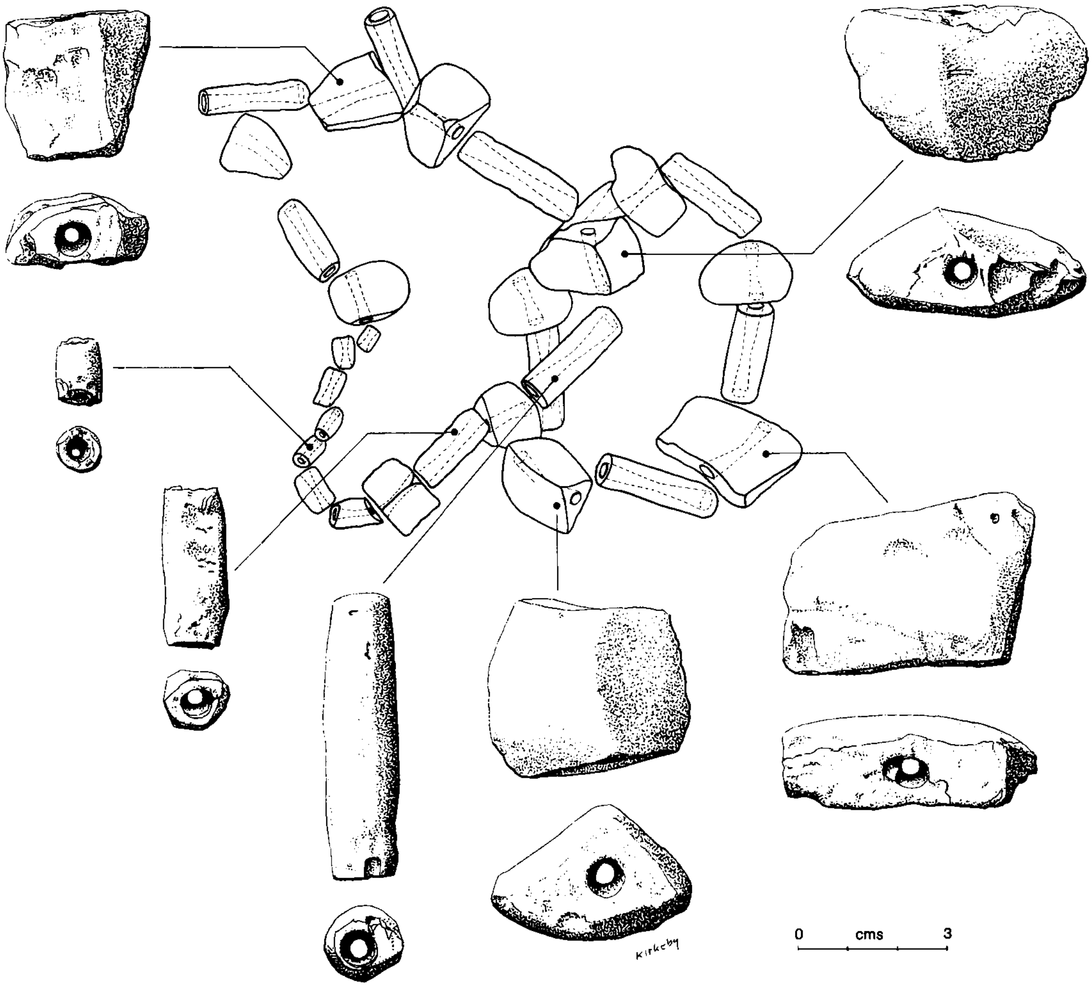


Fig. 17. The amber beads as strung. J. Kirkeby del. 2:3.

Facades are known from long barrows with and without palisade or stone kerb. The few published examples alone are enough to show there was not a uniform construction. Among other things the number of posts varied. Most palisades had four postholes in line. The facade of the barrow at Rude (no. 20) was more complicated, with multiple phases – an earlier unburnt facade with attached horseshoe enclosure, and a later facade built of seven split logs, that all were burned down (Madsen 1980, 88–96). At several sites, including Rude (no. 20) and Bygholm Nørremark (no. 26), it was shown that the facade had been burned down before being covered by the barrow. At other sites, for instance Onsved Mark (no. 1) and Højensvej (no. 6), the posts were pulled up after having served their purpose, and at Højensvej their place was covered by stones and fill. The majority of the publications do not contain information making it possible to explain when in the history of the monument the facades were erected and destroyed. F. Kaul mentions the possibility that they were raised to mark a coming barrow (Kaul 1988, 73), i.e. before burial and barrow construction.

It is quite possible that the order of construction of the different parts of the monuments was not everywhere the same. At some places the facade may have been erected first, at others it may have continued through a series of building phases, and sometimes it may have come last in the building sequence.

Most of the facades have provided pottery that is interpreted as ritual deposits. Radiometric dating of the faca-

Fig. 18. Long section in the palisade trench on NW side of feature.

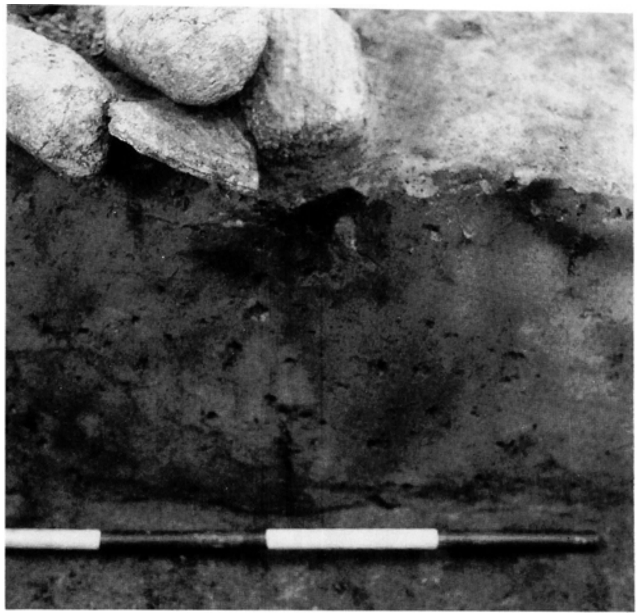


Fig. 19. Post shadows in palisade trench.

des can date the pottery and illustrate the cerámic sequence in the early Neolithic.

The facade at Lindebjerg (no. 2) is dated to 3060 ± 100 b.c. (K-1659). In connection with this structure there were found remains of four funnel beakers – three small and a large. The former had somewhat straight neck and rounded body and base. The latter had a more outward curved neck. Two of the small vessels were ornamented under the rim with respectively twisted cord and a row of jabbed impressions (Liversage 1981, fig. 24).

The facade at Rustrup (no. 23) is dated to 3030 ± 100 b.c., 3010 ± 100 b.c. (K-2254), and 2960 ± 100 b.c. (K-2253). At this facade were found two small lugged beakers decorated in surface-covering style with jabs and stab-and-drag (Fischer 1976, fig. 9a).

Rude (no. 20) provided C14 datings of 2960 ± 90 b.c. (K-3124), and 2860 ± 70 b.c. (K-3125). At the facade were found remains of three funnel beakers with outcurved neck and hemispherical body and base. Two of them measured 12–15 cm, while the third was 23.5 cm high. One of them was decorated with two rows of jabbed impressions below the rim (Madsen 1980, fig. 14).

All these pots can like those from Storgård IV be described as Early Neolithic B or non-megalithic C, and would earlier have been placed in the later part of the EN. The C14 determinations however give an earlier dating. Surface-covering decoration using combinations of various types of impressions is called the Volling style and dated to the period 3200–2800/2700 b.c., and is widespread in Jutland. The pottery from Lindebjerg would today be placed in the Svaleklint group, which was probably contemporary with Volling and is found on Zealand. At Bygholm Nørremark (no. 26) pottery of megalithic C character was found with the facade (Madsen 1979, 307). This facade is C14 dated to 2790 ± 100 b.c. (K-3473).

In the facade at Surløkke (no. 36) was found a funnel beaker with outcurved neck, rounded body with vertical fringe pattern, and round base, and thus in megalithic-C style (Sterum 1983, 40). C14 datings of pottery with vertical scored fringe on the belly from other Funnel Beaker contexts places this decoration in the period 2800–2600 b.c. (P. O. Nielsen 1984 and Andersen 1981).

At Teglværksgården (no. 31) the sherds in the facade trench included some from a funnel beaker decorated below the rim with chequerboard pattern in whipped cord (Faber 1976, fig. 4). This can be placed in the Virum style and dated to a late part of the EN.

If the radiometric datings and the pottery chronology is correct the timber facades of long barrows can be dated to the entire Early Neolithic. However there is no indication that they were erected in the Middle Neolithic.

Palisade enclosures

At seven sites, all in Jutland, the rectangular or trapeziform footing trench of a palisade was found. A rectangular palisade enclosure is known from the long barrow at Troelstrup (no. 18), where a palisade with a number of phases was found together with both wooden and megalithic chambers (Kjærum 1977, fig. 1). In the southern part of the trench lay a large plain lugged jar (Kjærum 1977, fig. 6). The relative dating of this monument is 2800/2700–2600 b.c.

Trapeziform palisade enclosures are known from Bygholm Nørremark (no. 26), Teglværksgården (no. 31), Harreby I (no. 32), Harreby II (no. 33), and Surløkke (no. 36). Three of these monuments were small (nos. 31, 32, 36), between 14 and 27 m long and 1.5 to 5.5 m wide. No grave was found inside them. They may be a special south Jutland variant datable to the last part of the EN. The recently excavated site Harreby II (no. 33) revealed a trapeziform outline of not very large stones, which may also have lain in a foundation trench (Jørgensen 1986, 12–13). The largest trapeziform structures is the one from Bygholm Nørremark (no. 26), which was a 60 m long and 4–13 m wide enclosure surrounding graves, mortuary houses and facade (Rønne 1979, 5).

At Mosegården (no. 21) there were two parallel very long footing trenches in which there could be observed traces of large split posts (Madsen and Petersen 1984, figs. 17–21). The trenches are C14 dated to 3130 ± 90 b.c. (K-3463) and 2940 ± 90 b.c. (K-3464). Inside the enclosure were found secondary megaliths below which were Early Neolithic settlement remains with pottery decorated in Volling style (Madsen and Petersen 1984, figs. 17–21).

Palisade enclosures are thus found during the whole Early Neolithic. It is not known why the palisades had different shapes, but it should be noted that at Storgård IV it was more important to enclose the area east of the grave than to adhere to a rectangular form.

Ditches and trenches

Round-sectioned stoneless ditches bordering a barrow in one of its phases have not earlier been recorded in Denmark.

Slightly waisted ditches 12 m long and 1.4–1.5 to 3–4 m wide north and south of one of the graves at Hejring are mentioned by T. Madsen (1979, fig. 3b). Inside the ditches outside the grave stood a large plain lugged jar and a large plain lugged beaker. C14 datings of the grave give an average dating of 2655 b.c. ± 100 (K-2194–2197).

It is perhaps only a matter of time before other monuments with ditches turn up in Denmark. T. Madsen and F. Kaul point to the many similarities existing between the Danish and the English long barrows. In England many long barrows with flanking ditches are known, and these are sometimes very large and deep with U-shaped section. The ditches lie outside the palisades and are interpreted as quarry ditches dug to obtain material for the mounds (Ashbee 1970, 47).

Grave types in the Early Neolithic long barrows

The Early Neolithic long barrows contain one or more graves. These can be situated near the facade or anywhere along the axis. Many of them are so badly preserved that nothing can be said about their original construction. The determinable graves fall into the types, Konens Høj, Troelstrup, closed graves set around with field stones, regular plank cists, and simple earth graves.

Type I. The Konens Høj type. The graves show up as long narrow features with a round or elongated posthole at each end and sometimes also have rows of field stones along the two sides. The end-pits can, as at the eponymous site, go deep into the subsoil, as much as 1.2 m under the grave floor (Stürup 1966, 15).

Today 16 graves of Konens Høj type are known. Most of them were found at sites where a long mound or an occupation layer was recorded, or at least there is information that a low mound was present. When found under long barrows they have been orientated parallel with it, and lay nearly always E-W (nos. 3, 19, 25, 26, 35).

The Konens Høj type is found throughout Jutland from the Danish/German border to the Randers area. New excavations from the islands show they were in use there at the same time. They are sometimes reconstructed and described as tent-shaped structures of temporary nature and were sometimes destroyed by burning or by pulling out the posts (Madsen 1972, 138).

Various criticisms have been directed at this reconstruction. D. Liversage considers that the graves were built of wide planks at the ends and sides. His illustration suggests that the end planks inclined inwards and the side planks were supported by fieldstones (Liversage 1983, fig. 7).

Most recently F. Kaul discusses the possibility that the end posts were removed before the burial, and there therefore can be no question of tent-shaped graves (Kaul 1988, 75). As nearly all graves of Konens Høj type were excavated before the type was recognized as such, it is difficult to reconstruct the sequence of events at them. The presence of both long and round postholes might indicate that there was more than one form.

The Konens Høj type is C14 dated at the eponymous site to 2900 ± 100 b.c. (K-919). Pottery from others, among them Ravning Mark (Ebbesen and Mahler 1980, fig. 27) points to a Volling dating in 3200–2800/2700 b.c., while the pottery from Barkær (Glob 1949, fig. 7) shows a later use. No finds pointing to the Middle Neolithic have been occurred in these graves.

Type 2. The Troelstrup type. Graves of this type have a three-sided burial chamber open at one end. They are built of wood or of wood combined with stones. Sometimes there is a little passageway or "antechamber" in extension of the entrance.

At the present time 15 graves can be assigned to this type with considerably certainty. Nearly all are recorded in long mounds (nos. 2, 11, 13, 14, 15, 17, 18, 33, 34). It is highly probable that all graves of this type were originally under long mounds. Most of the known examples are placed at right angles to the mound and have their entrance facing one of the sides.

Graves of Troelstrup type are found especially in northern Jutland, but are known from south Jutland and presumably also from Zealand.

The graves seem to fall naturally into older and younger sub-types.

Type 2a. Wooden graves of Troelstrup type. These were built of wood only, which stood in a trench packed with small stones. The C14 dating of Rustrup feature II is the earliest dating of an Early Neolithic grave – 2970 ± 100 (K-2355). Pottery found in the fill is decorated with twisted cord impressions or surface-covering jabbed patterns (Fischer 1976, figs. 40–46).

Lindebjerg's feature B may have been a comparable wooden burial chamber, and was reconstructed as such by the excavator (Liversage 1983, fig. 5).

Type 2b. Graves built of wood and stone of Troelstrup type. The younger type, which is known from for instance Østergårds Mark, Hejring, and Troelstrup (Madsen 1979, fig. 2), consisted of an internal three-sided wooden construction as much as 1 m high with wooden covering and a little wooden passage. They were supported externally by a piled heap of fieldstones. At Østergårds Mark the transition from passage to grave was marked by a row of stones.

C14 datings date the grave type to 2655 ± 100 b.c. (Hejring, K-2394–2397) and a similar date is suggested by the sequence of graves at Troelstrup. It appears that the type may have continued into the Middle Neolithic. At Harreby (II) together with a number of early dolmens was found a three-sided feature of heaped field stones, in which was a lugged beaker from MN I (Mathiassen 1942, figs. 5–6 and Jørgensen 1986, 11).

Type 2c. Stone-built burial chamber with wooden cover and "antechamber". This type is only known from a small number of sites, among which the Skibshøj long mound is the best preserved. The grave was constructed on three sides out of fairly large stones on which more stones had been heaped in several layers. The floor was paved, and the paving continued out through the opening at the end. Where it terminated there were found two postholes which together with the rear wall of the grave must have supported the large planks that roofed the chamber and "antechamber" (Jørgensen 1977, 8–9).

Type 2c cannot yet be dated more closely within the Early Neolithic.

Type 3. Closed graves surrounded by stones of limited size. These appear as surrounding stones in one or more courses. A high example is seen in grave 6 of the Ølstrup barrow (Mathiassen 1936, figs. 7–9) and a low one occurs at Bygholm Nørremark (Rønne 1979, 5).

This is the commonest of the Early Neolithic grave forms, being known from at least 22 sites, of which only a few were found underneath long barrows however (nos. 5, 7, 12, 27, 28, 30). They are found all over Denmark.

Although wood has not been found in these graves it may be assumed that they consisted internally of a wooden cist.

Graves of type 3 resemble graves from many other archaeological periods and are only datable if grave goods are present. They occur also in the Middle Neolithic.

Type 4. Planken coffins. The closed rectangular planken coffin is only known from Bygholm Nørremark (Rønne 1979, 6). The planks survived as thin lines in the soil. There were supporting stones at the ends.

There were no grave goods in this grave, which contained the remains of four skeletons, but the stratigraphy of the site indicates a placing in the Early Neolithic.

Type 5. Simple burials. The simple burial without stones or indications of construction is found occasionally, both under barrow (no. 6, 22, 23, 24, 28) and under a level surface.

Sometimes a feature is revealed as a grave only by the grave goods. An example is Rustrup feature I. In a small, scarcely visible soil change was found a polygonal battle-axe, two transverse arrowheads and a waisted amber object (Fischer 1976, figs. 4, 35, 36).

Graves of this type belong presumably to the whole Neolithic period.

SUMMARY AND CONCLUSION

The long barrow, Storgård IV is one of a series of Early Neolithic structures with timber facades and surrounding palisades. It was erected in more than one phase, and as a new element in our knowledge of the Danish long barrows had flanking ditches in the first of them. Facade and ditches together formed a trapeziform structure.

The construction of the grave is not exactly matched in the other Early Neolithic monuments, but is no doubt closest to the planken cist in the Bygholm Nørremark barrow. The palisade enclosure was constructed in the second phase and surrounded a grave or mortuary house. It had three rectangular sides.

The pottery from the mound fill and the facade places the monument in the Jutland Volling group, the time bracket of which is 3200–2800/2700 b.c.

If the long barrows with wooden features are regarded as a whole it is striking how much variation there is in the construction and size of facade, palisade, and fill.- Nevertheless an overriding idea finds expression in the depositions of pottery at the facades and palisades. Pottery and C14 dating show that facades were in use throughout the Early Neolithic, and the use of palisades can have been equally long. At present timber facades are known from the whole country, but palisades have so far only been found in Jutland. Future excavations will show whether genuine regional groupings lie behind this.

In most of the barrows in question there were found graves of the types described above. It can be seen that the Danish term "simple jordgrave" is a poor description. All except the ordinary pit graves contained a wooden structure that was a tent-shaped, plank-built, open, or closed cist or chamber. These forms were in use before and alongside the earliest types of dolmen. Only the Konens Høj type does not continue into the Middle Neolithic. Thus they were not merely the predecessor of the dolmen, but were an independent grave form.

It can be argued that all the graves of Konens Høj and Troelstrup type were originally situated in long barrows, whereas the other types can be found as well under a level surface. The two types each has its main area of distribution – the Konens Høj type especially in south and east Jutland, and the Troelstrup type in northern Jutland. Future excavations will show if this picture is correct.

The Danish monuments dealt with here should be seen as part of a common north European burial tradition extending from England in the west to Poland in the east (see distribution maps, M. Midgley, 1985, fig. 4 and Ashbee 1970, fig. 1–2). In all of this area the long barrows had certain features of layout in common.

The Danish barrows are most often compared with the English, which is not fortuitous considering the many points of similarity between them such as facades, palisades, shape, and now also flanking ditches. However it is hard to imagine direct mutual exchange of ideas between the Neolithic inhabitants of Denmark and England.

It is more likely that the tradition of erecting long barrows came to Denmark via the area south of the Baltic and Schleswig-Holstein, where the pottery is supposed to have its parallels despite the discrepancies in the C14 dates. The pottery development in the early part of the Funnel Beaker culture is explained today by supposing that the Jutland Volling style was inspired indirectly by the Rössen-derived Dümmer pottery, while the Zealand and Scanian Oxie style was derived from Sarnowo-Berlin Britz (Madsen and Petersen 1984, 106). There were two areas stimulating the development of the pottery.

Perhaps the spread of the long mounds followed the same channels and is shown by the different grave forms. In this case the area south of the Danish/German border will be found important for understanding the burial custom in Jutland, while the area south of the Baltic will be found important for the east Danish and Scanian area.

Unfortunately only a few excavated long barrows are known today from Schleswig-Holstein, Niedersachsen, and Zealand-Scania. If observations made in Jutland are applicable elsewhere, the barrows with timber structures and graves may lie under those with megaliths. Until more is known about this, no answer can be given to the question of the origin of early long barrows in Denmark.

Translated by David Liversage

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NOTES

1. VSM 445 E, Storgård IV, Fjelsø parish, Viborg county. Sb 119. Excavated in June/July 1986. Financial support from Naturgas Midt-Nord. Reconnaissance, Jytte Nielsen. Excavation participants, Bodil Nørgård, Hugo Sørensen, Margit Bagger Larsen, Martin Mikkelsen, Kirsten Christensen, Niels Milan Petersen, Hans Ulrich Kleiminger. Thanks are due to Mette Iversen, Viborg Stiftsmuseum, and Torsten Madsen, Institute of Prehistoric Archaeology, University of Aarhus.
2. See Ebbesen and Mahler (1980), Madsen and Petersen (1984), and P. O. Nielsen (1985).
3. The timber facades at Bjørnsholm and Kappelshage are unpublished. Thanks are given to Erik Johansen, S. H. Andersen, and Martin Mikkelsen for allowing their inclusion.

Appendix

List of Early Neolithic long barrows in Denmark:

1. **Onsved Mark**, Skuldelev parish, Frederiksborg county (Kaul 1988).
2. **Lindebjerg**, Tømmerup parish, Holbæk county (Madsen 1979, no. 29; Liversage 1981; Midgley 1985, DNK-8).
3. **Asnæs Forskov**, Årby parish, Holbæk county. (Gebauer 1990).
4. **Vedskølle**, Herfølge parish, Præstø county (Thorvildsen 1941, no. 128–129; Brøndsted 1957, p. 191; Kaul 1988).
5. **Stengade I**, Tullebølle parish, Svendborg county (Skaarup 1975; Madsen 1979, no. 28; Knöll 1976, 83A; Midgley 1985, DNK-18; Kaul 1988).
6. **Højensvej**, Egense parish, Svendborg county (Thomsen 1987; Kaul 1988).
7. **Højtvedgård**, Mygdal parish, Hjørring county (Knöll 1976, no. 1; Madsen 1979, no. 1).
8. **Kappelhage**, Stagstrup parish, Thisted county (unpublished, excavated 1988 by M. Mikkelsen).
9. **Tolstrup**, Næsborg parish, Ålborg county (Madsen 1975, 1979, no. 2; P. O. Nielsen 1985, no. 37; Midgley 1985, DNK-21).
10. **Bjørnsholm**, Ranum parish, Ålborg county (unpublished, excavated 1988 by S. H. Andersen and E. Johansen).
11. **Den svenske stald**, Giver parish, Ålborg county (S. V. Nielsen 1943; Knöll 1976, no. 25).
12. **Engedal**, Daugbjerg parish, Viborg county (Jensen 1985).
13. **Skibshøj**, Vroue parish, Viborg county (Jørgensen 1977; Madsen 1979, no. 9; Midgley 1985, DNK-17).
14. **Sjørup Plantage**, Vroue parish, Viborg county (Jørgensen 1977; Madsen 1979, no. 8; Midgley 1985, DNK-16; Kaul 1988).
15. **Østergårds Mark**, Vellev parish, Viborg county (Madsen, 1972, 1979, no. 10, 1984; Knöll 1976, no. 31a; Midgley 1985, DNK-12; Kaul 1988).
16. **Storgård IV**, Fjelsø parish, Viborg county (Kristensen 1987; Kaul 1988).
17. **Heiring**, Klejtrup parish, Viborg county (Madsen 1979, no. 5; Midgley 1985, DNK-7).
18. **Troelstrup**, Vester-Tostrup parish, Viborg county (Kjærum 1977; Madsen 1979, no. 4; Midgley 1985, DNK-22).
19. **Barkær**, Feldballe parish, Randers county (Glob 1949, 1975; Brøndsted 1957, p. 172–74; Madsen 1979, no. 12; Knöll 1976, no. 41B, 1981, no. 27; Midgley 1985, DNK-2; Kaul 1988).
20. **Rude**, Saksild parish, Århus county (Madsen 1979, no. 19, 1980; Midgley 1985, DNK-13; Kaul 1988).
21. **Mosegården**, Søvind parish, Skanderborg county (Madsen 1979, no. 20; Madsen & Petersen 1984; Midgley 1985, DNK-10).
22. **Fredensholm**, Tåning parish, Skanderborg county (Frederiksen 1975).
23. **Rustrup**, Them parish, Skanderborg county (Fischer 1976; Madsen 1979, no. 15; Knöll 1981, 32x; Midgley 1985, DNK-14; Kaul 1988).
24. **Salten Abildgård**, Them parish, Skanderborg county (unpublished, excavated 1947 by C. L. Vebæk).
25. **Salten Langhøj**, Them parish, Skanderborg county (Becker 1947; Madsen 1979, no. 17; Midgley 1985, DNK-15; Kaul 1988).
26. **Bygholm Nørremark**, Hatting parish, Vejle county (Rønne 1978, 1979; Madsen 1979, no. 21; Midgley 1985, DNK-4; Kaul 1988).
27. **Ravning Mark**, Bredsten parish, Vejle county (Ebbesen & Mahler 1980; Kaul 1988).
28. **Ølstrup**, Ølstrup parish, Ringkøbing county (Mathiassen 1936; Thorvildsen 1941, no. 89; Madsen 1979, no. 14; Midgley 1985, DNK-11).
29. **Lomborg**, Lomborg parish, Ringkøbing county (Johansen 1917; Thorvildsen 1941, no. 83; Madsen 1979, no. 14; Knöll 1981, no. 35; Midgley 1985, DNK-9).
30. **Sædderup**, Nørre Skast parish, Ribe county (unpublished, excavated 1890 by A. P. Madsen).
31. **Teglværksgården**, Varde parish, Ribe county (Faber 1976; Madsen 1979, no. 22; Midgley 1985, DNK-20; Kaul 1988).
32. **Harreby (I)**, Sønder-Hygum parish, Haderslev county (Rieck 1982; Madsen 1979, no. 24; Midgley 1985, DNK-6).
33. **Harreby (II)**, Sønder-Hygum parish, Haderslev county (Mathiassen 1942; Jørgensen 1986).
34. **Gelsbro**, Gram parish, Haderslev county (Rieck 1984; Jørgensen 1986).
35. **Vedsted**, Vedsted parish, Haderslev county (Madsen 1972, 1979, no. 25; Knöll 1976, no. 61; Midgley 1985, DNK-23).
36. **Surløkke**, Dybbøl parish, Sønderborg county (Sterum 1983; Midgley 1985, DNK-19; Kaul 1988).

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Bronze Age Houses at Hemmed Church, East Jutland

by NIELS AXEL BOAS

At the end of the 60's and during the 70's the dwellings of the late Stone Age and Early Bronze Age population became known for the first time as a result of settlement excavations in Jutland (J. Jensen 1988, 155–74). The Djursland peninsula made its contribution in 1971–72 with the excavation of the mid-ridged houses at Egehøj, which lay a good half kilometer NW of the village of Hemmed (N. A. Boas 1980, 1983). In 1968 part of a post-built house from the early Late Neolithic was excavated at Svapkæret, about two kilometers east of Hemmed (N. A. Boas 1986). In 1974 a little house was excavated at Hemmed bog about 2 km west of Hemmed and was with some caution given a date in the Early Bronze Age (N. A. Boas 1980) (fig. 1).

The present article is a preliminary report on the excavation of a new settlement near Hemmed Church. Conditions of preservation were particularly good owing to the presence of a sealing layer of aeolian sand, which had been deposited in prehistoric times. It produced one of the largest and best preserved houses known from Denmark's Bronze Age.

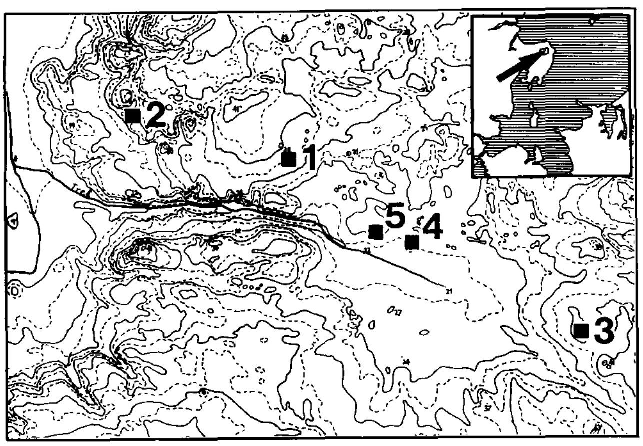


Fig. 1. Settlements excavated near Hemmed. 1. Egehøj (Early and Late Bronze Age). 2. Hemmed Kær (Early Bronze Age). 3. Svapkæret (Late Neolithic A). 4. Hemmed Plantation (Late Neolithic A and C and Late Bronze Age). 5. Hemmed Church (Late Neolithic C and Early Bronze Age).1:24.000.

One of the effects of sandy soil is to encourage afforestation, and this is what brought about the present excavation in 1987. The site is c. 200 m E of Hemmed Church.[1] Modern forestry often causes serious disturbance. One way it does this is by removing tree stumps by machine. Excavators of sites with tree pits know how much damage this can do. When a tree is uprooted by the wind or a machine the archaeological evidence is often destroyed over an area of several m^2.

THE EXCAVATION

An area measuring about 800 m^2 was opened in the corner of a field in process of afforestation. Concentrations of burnt stones had earlier been observed there, and a little Bronze Age pottery and flat-flaked flint had been collected. The excavation was supported by rescue funding from the Office of the State Antiquary.

In 1987–88 remains of four houses were found, representing settlement from the Late Neolithic/Early and Middle Bronze Age. The eastern end of house I had been sealed shortly after abandonment by a layer of blown sand that was originally nearly a half meter thick. Dune formations more than a meter high can be seen in the forest only 100 m N and NE of the site. In 1988 a test excavation in Hemmed Plantation about 150 m to the east also revealed a layer of blown sand up to a half meter thick, in this case sealing a Late Neolithic occupation layer with 2–3 houses.[2]

In the following we will concentrate on describing the large long-houses from the middle of the Bronze Age, house I, only dealing briefly with the three other houses as the excavation is not yet completed.

THE LATE SETTLEMENT

House I, a large dwelling house from the middle of the Bronze Age

Fig. 2. Above: Plan of houses I–II and associated structures. Horizontal hatching indicates accumulations of cooking stones with blackened earth; vertical hatching shows clay floors; dotting indicates sand layers that continue in under the clay floor; hearths are indicated by heavy stippled lines. 1:200. - Below: Section through house I. 1:200.

Fig. 3. House I. Line of wall posts (right). Sand deposits are seen in the holes for the roof posts and the cooking pits inside the house.

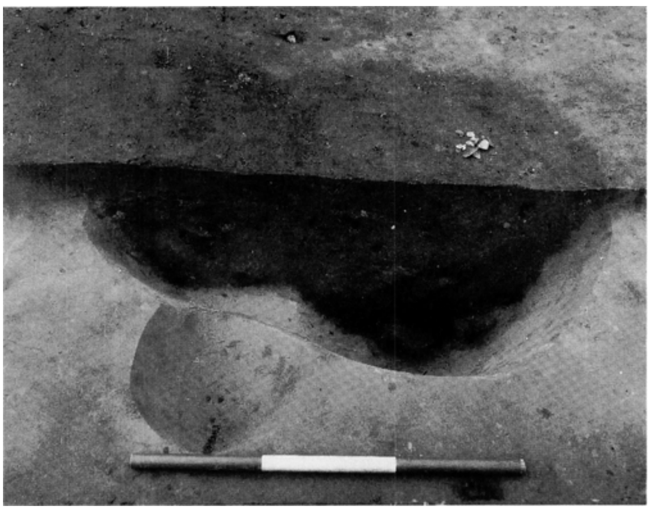


Fig. 4. E-W section through two cooking pits north of the fireplace in the western room of house I. Seen from N.

The mechanical removal of the plough layer followed by careful cleaning revealed the outline of a rectangular three-aisled longhouse measuring 30 x 10 m with rounded corners (fig. 2). The wall and roof posts were visible in the occupation layer up to 0.2 to 0.3 m above the natural subsoil. Apparently the blown sand had been deposited shortly after the house was abandoned. The result was that it could be seen in the top of almost every posthole.

It seems that the posts at the east end of the house were still present during the sand-blow and caused a protective blanket of sand about 0.3 m thick to settle over the house.[3] The house wall showed up as a row of dark humic patches against the pale yellow blown sand (fig. 3).

House I lay E-W turned towards NW-SE. The walls were straight rows of posts at intervals of 0.4 m. None of them penetrated through the occupation layer into the natural subsoil as they were only c. 0.2 m deep. They would not have been observed if the occupation layer had been cleared away by machine, and cultivation would have destroyed them if it were not for the protective layer of blown sand. In the exact middle of the north wall was seen an entrance, with the holes for the jambs, which were drawn half a meter inwards into the house. The eastern post went down a full half meter below the occupation layer and may have held a door. Half way between this central door and the west end was another-similar entrance. The line of posts of the ends and north wall was flanked on both sides by a belt of dark grey humic sand altogether about a meter wide. As a layer this was so thin that it could not be recorded in section, but it may nevertheless be presumed to be the lower part of an earthen panel, perhaps of sods, supporting the shallow wall of posts.

A line of mould at most 5 cm wide joined together the outer sides of six wall posts in the south wall nearest the house's SW corner. Alongside and up to 1,5 m outside the south wall in the same area was found most of the burnt daub recovered during the excavation. It amounted to 1.2 kg of sand-tempered, red-fired burnt clay. Some of the pieces had been exposed to a temperature so high that they were blistered and slaggy with a blueish glassy surface. A few pieces have definite impressions of withies c. 2 cm thick. A few retain a flat, rough, wiped "wall" surface. Unfortunately the SE corner of the house could not be investigated as it had been dug away in 1911, and parts of the south wall are incomplete.[4]

Fig. 5. Cooking-stone pits in middle room of house I. The middle cooking pit and two roof posts are seen in section.

Fig. 6. N-S section of east end of house I. The north wall and interior are on the right of the picture seen from W.

Internal arrangements

The internal bearing construction of the house was 8 pairs of roof posts giving a 5 m wide central and two 2.5 m wide lateral aisles. The holes for these posts were c. 0.4 m in diameter and 0.7 m deep. Usually a half score or so of fist-sized cooking stones had been placed as lining at the foot of the post. The distance separating each pair of holes from the next in the six middle sets was 2.5 m, and the distance to the end pairs was 4 m. Traces of digging to put in replacements was observed in several places. The house had been divided into three rooms by means of two solid partition walls. The western one was placed at the third pair of roof posts by the addition of five extra double posts. A similar eastern partition, apparently of single posts, was seen at the second-last pair of roof posts. The posts of the partition walls were a little smaller than the ones holding up the roof and lacked the base linings.

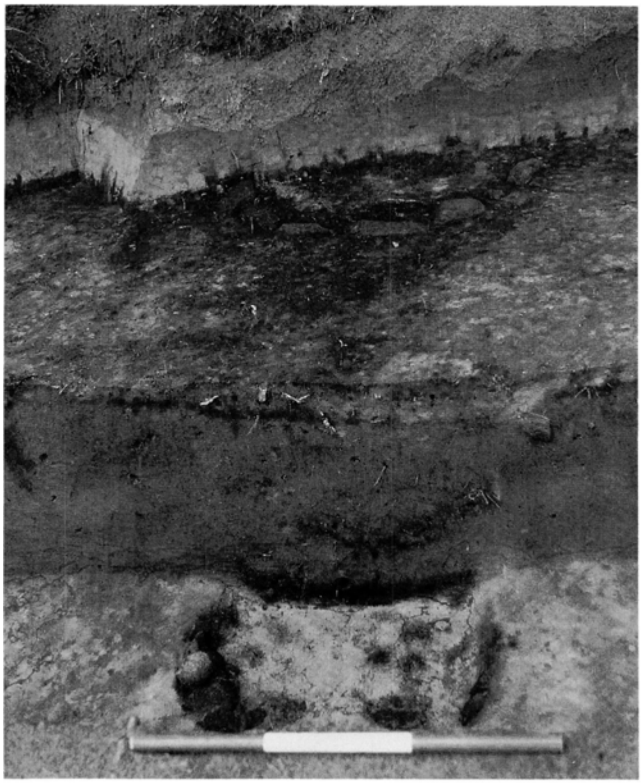


Fig. 7. E-W section through E end of house I. From above, section through modern plough layer and blown sand; then in plan the fireplace surrounded by occupation layer and the clay floor, which cut through the section through the cooking pit north of the hearth. Seen from N.

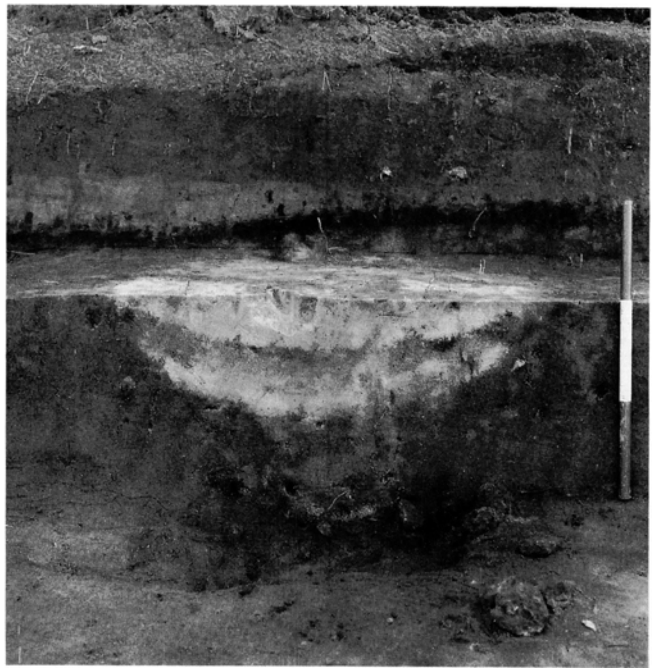


Fig. 9. E-W section through pit west of hearth in eastern part of house I. The pit seems like the fireplace to have had a deposit of whitish-yellow sand added, covered again by yellow blown sand. Seen from N.

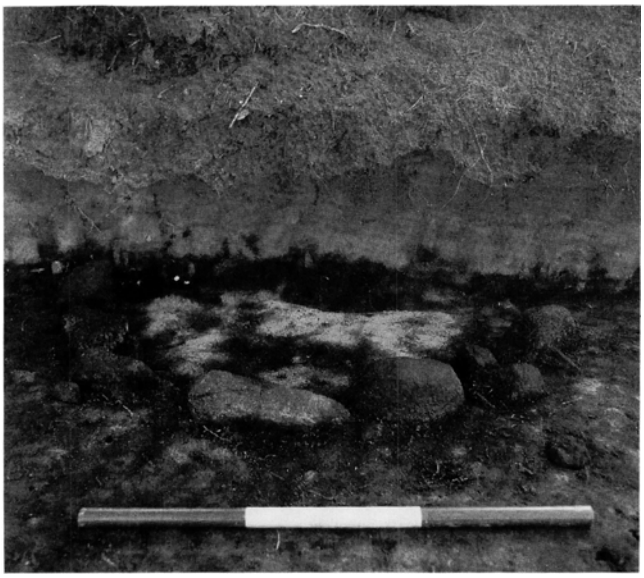


Fig. 8. Stone fireplace in eastern part of house I. Basal layer of coarse whitish-yellow sand. Seen from N.

Fig. 10. Ard marks under the middle room of house I. Seen from ESE.

The western room

The western part of the house was not as well protected by blown sand as the eastern part. This room measured nearly 110 m^2. It had its own entrance from the north, and possessed a clay floor, remains of which were preserved where they had subsided west of the northern roof post in the partition wall. The rest had been ploughed away. Midway between four roof posts was seen a reddish patch of sand 3/4 of a meter across, which must be the very bottom of a hearth.

Around the hearth were five single cooking pits and two groups of respectively two and four intersecting pits. The pits excavated so far are nearly round, about 0.8 m in diameter and nearly 1/2 m deep with rounded base covered by a scattered layer of fire-cracked stones the size of a fist (fig. 4). The fill is uniformly speckled and without stratification apart from being blacker at the base. A thin layer of cooking stones extended across the SE part of the room between the wall and the roof-posts. This and the three circular cooking-stone hearths 0.4 to 0.7 m wide in the same area can have belonged to the floor layer of the house.

In the SW corner, connected with roof post and wall line, and also 2.5 m outside the wall, were seen pairs of elongated doublepost/plank holes. The three sets of planks clearly formed N-S rows. Two corresponding sets were aligned E-W, of which the westerly pair lay between the south-western roof post and the end-wall. The fill in the "plank-holes" was indistinguishable from that in the holes for the roof-posts. These still unexplained pairs of planks belong stratigraphically to the house. So the SW corner of the house may have possessed a couple of-separate folds or stalls.

The central room

The 120 m^2 central room was bounded on the east and west by the partitions already described, and the entrance was from the north; only the most eastern part of this section was covered by blown sand. The south wall was incompletely preserved, what had not been removed by recent disturbance being obscured by tree roots, burrows, and earlier occupation (houses II and IV). The few features belonging to the room were, apart from the six free-standing roof posts, three cooking pits in its northern part and a cooking-stone hearth near the middle. The cooking pits had the same shape and size as those in the western room, but differed in being filled entirely with cooking stones. The one between the two northern roof posts had, like many of the postholes, blown sand in its central part (fig. 5). This may mean the pit was open when the sand was deposited. Of the apparently completely flat floor surfaces, that in the middle room was raised about 5 cm above the clay floors of the eastern and western rooms. The postholes that were investigated in the middle section of the house contained charred cereal grains.

The eastern room

Only about half of the originally 70 m^2 room survived, but this part of the house was sealed under the blown sand that was also recorded in many of the pits and postholes. Below this was found, underneath a dark brown humic sand layer only a single centimeter thick, a 2–3 cm thick floor layer of yellow stamped clayey material, filling the space between the partition wall and the last roof post. This came to an abrupt end 0.8 m from the posts of the north wall (fig. 6). The floor was laid on a 5 cm thick layer of coarse, slightly humic sand, that bounded the clay floor in a 0.5 to 1 m wide belt to the north and west (cf. figs. 2 and 6). This had been placed partly on old cultivated soil with ard marks and partly over a natural hollow a half meter deep and 8 m across, which was more or less filled when house I was built (fig. 7 and 2, section).

Midway between the last four posts was a round hearth. This was surrounded by an approximately meter wide circle of head-sized stones (figs. 2 and 8). Pieces of charcoal lay in and near the hearth (see contribution by C. Malmros, this volume). Two cooking pits were investigated close north and west of the hearth. Their size was the same as that of the pits in the western room, but the northern one was 0.6 m deep and had a nearly flat base on which there rested only a few cooking stones. It was quite clearly sealed by the clay floor, which had subsided a couple of centimeters into it (fig. 7). The pit may have been in use during the lifetime of the house and then been filled up and the floor replaced. The charcoal, which was concentrated in the bottom 5 cm shows, just as with the hearth, that a wide variety of woods were used as fuel (see C. Malmros' article, A19). Charcoal from the hearth and the pit have been C14 dated respectively to 1000 and 985–940 B.C. calibrated (K-5169, K-5170).[5] The slightly smaller pit west of the hearth seems like the hearth to have had placed in it a layer of yellow subsoil sand, and shortly afterwards to have been finally filled up by the blown sand (fig. 9).

A shallow hollow 1.5 m across was associated with one of the last roof-bearing posts and like it had yellow blown sand as the top layer in its fill. The bottom part was filled with cooking stones in red-brown humic and carboniferous material fully 10 cm thick.

Directly under the floor a 3.5 x 1.5 m rectangular structure showed up, made of at least 12 small stake or post holes. This structure had been placed between the northern roof posts and the northern edge of the floor and seems to have abutted against the partition wall. The structure can be interpreted as the remains of a bench, bed, or other furnishing placed beside the wall near the fireplace.

Unfortunately the inhabitants seem to have tidied up well before the floor was sealed by blown sand. A few groups of sherds, some hammerstones, and a few pieces of flint waste is all that was recovered from the thin soil layer on the floor and around the hearth. Samples have been taken for analysis, and a baulk about 1 m wide has been left over the SE corner of the house, from which it would be possible to take further samples in the future.

Ard marks

After removing the at least 0.2 m thick and very rich occupation layer on which house I had been erected, there appeared a network of ard marks (fig. 10). The two dominant ploughing directions were WNW-ESE, and NNE-SSW, coinciding with the axial and transverse orientations of the house. The marks were most clearly observed under the middle part of house I and in the northern part of the excavation cutting. No field boundaries could be distinguished in the c. 250 m^2 where ardmarks were present Marks could be observed at different levels, probably owing to periodic phases of sand blowing when large areas had been taken under cultivation during the Bronze Age occupation.

House II

The north wall of this house coincided with the line of the southern posts of house I, so that postholes number 3 to 6 from the west in house I were in contact with the north wall of house II, the rounded NW corner of which lay between posts 2 and 3 of house I. Though this house was very incomplete in its preservation, its wall construction was exactly the same as that of house I, except that all the postholes reached into the natural subsoil. The roof-bearing construction is not yet fully investigated as the postholes have not been sectioned. To judge from the indications in plan it is a mid-ridged building. A feature resembling a roof posthole midway between the western end and a patch of red-burnt sand may be the bottom of house II's western hearth. If this is situated axially in the building as in house I, the original width can be estimated as c. 7 m, which is normal for a Bronze Age house. So far no finds have been made which date the building more precisely. Stratigraphically it preceeds house I, the holes for whose roof posts cut the wall posts of house II. Traces of house II's wall seem to have influenced the orientation chosen for house I.

Features outside the houses

In the area north of the big side-aisle house were excavated four 5–10 m large accumulations of cooking stones in dark, sooty earth, and also five round and an elongated cooking pit, a pair of smaller cooking-stone hearths, a larger pit, and a N-S row of 7 or 8 posts which from their stratigraphy and fill can be related to the above-mentioned settlement. West of the big house was seen an elongated cooking pit that clearly extended in under the west gable of house I and may therefore probably be attributed to house II, which lay a little further east. Near by was seen a group of round pits, about two of which cut into the elongated pit. South of the big house were seen two groups of round cooking pits, a western one with 7–8 and an eastern one with 12–13 pits. The most easterly of them had disturbed the end posts in house II, showing it to be later and therefore probably attributable to house I. Pits west and south of the big house are not yet fully excavated.

The at most 30 cm thick layer with accumulations of cooking stones north of the big house had the greatest concentration of stones in the middle and a heterogeneous spread to all sides. In one accumulation of cooking stones situated about 10–20 m due north of house I's middle entrance, signs of deliberate arrangement could be observed. A concentration or low heap measuring c. 3 x 2 m of cooking stones and stone debris almost without earth had, like the eastern end of the big house, been partly covered on its western side by pale yellow blown sand. In the middle of this heap was found

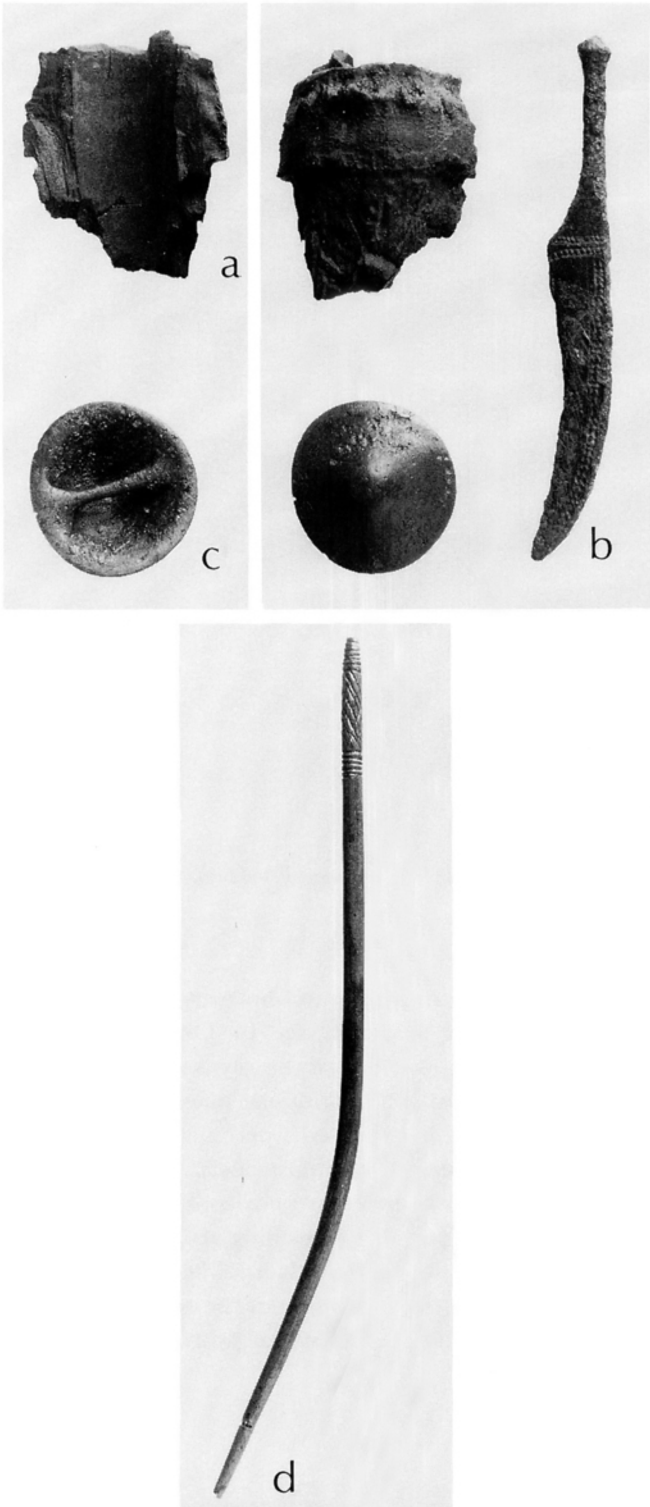


Fig. 11. Bronze objects from the later settlement: a, casting jet; b, toilet knife; c, tutulus. From the earlier settlement: d, bulb-headed pin with head missing. C. 1:1.

a casting jet of bronze (fig. 11a). In a smaller collection of cooking stones a little further north was found a well preserved bronze tutulus (fig. 11c). The up to 30 cm thick soot-blackened layer with the cooking-stone accumulations was sharply distinguished from the underlying c. 20 cm thick cultivation and occupation layer. In the layers with cooking-stones was found a certain amount of pottery (fig. 14), and this was clearly different in form, temper, and firing from the pottery of the underlying occupation layer (fig. 15). Together with the pottery in the upperlayer were found fragments of a miniature vessel resembling a crucible (fig. 14f), together with a little flint waste and a few flint implements (fig. 17b).

A larger pit between house I and the above-mentioned accumulation of cooking-stone with bronze was of rounded rhombic form above, nearly 2 m wide, and 1 m deep with flat base and vertical sides. Unlike the cooking pits it contained a markedly stratified fill, at least ten layers, and also a pair of humic streaks and c. 1/2 kg of pottery. To judge from the organic layers and the shape it may have been used to hold something, or been a privy, a miniature cellar, or perhaps a tanning pit.

THE EARLY SETTLEMENT

For reasons of economy the excavation of the rich lower occupation layer and the recording of ard marks was done in two smaller sections of the area opened in 1987. In the northern section of over 200 m^2 there was excavated about 50 m^3 of occupation earth containing pottery; clay "caulking" (burnt clay strips), flint tools and waste, etc. This in itself was enough to indicate the presence of a house (fig. 13).

House III, a Late Neolithic/early Bronze Age longhouse

A seven meter wide, post-built house with a single row of roof posts extended WNW/ENE with a deviation of 26°. It had been protected by the later layers of cooking stones both to the east and west, and only on the NE side had a modern sunken road and cultivation removed part of the rich occupation layer. The south wall, which consisted of a straight row of posts slightly less than a meter apart, but in a couple of places 1.5 meters, showed that the house had been at least 22 m long. Only a small part of the north wall has been uncovered, so the width of the building was 7 m. Three roof-posts can at the present mo-

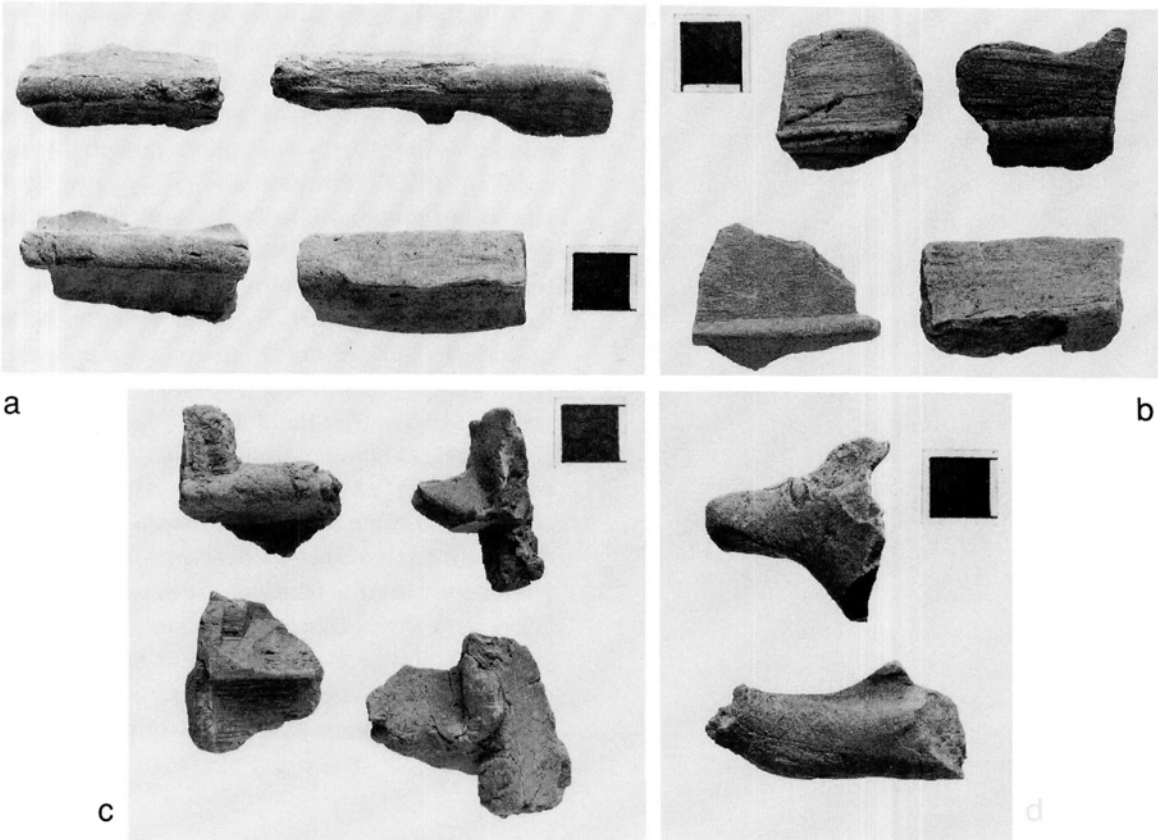


Fig. 12. Clay caulking from house III: a, triangular strips; b, flat triangular strips with impressions of planks; c, vertical and horizontal plank impressions and plank ends; d, clay projections. Different scales. Scale inserted: 1 x 1 cm.

ment be seen in line down the middle. The distances between them were large – 6 and 8 m. In the centre of the eastern part was seen the fireplace, a 1,7 x 1.5 m rounded patch of red-burnt sand. So far only a round hearth or cooking-stone paving has been investigated. It had been inserted c. 0.2 m into the subsoil and provided with a small post on the south side. Carbonised cereal grains were found in two irregular pits in the eastern end of the house.

Clay caulking

About 2 kg of clay caulking was recovered from the fill, most commonly over house III's eastern end, the hearth, and the postholes. It took the form of clay "sausages" 1–1.5 cm thick that had been pressed in between the planks in the house walls. Unlike the sand-tempered daub of house I this material was untempered. It was a compact, finely levigated clayey mass. On one side the strips, which are triangular and burnt red, retain finger impressions from being pressed in. On the two other sides are seen impressions of the planks (fig. 12a). The latter meet with an irregularity that may mean that radially split planks were used, perhaps inserted into grooves in the vertical earthfast posts. Some pieces of caulking show for instance two horizontal and a vertical plank (fig. 12c). Traces of dowelling are barely discernible (fig. 12c). From where it lay it is likely that the caulking was used on the inner side of the walls, in contrast with the daub in house I, which lay primarily outside the wall.

House IV

The other section excavated down to the natural subsoil in 1988 included the area under house I and south and west of it, altogether c. 300 m^2. From here c. 100 m^3 of occupation layer was removed and found to be nearly as

Fig. 13. Plan of ard marks seen in the natural subsoil and houses III–IV with features provisionally associated with them. 1:200.

rich in finds as the northern section. Various postholes, clearly older than houses I and II, showed up in the natural surface under the occupation layer and the ard marks. Patchy red-burnt sand measuring c. 1.5 x 1.3 m must be the base of a fireplace, corresponding to the observations made in the other houses. A complete excavation will probably reveal the shape of the house to which the fireplace belonged, but this was not completed in 1988. Presumed wall posts are included in the plan, fig. 13.

On the bottom of the large hollow under the east end of house I were found a couple of small accumulations of cooking stones, a large part of a pot (fig. 15a), a dozen scrapers, some flint waste, and on the northern side a few pieces of clay caulking. Charcoal from a collection of cooking stones on the floor of the hollow gave a C14 date of 1525 ± 80 B.C. calibrated (K-5168).[5]

FINDS

Settlement layers are cumulative deposits. This is true also of the site at Hemmed Church, where at least three settlement phases can be distinguished (houses I, II and IV). Fortunate circumstances have resulted in the preservation of a fairly clear stratigraphy. Sand blown in before, during, and after the periods of settlement have formed protective layers (i.e. over the east end of house I). Extensive collections of cooking stones from a variety of activities requiring the use of fire have, especially during the youngest settlement, sealed areas of the site under dark, sooty, semi-continuous layers in which later disturbances were clearly distinguishable (fig. 2). The stratigraphy made possible a degree of separation into an upper horizon, stratigraphically associated with house I (II), and an earlier horizon (fig. 2, layer 3) which, despite having been cultivated in the period between the settlements, contained a fragmentary but considerable artifact material associated with house II-IV. The two settlement horizons are so far as possible kept separate in examining the finds.

The total material from the site consists of:

Burnt Clay	
caulking	1,976 g
clay daub	1,165 g
Pottery	26 kg or 4,076 pieces
Flint	
flakes	66,311 g
cores/core rejuvenation flakes	55
scrapers, disc or handled	111
daggers, dagger roughouts	6
arrowheads/arrowhead roughouts	32
sickles/sickle roughouts	10
borers, discoid borers, borer points	27
knives on flakes and blades	6
strike-a-lights (including miniature daggers)	16
roughouts	8
fragments of flat-flaked implements	4
inset for flint-edged sword	1
miniature axes, bifacial	2
notched and denticulated pieces	17
retouched flakes	6
total number of flint implements	246
Stone	
mullers	26
hammerstones (1–2 partial striking surfaces)	15
grinding and polishing stones	5
burnishers	7
quern/grinders	3
total number of stone implements	56
Amber	
beads	2
lumps	2
Bronze	
toilet knife	1
jet	1
tutulus	1
pins	2
spiral wire	1
Organic material	
calcined bone	350 g
animal teeth	3
charcoal	not counted
carbonised cereal grains	not counted

Pottery from the late occupation

About 10 kg of pottery can be attributed to houses I(–II) and the extensive cooking-stone accumulations in black earth. Of this 6.5 kg was found in the accumulation with the casting jet and tutulus north of house I, nearly 1 kg lay on the floor of the eastern room, and the last c. 2.5 kg lay scattered over the site.

The pottery is tempered with sand and mica and is fired black, grey-black, red-brown, or brownish yellow. Uniform coloration of the sherds is usual. A few large, thick-walled vessels have "sandwich" coloration with external grey-black hue sometimes with burnt food crust. Wall thickness varies from 3 mm for the fine ware to an average of 6–7 mm for the middle-sized pots and up to 10 mm for most of the large storage jars with coarse slurried surface. In contradistinction to published settlement pottery from the Late Bronze Age, biconical forms and forms with conical neck and strongly rounded shoulder do not occur in the material (cf. B. Draiby 1984, 178, types A, B, D, and BC). The dominant form is concave-convex with carination (fig. 14a). Sherds of flowerpot and barrel shaped vessels are present (fig. 14b), as are vessels with S-profile (B. Draiby 1984, type AB) or with slightly angular S-profile (fig. 14c). All twelve handled sherds were associated with the late occupation (layer 1). The strap lugs were all joined to the rims of carinated concave-convex bowls (fig. 14d). No lugs or handles have central groove or concave sides. Two vessels with S-profile without carination have in the middle of the body a little nearly round knob (fig. 14e). The only decorated sherd present has alternately sloping fingernail impressions, as seen on the vessel from the Borbjerg hoard (Ørsnes 1958). A half dozen large pots have rough, slurried surface and a narrow burnished zone near the rim (fig. 14c).

A single sherd from a flanged lid has flat upper surface. A barrel-shaped miniature vessel is hard fired and may have served as a crucible. It was found near the casting jet in the big cooking-stone accumulation. One bowl or biconical vessel with rounded carination could be assembled until the profile was nearly complete (fig. 14c).

About 120 out of the total of 270 rim sherds could be attributed to the later occupation. They represent at least 100 vessels. The rims are normally flat, tapered in section, and bent outwards. Only in a couple of cases was a collar at the rim observed (cf. Draiby, 1984, 194) (fig. 14a). An internal facet is found on only one black-fired rim sherd. Out of about 83 base sherds c. 22 can be assigned to the later occupation. Usually there is no marked foot, but this is seen in a few cases.

Pottery from the early occupation

About 16 kg of pottery was found in the two excavated sections of the old cultivation soil over houses II-IV. The greatest find density was at the houses (fig. 16). The sherds were very small with an average weight of 6 g. In contrast with the later wares this pottery is coarsely tempered with angular debris from cooking stones. The colour is reddish to yellow-brown, often with a dark grey core. The sherds are on the whole too small to show the distribution of pot sizes. The thickness is 1/2–1 cm for the small and 1–2 cm for the medium and large pots (fig. 15). The forms agree completely with the ones found near by at the Egehøj site (Boas 1983, 100, fig. 7–8, and fig. 10–11). There are bucket-shaped vessels (fig. 15a), vessels with S-profile (fig. 15b), and incurved rims (fig. 15c). Bases with straight side without foot and bases with marked foot (fig. 15f) are equally common, but slightly offset foot is rare. One base has a "ring-foot" or hollow base (fig. 15f). The only nearly complete base is from a miniature vessel with thick bottom slightly under 3 cm in diameter. A bucket-shaped vessel with wide groove below the rim and a perforation in the groove was found near the bottom of the hollow under house I (fig. 15a). It lay together with charcoal dated radiometrically to 1525 B.C. This pot is gritted with sand and fired grey-black. A couple of small sherds with strong secondary firing and inturned rim may be from crucibles (fig. 15e). They resemble the crucible fragment found in the late cooking-stone layer over house III. Similar examples are known from Haag near Thorsager in Djursland (Neergaard, 1908, 288, fig. 3). Two sherds are from pottery sieves. Sixteen sherds have cordons placed less than a centimeter below the rim (fig. 15d).

Flint

Altogether 70 kg of flint waste has been recovered from the site. In this case it can be more difficult to identify the material from the two settlement horizons, as it was moved more easily moved by human activities during the settlement and by bioturbation subsequently. The raw flint seems to have been very fully exploited as only 4 kg of cores and waste lumps were left.

Scrapers are the commonest tool. Of the 111 scrapers 20 are rejuvenation flakes. Only a couple are genuine handled scrapers, the others are pear-shaped, round, or narrow (fig. 17a). Out of 15 nearly complete arrowheads 3–4 belonged to the younger settlement. These and a couple of loose finds are distinguishable from the older arrowheads by having a leaf shaped outline (fig. 17b, above left). The sides curve right to the ends of the barbs, which therefore bend inwards. The maximum width of these arrowheads is more than 150% of the distance between the barbs, while the corresponding figure for the arrowheads from the earlier layer is less than 150%.

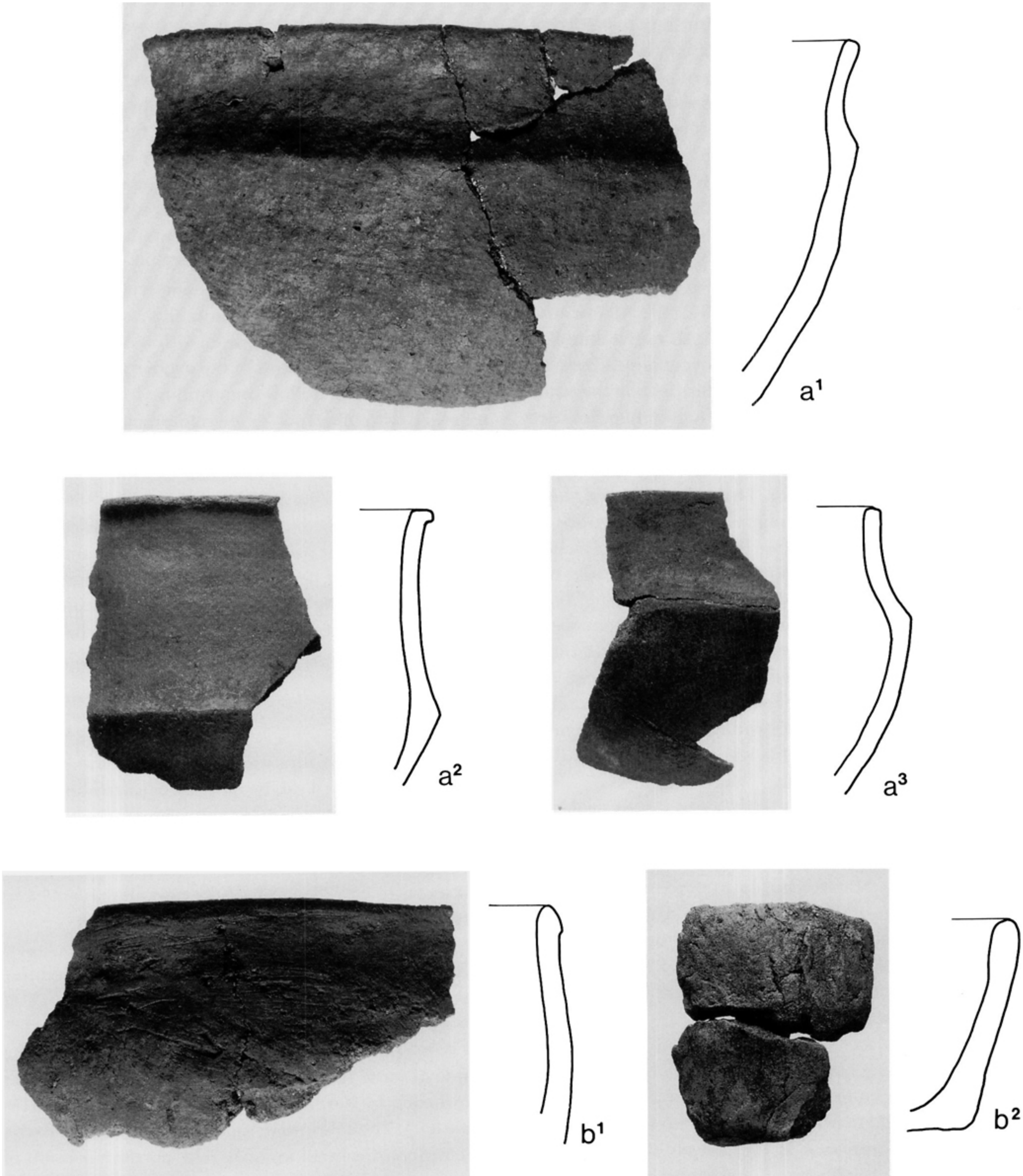
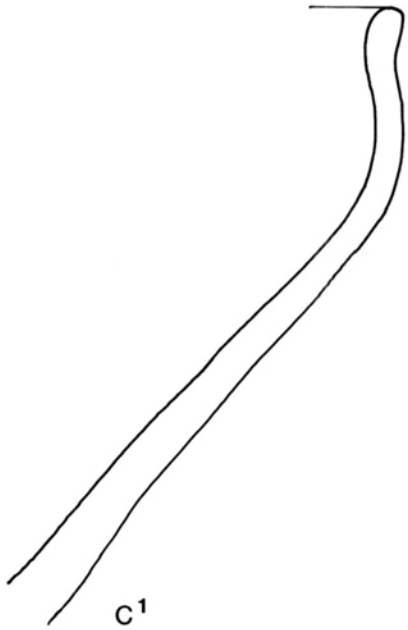
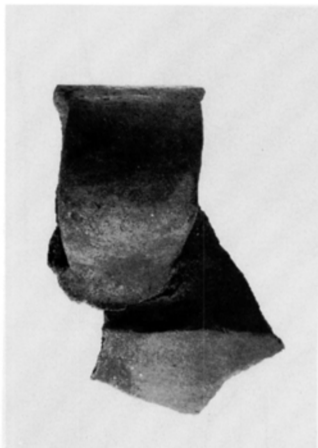


Fig. 14 a-f. Pottery from the Middle Bronze Age.



c^1

c^2



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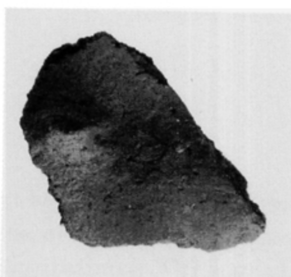

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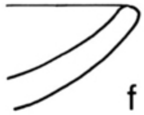

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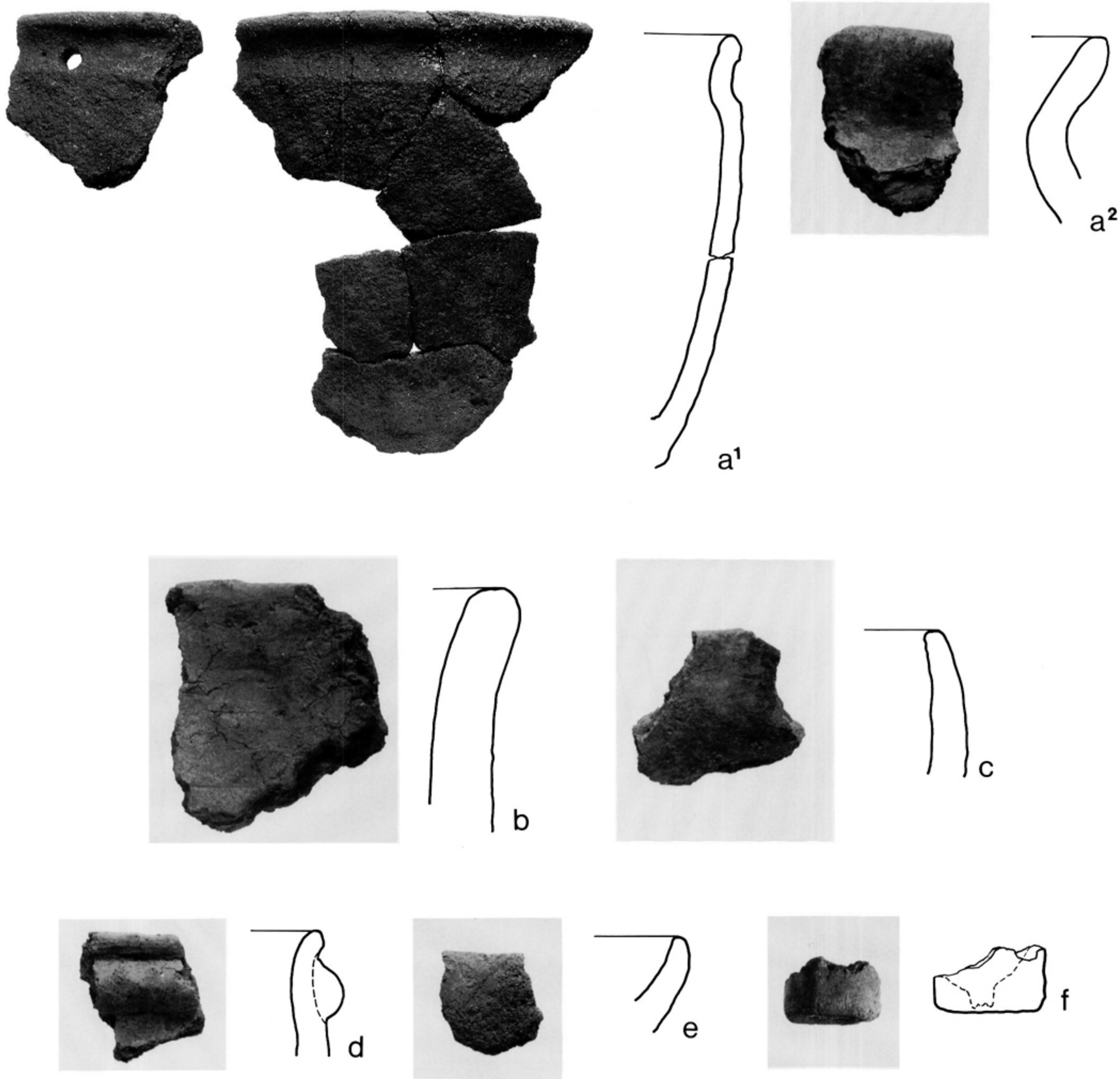


Fig. 15 a-f. Pottery from Early Bronze Age.

As with the arrowheads from Egehøj, the hollow base can be either rounded or angular (fig. 17). Roughouts are less common than at Egehøj.

Three dagger fragments are of determinable type. One (a loose find) is a type VA handle (Lomborg 1973, 58), and the two others come from the old lower cultivation layer. There is a type VA handle from near the south side of house III and a type IV C handle from near house IV (fig. 17c). Apart from a couple of simple sickle-shaped flakes, fragments of pressure-flaked artifacts are too small

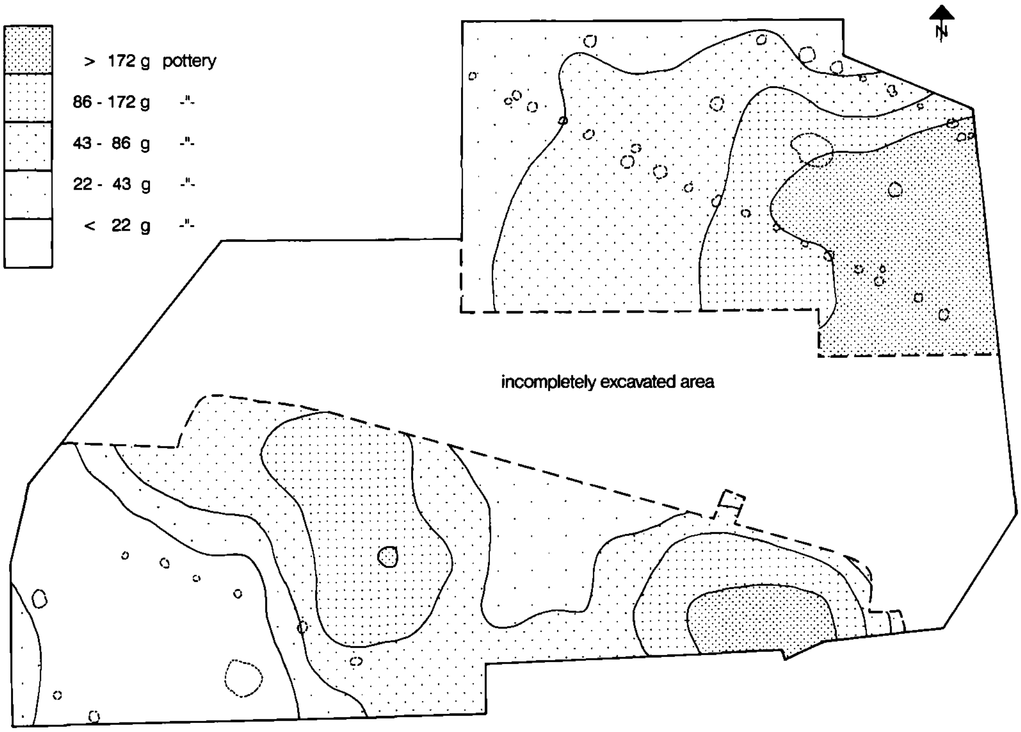


Fig. 16. Distribution of Early Bronze Age pottery.

for a possible type determination (fig. 17d). There are 16 strike-a-lights of which a few are shaped as miniature daggers (fig. 17c). The borers are 13 drills, 9 core or long narrow borers, and 5 disc borers (fig. 17b).

The unusual forms include a polished and an unpolished bifacial miniature axe (fig. 17e) and part of the inset from the edge of a flint-edged sword (fig. 17f). Finally there are a dozen roughouts and fragments of flat-flaked implements and a few flakes with "work-retouch". Two loose finds of coarse blade knives could belong to the younger settlement (fig. 17d). A few flakes are reworked as flake knives (fig. 17d, bottom).

Stone implements

Mulling stones were scattered throughout the site. Their size is 5–10 cm. One slightly larger elongated stone has pronounced marks of hammering at one end. In particular the hammer-stones of the later layer show damage all the way around, whereas the older layer contains many stone hammers with marks of use at one or both ends only (fig. 18). On both mullers and hammerstones can be found areas that are polished smooth. This is unknown on Iron Age mullers. "Burnishing stones" are small round pebbles of various shapes. They are only slightly worn. An axe polisher may be earlier, as pieces of polished thin and thick butted axes have turned up at the site, as well as 12 potsherds from the Single Grave Culture and 3 type D arrowheads. A pair of quern fragments and a rubber were found together with the cooking stones.

Bronze

As already said, a piece of a presumed casting jet 3 cm in size was found in the upper part of the accumulation of cooking stones north of house I and over house III. It had casting rim and marks of chiseling at one end (fig. 11a). A similar rim is seen on a spearhead mould from Vindblæs. The jet could have been removed from the socket of a similar spearhead (Vestergaard Nielsen, 1956, 46, fig. 6). In the northern part of the cooking-stone deposit was found a small, smooth, plain tutulus with attachment bar behind. In front it is conical with rounded point (fig. 11c). A probable bulb-headed pin was found in the lower occupation layer c. 4 m S of house III. Both point and head are missing. The shank's upper end has groups of horizontal lines and a cross-hatched zone. The bottom third is slightly bent. Thus bronze was found in both the

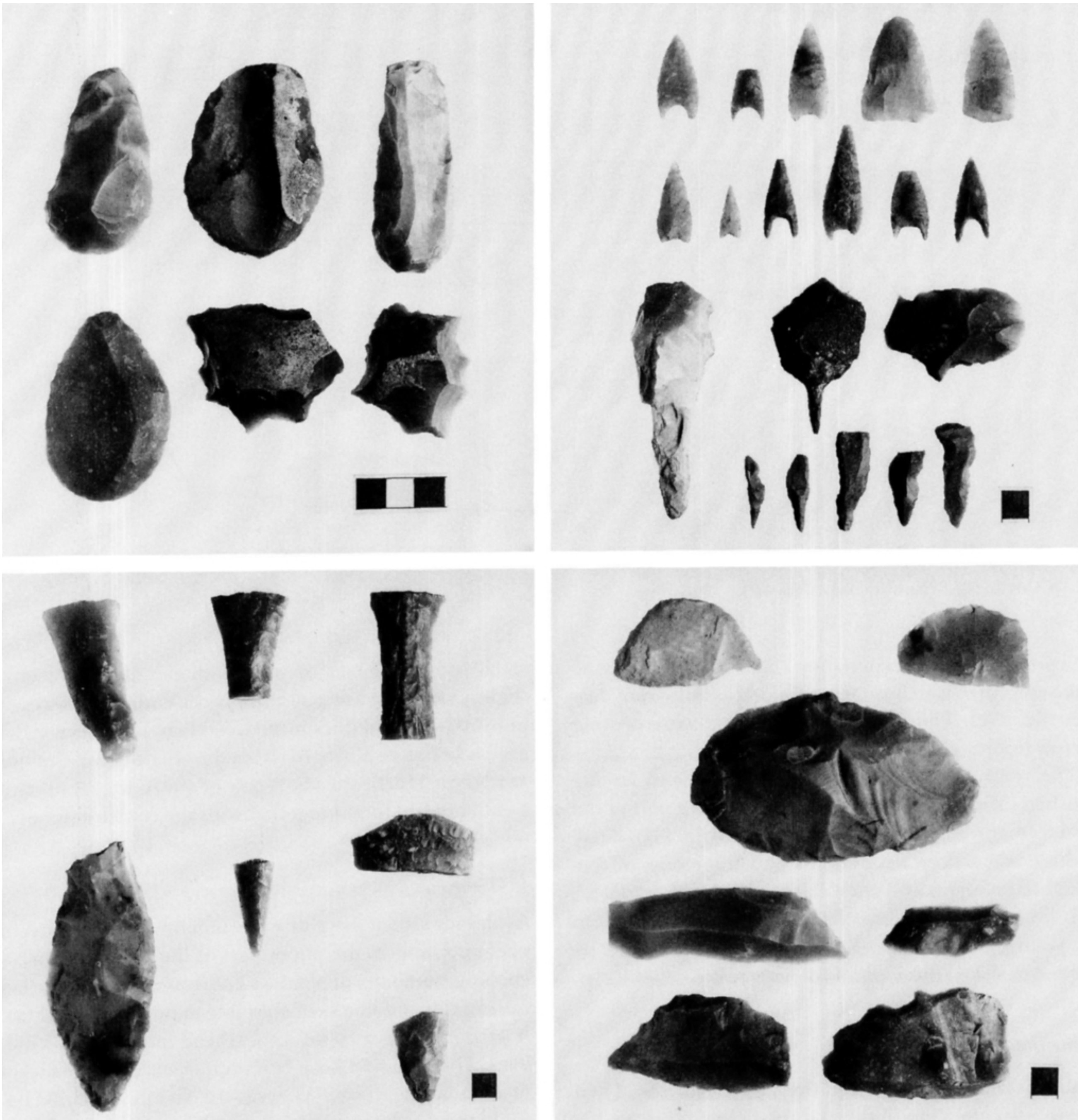
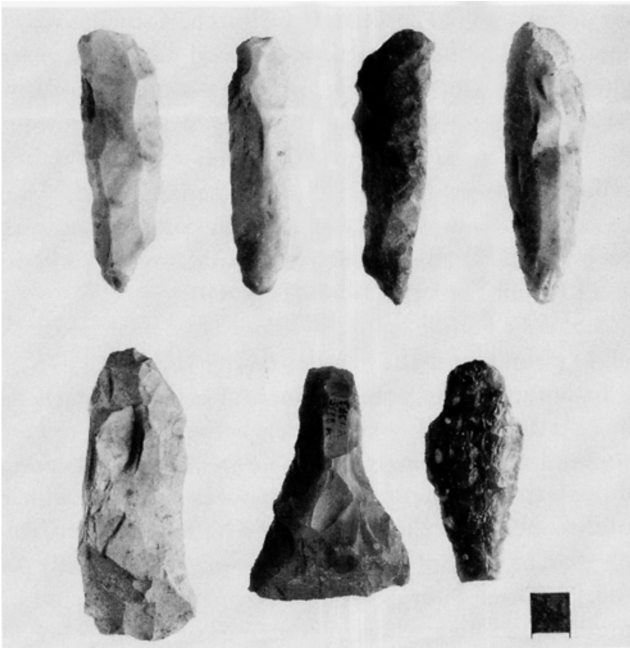
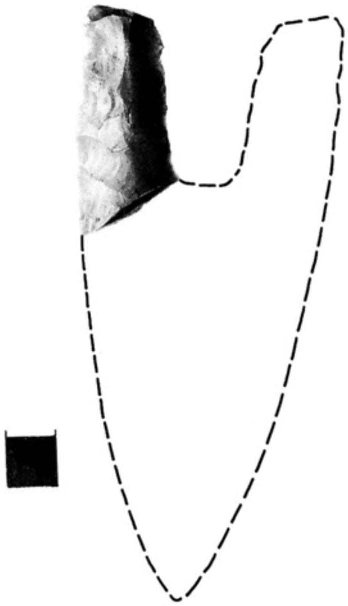


Fig. 17. Flint implements from the Bronze Age settlements at Hemmed Church: a, handled scraper, elongated and denticulated scrapers; b, arrowheads, arrowhead roughouts, core, disc, and drill borers (the three on the upper left are from the late settlement in the Middle Bronze Age); c, dagger fragments and roughout for a dagger-shaped strike-a-light (lower left); d, flat-flaked sickle and roughouts for sickles; blade and flake knives; e, strike-a-light and dagger-shaped strike-a-light (lower right); two bifacial miniature axes (lower left); f, fragment from the point of a flint-edged sword. Different scales, scale inserted = 1x1 cm.





earlier and the later settlements. A couple of years earlier a toilet knife was found on the surface about 10 m W of house I (fig. 11b).[7]

Amber

Two small damaged beads were found a couple of meters north of the fireplace at the west end of house I. They are c. 7 mm in diameter and flattened spherical in shape. The lumps are unworked.

Organic materials

350 g of small fragments of burnt bone may be mentioned. The pieces were seldom larger than 1 cm and lay scattered throughout the occupation layers of the site.

As carbonised grain was observed in postholes of house I and pits of house III, soil samples were taken. The burnt bone and soil samples have not yet been examined.

DATE OF THE OCCUPATIONS

As already shown in the description of the features and artifacts from the site, it was possible to distinguish two settlement phases stratigraphically. The upper one consisted of five or six extensive accumulations of cooking stones, each of 100–500 kg of shattered fieldstones and dark sooty sand. Houses I and perhaps II belong to this layer. There were also cooking-stone pits which did not contain datable material apart from a little pottery. On the other hand pottery was found throughout the cooking-stone accumulations, particularly in the largest of them, which was north of house I.

Some of the pottery forms are known from period IV of the Bronze Age, i.e. the concave-convex vessels, the S-profiled vessels with and without carinated body, and the simple bucket-shaped wares. Sherds of large vessels with slurried body with narrow, smoothed zone at top and bottom, strap-shaped handles joined to the rim, small round knops, an internal facet at the rim, an external collar at the rim, and the body sherd with fingernail impressions, are all typical Late Bronze Age elements. However much is lacking that is found at settlements where period V pottery dominates, as at Fragdrup and Voldtofte (Draiby 1984; Jensen 1967). Biconical and conical-necked forms scarcely occur, and the same goes for use of cordons, ornamentation with parallel lines, protruding lugs, and oval knops. The only fragment of a lid present could because of its flat upper side be either Late or Early Bronze Age (Broholm 1943, DB II, 132). It is still almost impossible to draw comparisons with period III settlement pottery as this is still nearly unknown in Denmark. Local grave pottery from Djursland is unknown from periods II and III and extremely rare in period IV. The bronze toilet knife ploughed up near house I dates from period III.

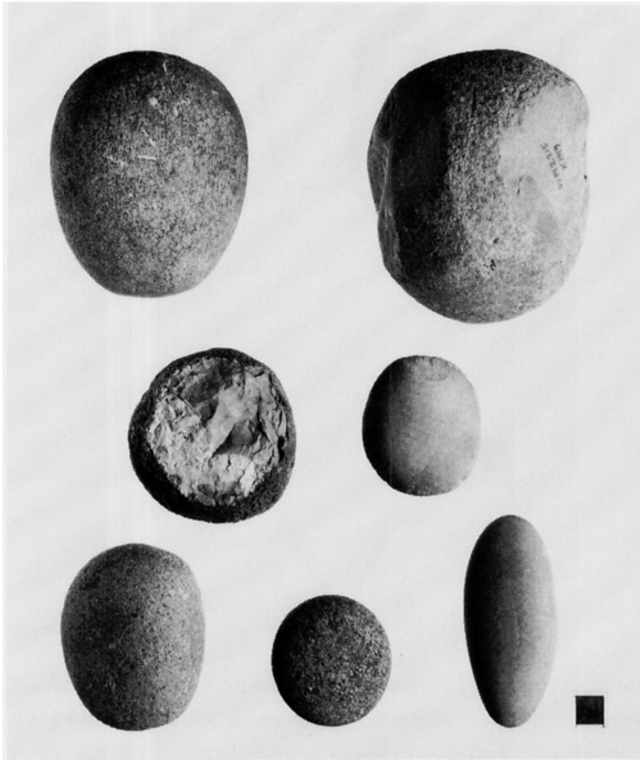


Fig. 18. Stone tools from the settlements: hammer-stones (upper right, middle, right, lower left); muller (upper left); burnishing stones (lower centre and right). Inserted scale = 1x1 cm.

The pottery from the lower settlement phase has by and large the same elements as the neighbouring Egehøj site (Boas 1980; 1983). This is true of the forms, tempering and firing. The most characteristic features are coarse thick and thin walled ware with large grits, bucket-shaped vessels constricted at the rim, vessels with simple profile and inturned rim, vessels with a single high cordon, marked and articulated foot.

Flint tools are rare in the later phase. A little dagger-shaped strike-a-light of Lomborg's type D (Lomborg 1960, 160) was found in the big accumulation of cooking stones where bronze was found, but it can be older and intrusive. The hollow-based leaf-shaped arrowheads that seem to belong to the younger settlement occur a couple of times at Egehøj (Boas 1983, fig. 5, no. 6 and 8) and three were found in each compartment of a double cremation cist that was inserted into the SE side of the barrow, Egehøj. Bronze double-buttons with star decoration date the graves to period III.[6]

The arrowheads from the early settlement have about the same variation and shape as those from Egehøj (Boas 1983, 95, fig. 5); the mean length/breadth index was 128 at Egehøj and 130 at Hemmed Church. A small, square, flat-flaked flint has a break at one end just at the place where the outline begins to curve. It may be the broken-off "tail" of the point of a flint-edged sword (Rønne, 1988, fig. 1–2), and this would further support a dating to the earliest Bronze Age. A dagger handle of type V was found in the lower strata and can in combination with the presumed bulb-headed pin give a dating to early period I (Lomborg 1973, 145–47, fig. 84B).

A type IV handle from the lowest layer near house IV might point to a slightly earlier dating (LNC).

In summary, the pottery, flint and bronze artifacts indicate a dating of the lower or earlier settlement to Late Neolithic C and Bronze Age I. The archaeological dating of the later settlement cannot on the basis of the bronze tutulus, the pottery, and the strike-a-light be set more closely than to the end of the Older Bronze Age or early period IV. These datings are approximately supported by three C14 datings, where two datings of "reliable" charcoal from house I place that house near the middle of the Bronze Age, c. 1000 B.C., while the dating of the charcoal from layers under the house agree with the Egehøj datings (Boas 1983, 101). The difference between the datings of house I here and the house at Trappendal (Andersen and Boysen 1983) are remarkable, for both are nearly identical in construction.

SUMMARY AND CONCLUSION

The excavations carried out so far of the site at Hemmed Church have, thanks partly to the sealing layer of blown sand, given new information about settlement in the early and middle parts of the Bronze Age and make possible the checking and confirmation of the results from the earlier investigations at Egehøj. House II, the midridged house, may turn out to be considerably longer than the largest building, house I, at Egehøj. The similarities in the post construction are evident, but the Hemmed Church house lacks the lowering of part of the floor. In this respect it resembles more the SW Swedish Late Neolithic C houses from Fosie IV, site III; also "indrawn" wall posts are seen in the Hemmed house (Björnhem, N. and Säfvestad, V. 1987, 14). The caulking with clay of plank walls indicates an entirely different wall construction than in the c. 600 year younger house I.

House I gives evidence of great precision of workmanship and has given new and detailed information about construction and internal arrangements. Like the unique cult building at Sandagergård (Kaul, F. 1987) the walls had a wide raised sockle of earth or peat. There were partition walls and carefully laid clay floors. In the living rooms at both ends there was space between the roof posts for stone fireplaces with auxiliary fire pits as in the Højgård houses (Ethelberg, P. 1987), and traces were seen of different kinds of post features that could be furnishings, alcoves, small rooms, etc. The presence of cereal grains in the central room suggests a storage or provisions room.

Outside the middle entrance could be seen indications of bronze foundry activity. Round or elongated pits, both single and grouped, indicate activities that required the application of heat, such as corn drying, pit kilns, cooking, pottery firing, etc. Perhaps some of the questions that can be put to such a rich material will be answered by future investigations before the growth of the trees permanently prevents a deeper insight into the daily life of the Bronze Age people.

Translated by David Liversage

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NOTES

1. Hemmed Church, Hemmed parish, Djurs Nørre herred, DJM 2215. The excavation was carried out by Djurslands Museum under the direction of the author assisted by Lisbeth Wincentz, Gert Hougård Rasmussen, Anne Bjerrekær, Lene Lund, and Niels O. Boas.
2. Hemmed Plantation, Hemmed parish, Djurs Nørre herred, DJM 2049.
3. Soil analyses were carried out in 1987 by the *Danske Hedeselskab* on samples of blown sand, on humic sand from under the east end of house I, and on subsoil sand. According to Frode Olesen, Skanderborg, the three samples show considerable similarity to blown sand caught in the air at Rimsø on 06/05 – 1987. "The material is exceedingly well sorted and consists chiefly of fine sand, 0.02–0.2 mm, which makes it probable that all three samples are wind transported material".
4. A son of the owner of that time, S. Bolther, Hemmed, has reported that his father said that many "old fireplaces" were dug away here when the Gjerrild-Ryomgård railway was constructed in 1911.
5. C14 datings from Hemmed Church:
   K-5168: 1320 ± 80 bc (= 1525 B.C. cal.) hollow under east end of house I.
   K-5169: 890 ± 75 bc (= 1000 B.C. cal.) fireplace in eastern part of house I.
   K-5170: 860 ± 100 bc (= 985–940 B.C. cal.) cooking pit under clay floor in house I.
6. Egehøj. KHM J.nr. 160/69. Burial mound excavated by the author in 1969.
7. Bronze knife (DJM 2010) and flint tools and pottery from the settlement presented to Djurslands Museum by the amateur archaeologist, Frank Jensen, Hemmed Kirkevej.

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Wood-anatomical Investigations of Charcoal from a Bronze Age Settlement at Hemmed Church, East Jutland

by CLAUS MALMROS

INTRODUCTION

During excavation by Djurslands Museum about 200 m east of Hemmed Church, which is situated 12 km northwest of the town of Grenå, a settlement was found in 1987–89 comprising house sites, pits, culture layers and cultivation layers from about 1500–1000 BC (Fig. 1) (Boas 1991, this volume). Some of these structures were unusually well preserved, due to a cover of drift sand, which also covered the eastern end of the latest house I with a 0.3 m thick dune. Two settlement phases can be distinguished, dated by a variety of flint implements and pottery. The early phase belongs to Late Neolithic C and Early Bronze Age period I, the later phase to the transition between the Early and Late Bronze.

In connection with the excavation, charcoal for C^{14} dating was collected in one part of the excavation, where structures from the two phases were clearly separated from each other. At the bottom was a c. 0.4 m deep depression containing culture layers with burnt stone, pottery and charcoal from the early phase, and at the top the remains of a long-house from the late phase. In this house I, which had two inner rows of roof-bearing posts and a room division, the charcoal lay in the easternmost room in a centrally placed fireplace (A3), in the surrounding floor layer, and in a cooking pit (A19).

RADIOCARBON DATING

A total of 6 charcoal samples were drawn from the excavation, which in the subsequent treatment have been amalgamated to form 4 samples. 1 sample weighed only 1.7 g and was too small, while 3 were large enough (3.7–13.2 g) for conventional dating, which was carried out at the radiocarbon dating laboratory of the National Museum and the Danish Geological Survey (DGU). The datings (Fig. 2) have been corrected for isotope fractioning and expressed in conventional C^{14} years b.p. and in calibrated calendar years according to Pearson & Stuiver (1986). A C^{14} sample from the early phase has been dated to 1525 BC (K-5168), which corresponds to the age of the nearby Egehøj houses, which are from the Early Bronze Age, period I (Boas 1983).[1] Two samples from the late phase at the Hemmed Church settlement are dated to 1000 and 940–985 BC (K-5169 and K-5170).

WOOD-ANATOMICAL INVESTIGATION

It was desirable to identify as much of the charcoal as possible in order to learn which species had been used. Identification was often difficult, because the individual pieces of charcoal were very small, as a rule less than 0.1 g. Altogether, 196 pieces of charcoal and bark, equivalent to 55–70% by weight, were identified (40 pieces are from the early phase and 156 pieces are from the late phase).

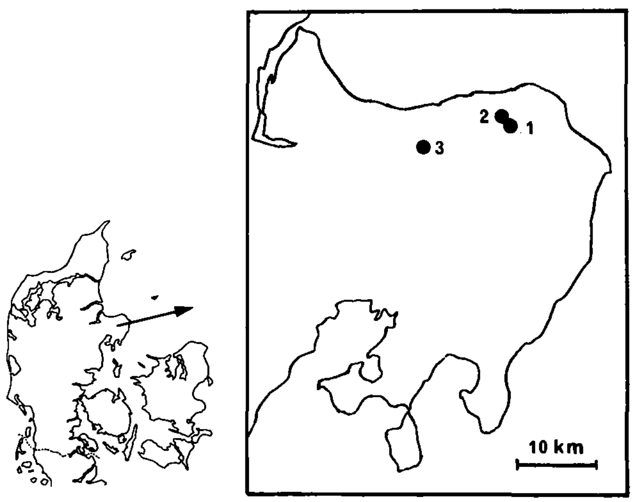

Fig. 1. Location map. 1: Hemmed Church settlement, 2: Egehøj settlement and barrow, 3: Fuglsø Bog.

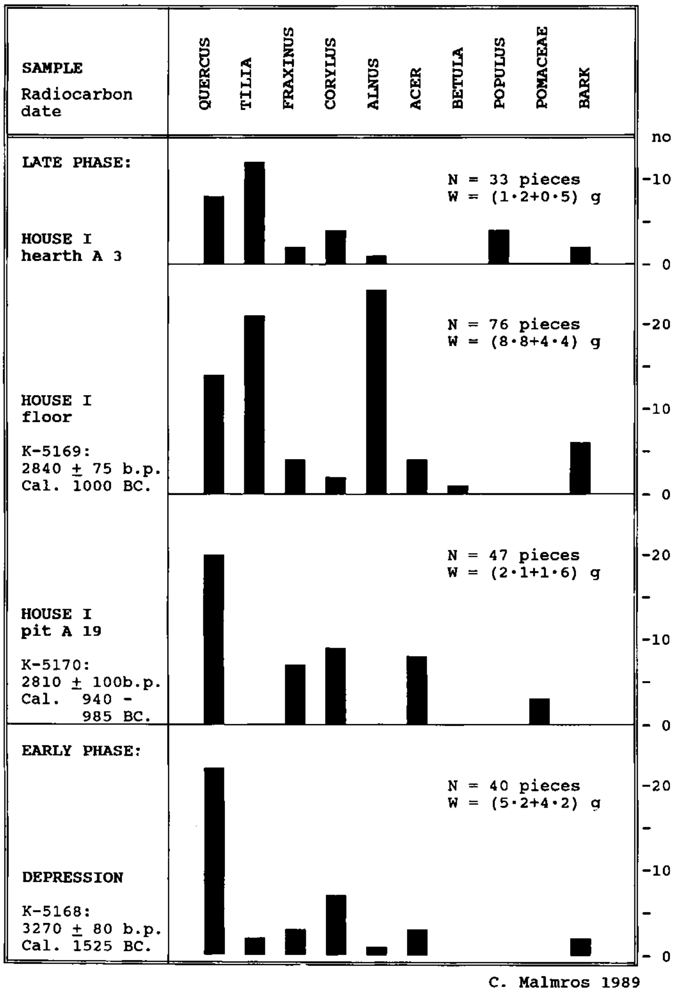

Fig. 2. Radiocarbon dates and distribution of wood species (pieces of charcoal and charred bark) from the Bronze Age settlement at Hemmed Church, East Jutland. N: total number of identified pieces. W: weight of identified + unidentified pieces. Dates in radiocarbon years and calendar years according to Pearson & Stuiver (1986).

The charcoal can be assigned to 9 genera (Fig. 2). Oak, *Quercus*, ash, *Fraxinus*, and hazel, *Corylus*, occur in all 4 samples; lime, *Tilia*, alder, *Alnus*, and maple, *Acer*, in 3 samples; while birch, *Betula*, aspen, *Populus* and apple or rowan, *Pomaceae*, are each found in only 1 sample. In addition there were 10 pieces of charred bark, one piece of which was identified as *Alnus glutinosa*, black alder. Despite the small size of the samples, it was in some cases possible to identify charcoal and bark of thin branches, which are particularly common in the sample from the fireplace in house I. They occur in smaller quantities in the other samples.

30–45% by weight of the samples consist of innumerable small pieces of charcoal and bark, which have not been identified, but a superficial examination shows that they probably represent the same genera as mentioned above.

DISCUSSION

A comparison between the samples shows that 6 genera – oak, lime, ash, hazel, alder and maple – occur in both the early and the late settlement phase. The inhabitants of the settlement at Hemmed Church have thus at an interval of 500 years employed wood from the same species of tree, and presumably the wood was used for the same purpose, as fuel for cooking and for heating the houses.

When collecting fuel, people throughout most of antiquity could presumably make do with fallen wood and broken off dead branches, suited to the purpose (Malmros 1987). Thus, selection occurred, and some species may have been deliberately avoided, for example sloe, hawthorn and rose, which are furnished with sharp thorns and are difficult to break. A systematic production of fuel with tree felling and drying, as we know it today, would undoubtedly have resulted in a more limited number of species.

During burning at the fireplace, a considerable part of the original wood has disappeared, and subsequently a whole series of artificial and natural processes has further reduced the amount of charcoal. That charcoal which is finally available for the laboratory investigations makes up only a minute part of the fuel originally collected, and the species distribution will only to a limited extent reflect tree cover in the collecting area.

If it is assumed that the wood was collected from a limited area in the vicinity of the settlement, an analysis of the charcoal, under the above-mentioned circumstances, would give an idea of the local tree cover The species composition indicates a mixed, light forest consisting of oak, lime and ash, with hazel, alder, maple, birch, aspen and apple or rowan growing in glades and at the edge of the forest. The soil must have been relatively rich and damp.

Bent Aaby's pollen diagram from Fuglsø Bog, which lies 11 km west of Hemmed Church demonstrates vegetational development from the Stone Age up to the present day (Aaby 1985, fig. 5 and 1986, fig. 6). In pollen zone IXa (hazel-lime beech subzone), which is dated to

c. 1450–1000 BC, i.e. coeval with the Bronze Age settlement, a similar tree cover recurs, with the addition of beech, which, however, occurred only sparsely in this period. At the transition to the following pollen zone IXb, c. 1000 BC – 150 AD, beech expands markedly and becomes the dominant forest species.

The absence of charcoal of beech at Hemmed Church can naturally be due to the small size of the samples, which are a product of the aforementioned reducing factors. But it is also possible that beech grew far from the settlement or in dark stands devoid of undergrowth which could supply a sufficient quantity of fuel to make collection worth while. In the course of pollen zone IXa, gradual changes appear in the forst cover around Fuglsø Bog. The changes tend towards a more open landscape, and an increased content of dust in the peat samples indicates increasing use of the surrounding area for agriculture. The sand and mould drift from the open fields in the spring must have given rise to the blown sand demonstrated at Hemmed Church. It is this drift sand which has created the unusual preservation conditions which characterize this Bronze Age settlement.

Translated by Peter Crabb.

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NOTE

1. The Bronze Age settlement at Egehøj (800 m NW of Hemmed Church comprises three longhouses and two wells from Period I and secondary features: a cooking pit, an oven etc. from the Late Bronze Age (Boas 1983). A barrow 50 m north of the settlement contains a central grave from Period IIbc/III. The following radiocarbon dates are available (calibrations according to Pearson & Stuiver, 1986):

Early Bronze Age Period I

K-2238: 3160 ± 100 b.p. = 1435 BC.
Charcoal of *Quercus* from post-hole in house III.
K-2240: 3240 ± 100 b.p. = 1520 BC.
Charcoal of *Quercus, Ulmus, Tilia* and *Fraxinus* from well II.
K-2239: 3340 ± 100 b.p. = 1645 BC.
Charcoal of *Quercus, Tilia, Corylus* and *Acer* from well I.

Early Bronze Age period IIbc/III

K-1761: 2870 ± 100 b.p. = 1030 BC.
Decomposed wood of *Quercus* from coffin in central grave.

Late Bronze Age

K-2241: 2550 ± 100 b.p. = 790 BC.
Charcoal of *Quercus* from cooking pit "båe".
K-2223: 2400 ± 100 b.p. = 410 BC.
Charcoal of *Quercus* and *Alnus* from oven "bac" from period V–VI.

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Danish Plough-Marks from the Neolithic and Bronze Age

by HENRIK THRANE

INTRODUCTION

Our knowledge of Prehistoric agriculture and the study of it is not only a fairly recent affair (Hatt 1937); it has concentrated very unevenly on the various aspects. Iron Age field systems have remained a classic in Danish research (Hatt 1949; Nielsen 1970, 1984, 1986; Sørensen 1982; Lerche 1984 for the earliest survey). Agricultural tools have become another Danish speciality (Steensberg 1943; Glob 1951) with the "International Secretariat for Research on the History of Agricultural Implements" placed at the National Museum as focusing point. Crops have been studied with varying intensity (Hatt 1939; Helbæk 1954; Jørgensen 1977). Apart from Celtic fields, the fields themselves and traces of soil treatment have received less than due attention in spite of a growing body of information and the potentials of this source.[1]

The interpretation of certain soilmarks as furrows left by the share of the ancient plough type called the "ard" (Glob 1951; Bentzien 1969) still widely used over the world, was made in the late 1930'es. Priority seems to fall to A.E. van Giffen (1940), who in 1937 made the first identification. In Denmark the cultural geographer Gudmund Hatt who contributed so much to Danish archaeology (Hansen 1984) excavated some fine specimens during 1939 and 1940 in Western Jutland (Hatt 1941). Hatt himself published Gustav Rosenberg's excavation from 1908 at Vesterlund in Central Jutland (Hatt 1941, 161ff; cf. Thrane 1968), but actually meticulous excavators such as Vilhelm Boye and Georg L.F. Sarauw had made similar observations in 1874 near Næstved on South Sealand and 1897 in Store Vildmose in North Jutland. The interpretation of the humus-filled grooves in the subsoil has remained unchallenged and forms the basis of present analyses. Experiments (Hansen 1969) and ethnographical observations (Lerche & Steensberg 1983; Hagen 1985) have confirmed the interpretation. The present habit of excavating barrows and other monuments completely before their destruction has lead to a great increase in the number of observations after World War II.

The time lag between discovery and interpretation illustrates the first immediate problem about the ard-furrows, that of recognizing them for what they are. Archaeological observation is only possible thanks to the fact that humus was carried by the plough into the light, yellow subsoil. Cleaning a surface at the right level will only be possible in a very shallow zone where the overlying humus looses its fringe of root-holes, animal burrowings and water-transported material and changes into uncontaminated subsoil. Ideal conditions will normally prevail only for very few centimetres (2–4). It is therefore essential to find this level and to clean a sufficiently large area to establish whether the furrows form part of a regular system or may be disregarded as accidental. At a time when mechanized excavation prevails it is very important to keep this in mind. Various kinds

Fig. 1. Plough-marks under passage grave at Rosenfelt Mølle near Vordingborg, South Sealand. C. L. Vebæk excav. et phot.

Fig. 2. Plough-marks under Bronze Age barrow (Montelius per. II) at Melby, North Sealand (Aner & Kersten 1973 nr. 243 I) taken from turret for vertical photography, H. Thrane excav. et phot.

of photographic tricks may improve the possibilities of observations under less ideal conditions (Kossack *et al.* 1975, 289, Taf. 126).

Although Gudmund Hatt (1941) observed the ard-furrows as a by-product of his settlement excavations in the 1930'es, plough marks under barrows have become far more common. This is no doubt due to the fact that the narrow and shallow ard furrows will only remain reasonably intact when preserved by comparatively thick layers of soil. Otherwise the natural precipitation will wash out the humus components during the centuries and make the observation impossible. This process may remove the humus components nearly totally (e.g. Lindebjerg, Liversage 1981). Indications that ploughing had taken place may still exist in the shape of potsherds or flints standing on edge in the sides of the furrows. Observations of this kind need a painstaking cleaning of unpromising surfaces. Podsols and iron pan layers are other hazards and even within the same mound conditions may vary considerably (Thrane 1984a, 4off).

It would be interesting to know how fast this washing-out process destroys the ard-furrows in various soils, it might even throw light upon the dating of such furrows which are not stratigraphically squeezed in between two datable horizons.

DOCUMENTATION, DATING, AND INTERPRETATION

When plough-furrows have been observed, the next problem is to document their existence. There is no standard procedure for this, but in Denmark photographs of the cleaned surface or part of it are normally taken. Full coverage by vertical photography using turrets or other such means are, however, rarely used (Nielsen 1970) (Fig. 2). Normally the main furrows will be drawn rather schematically (Fig. 3). As most plough-furrows are nowadays excavated during rescue excavations of barrows and the like, this is hardly surprising since a full, naturalistic drawing of ard furrows with observations of bisections etc. is a very time consuming affair, normally far outside the budget.

Descriptions and measurements of widths, distances between furrows, cross-sections through individual furrows etc. seem normally to be regarded as extravagances. Most excavators probably regard the ard-furrows as rather a nuisance anyhow. As the observed bits are normally no more than fragments of the original pattern this is perhaps to be expected.

The attitude may also have been influenced by the difficulties of dating the furrows exactly. Normally the furrows under barrows and dolmens can be given a reasonably narrow terminus ante quem, i.e. the date of the construction of the covering barrow or rather its primary burial. (Too often the only dating graves are secondary ones – which of course does not improve the chance of dating the ploughing). As mentioned above, it remains unknown how long it takes for ard furrows to be washed out when only covered by an average topsoil (10–20 cm., S. Nielsen 1980; 1984). It will normally remain unknown how much time elapsed between the actual ploughing and the construction of the sheltering mound. The only way of narrowing this gap is to date an over-ploughed construction to a time shortly before the construction of the covering mound. This is very rarely the case, however (e.g. Asingh 1987 (this volume)). Even if the number of cases where the furrows have ploughed through underlying layers or constructions is nicely increasing, they still constitute a minority. More often than not the underlying layers are so much earlier than the mound on top of the plough furrows, that the date cannot contribute much to the dating of the ploughsoils. Thus we are left with dates for the ploughsoils such as "before period II of the Early Bronze Age", "earlier than Late Neolithic", "earlier than Funnelbeaker ENC" etc. The occurrence of potsherds or other datable finds in the ard furrows is normally no great help. They only indicate *termini post quos*, coming from deposits which had been ploughed out. To prove that a settlement or other deposit had been ploughed out immediately after surrender would need some extremely lucky circumstances. This will remain a major disadvantage in the study and the use of the ploughsoils as long as independent means of dating them remain unknown. Theoretically a situation where a burnt surface with charcoal had been ploughed through should give a *terminus ad quem* for the ploughing – provided that an immediate connection between the burning and the ploughing may be assumed, i.e. clearing a surface for ploughing by burning it. Even here the date depends upon a functional interpretation of the ploughed-out upper layer.

The date of the burial in relation to the preceeding ploughing (or use of the field) may be controlled in such instances where a. no vegetation-layer covered the old ground surface, b. the stones of the barrow constructions had sunk into the humus layer, because this was soft (not compressed by a long period of fallow) (Myhre 1977).

The problem of dating the ploughsystems exactly influences the interpretation of them significantly.

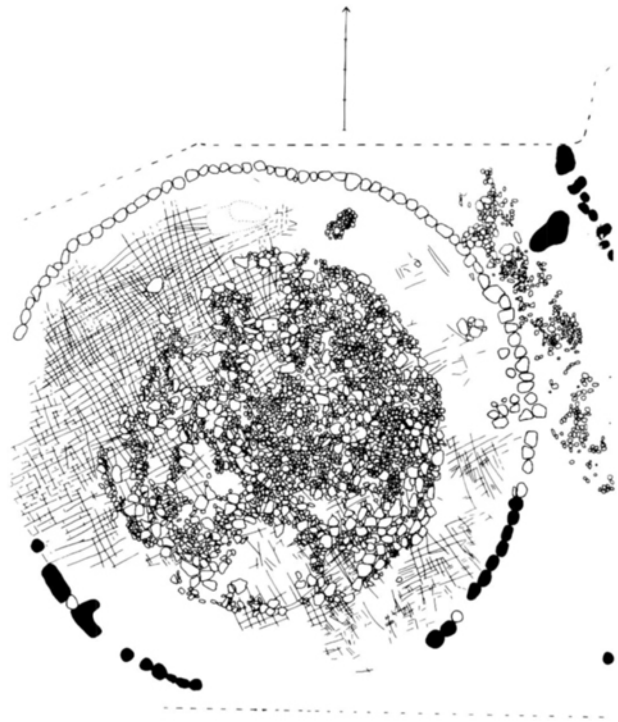

Fig. 3. Plough-marks under Bronze Age type barrow at Åbenrågården, Skiveholme parish, Central Jutland, N. H. Andersen excav.

The interpretation of the ard-furrows has been debated on and off over the last thirty years. Johannes Pätzold (1960) saw the plough-marks underneath the Bronze Age barrows as part of the burial ritual,[2] while most later writers have assumed a practical function of these furrows as well as for the furrows in Celtic fields or on settlements.

Here we may single out a special group of ard-furrows namely those encircling barrows. Furrows number from one to six and form quite neat circles (Wiell 1976). They cannot be traces of ploughing around the mound after its construction (similar to ploughing round the stone heap under the Vesterlund mound (Thrane 1968, fig. 15), but must be seen as elements of the construction ritual. The perimeter stones of the barrows in some cases cover the furrows. These circular furrows belong to the Late Neolithic and Early Bronze Age periods and are thus partly contemporary with the otherwise unique furrows demarcating flat-grave cemeteries on Bornholm (Klindt-Jensen 1964; Aner & Kersten 1978 nr. 2530). In this case it would seem foolish not to admit a close functional connection between the ploughing and the burial action. The association with the description in

Fig. 4. Distribution of plough-marks dated to Neolithic periods by overlying structures: 1. Early Neolithic C/Middle Neolithic Ia, 2. Middle Neolithic Ib-IV. 3. Single Grave Culture plus one Middle Neolithic V case.

the 23rd song of the Iliad provides yet another example of the internationalism of Bronze Age cultural ideas. What the exact idea behind the circular ploughing was, may be debated. Although it seems quite a practical idea to encircle the area under question, a purely practical explanation is hardly sufficient, and the association of ploughing as part of the annual fertilization ritual with the burial ritual does not seem strange in the Nordic Bronze Age which had other close links between burial equipment and symbols of the fertility gods (e.g. Late Bronze Age razors). The circular ploughing does not, however, throw any light on the criss-cross furrows which after all constitute the vast majority of plough-marks. For these independent interpretations must be made.

It has been suggested that the criss-cross ploughing was intended to loosen the soil so that turves for the mound building could be dug out easier than from an

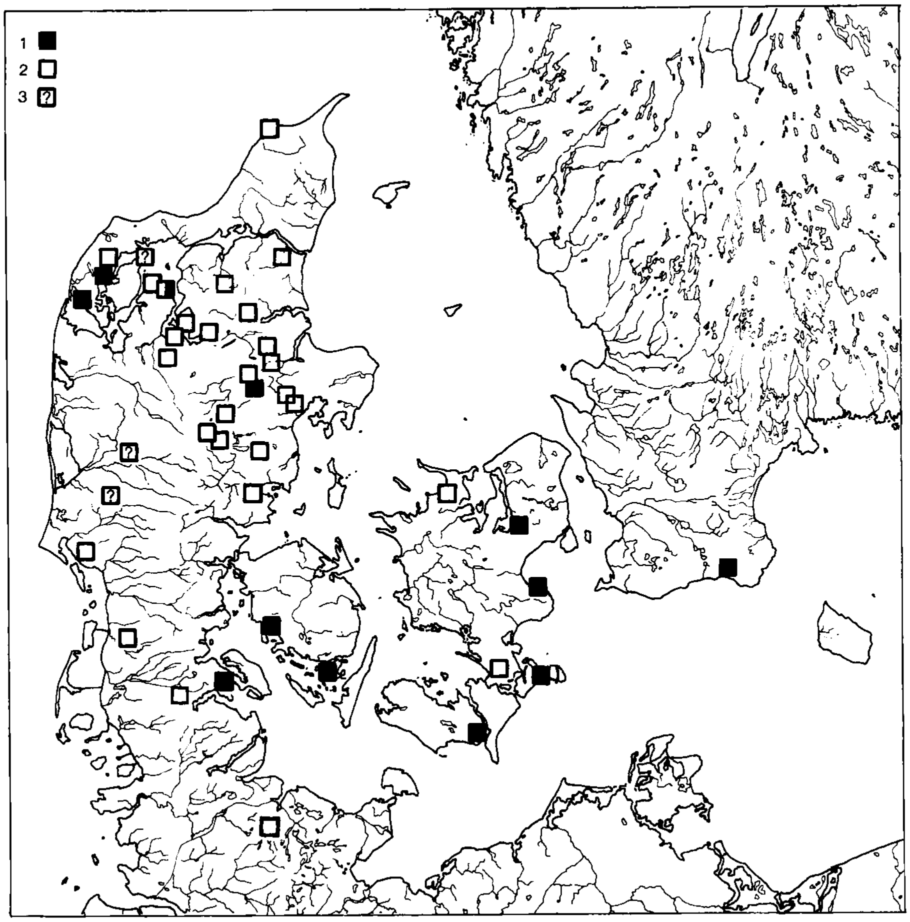

Fig. 5. Distribution of plough-marks as Fig. 4. showing the nature of the subsoil: 1. Heavy (clay), 2. Light, (sandy or gravelly). 3. Character of subsoil unknown.

unprepared field (Friis discussed by Nielsen 1971). This does not explain the occurrence of a criss-cross ploughing underneath the barrows themselves. – Recently Randsborg and Nyboe (1986, 170) in their study of grave orientation during the Bronze Age found that "one of the directions of ploughing is always parallel to alignment of the grave, so we must assume that ceremonies began with a ritual ploughing". This is indeed true in several cases, but certainly not always. Nor was the ground underneath the barrows always ploughed. Ignoring the fact that plough-furrows may have been overlooked in many cases, several mounds have been so thoroughly examined that plough-marks should have been observed – had they been present.

A crucial problem of the interpretation of the ard-furrows is why any furrows at all have remained visible? If a field was ploughed continuously over a number of years, a palimpsest of ard-furrows, so close that in the end it would be impossible to distinquish individual ploughing or furrows, would seem the logical result (Reynolds 1981, 95f). Conversely the preservation of the furrows would seem to indicate that the fields had been ploughed only once. If this was a general rule, there might have been a closer connection between ploughing and moundbuilding than otherwise suggested (apart from the purely ritual interpretation). The fact is that intact criss-cross furrowsystems or large parts thereof are known from the majority of ard-furrow occurrences. In most cases there are indications of additional furrows, which do not comply with the two main directions of the criss-cross ploughing from one cultivation. The odd stray furrows could be explained away as bits of extra work where the coverage or the breaking up of the soil was not good enough, but when the spare furrows clearly constitute part of another criss-cross system, the conclusion must be that the same plot had been ploughed regularly on at least two occasions (two seasons). As mentioned above (p 112) it needs a great deal of work to distinquish the optimal level for recording the furrows. This becomes even more true when two different systems have to be distinquished from another within a very shallow zone. It has been possible in some cases (e.g. Thrane 1982, fig. 4, supplementing Thrane 1967, fig. 10). In some of these instances the latest ploughing is the one for which Randsborg and Nyboe's observations fit (e.g. fig. 2). As here at Melby there is no reason to assume that the earlier ploughing had anything to do with the Bronze Age barrow constructed after the later ploughing. If a burial connection were to be sought for the first ploughing, it would have to be connected with some of the other mounds in the same (modern) field. If that were so, we are talking about cultivation of large fields of several hundred square meters and have to look for a more complex set of explanations for the apparently ritual ploughing. There may have been rules that farmers had to be buried on their own soil or that the fresher the tilling of the soil the better.

If we compare the plough-marks found under Stone Age monuments, under Bronze Age barrows or connected with Bronze or Iron Age settlements, they all seem to fall within the same category as regards size, shape, systematics etc. Basing the interpretation upon the actual plough-marks from the fields themselves (Nielsen 1970, 1986), there can be no doubt that the plough-marks under Stone and Bronze Age burial monuments belong to the same category. A priori I therefore regard all criss-cross ploughings as indications of practical agriculture. This does not mean that ploughing was not associated with a series of ritual and magic beliefs and rites, but it gives us the right to use the plough-marks unreservedly in our study of prehistoric agriculture.

FIELD SHAPES AND PREHISTORIC AGRICULTURE

Sometimes the patches observed under the later monuments preserve edges or even corners of fields. This at least seems the most probable interpretation now that we have the detailed observation from Store Vildmose (Nielsen 1970, 1987). The close similarity of the parallel ploughing along the edges and the curves at the corners of the Store Vildmose fields to the traces under the Bronze Age barrows is convincing enough (Aner & Kersten 1978 nr. 2238 og 2251; Thrane 1984a).

The areas occupied by criss-cross ploughing are quite often around ›400 m^2 (e.g. Aner & Kersten 1978 nr. 2238, 2242, 2251, 2362), the largest so far being the area under the long dolmen at Søndervrå (Kunwald 1958) covering around 1000 m^2, apparently of Early Bronze Age date. For a comparison the Bronze Age fields in Næsbyholm Storskov are quite small – around 300 m^2 (Nielsen 1984, 152f). Northwest German fields have sizes of 1575 and 1750 m^2 (Reichmann 1982) while Dutch fields may be as large as 2500 or 6400 m^2 (Müller-Wille 1979, 226); from Britain we know sizes of 1600 m^2 (Coles 1982 fig. 6,4 and 6,9) or 900 m^2 (Fowler 1981, 158) or 3500 m^2 (ibid). That individual field sizes should vary that much is hardly surprising in view of the different dates, soils and cultural background.

For a generation of Danish archaeologists it was the accepted truth that ard ploughing belong to the Bronze and Iron Ages (Brøndsted 1959–60), that all dated ard parts were Iron Age (Glob 1951), while only rock carvings and ard furrows under the mounds were evidence of Bronze Age ploughing. The first indication of an even earlier use of the plough was the system observed under the Single Grave barrow at Aldrupgårde (Kjærum 1954). (the pattern inside a passage-grave chamber on the island of Møn remains enigmatic and is disregarded here (Ørsnes 1957)). The dolmens at Steneng in Southwest Jutland gave the first indication that plough-marks could occur under megalithic tombs (Voss excav.; Nielsen 1981, 27; Thrane 1982 fig. 5). This turns out to be the case more and more frequently.

So far none of the plough-marks have been published in detail and we are lucky to have drawings etc. in recent publications of megalithic tombs (Skaarup 1982; Ebbesen & Brinch Petersen 1974; Jacobsson 1986).

We are somewhat better off regarding the Bronze Age finds as the great catalogue by Aner & Kersten (1973ff) is now publishing them by dozens.

So far I am aware of 39 sites with ard-furrows dated by the covering mounds to Danish Neolithic (Fig. 4–5). None of these have been examined as intensively as some of the British occurrences (Fowler and Evans 1967; Fowler 1981, 162), which is regrettable in view of the amount of information inherent in the humus soils and in the barrows themselves (cf Nielsen 1980; Dalsgaard og Nørnberg 1982). The material is illustrated here very summarily (Figs. 4–6) mainly to indicate the chronological, chorological and soil-type distributions.

A preliminary list of observations of ard-furrows from Denmark shows a considerable chronological and geo-

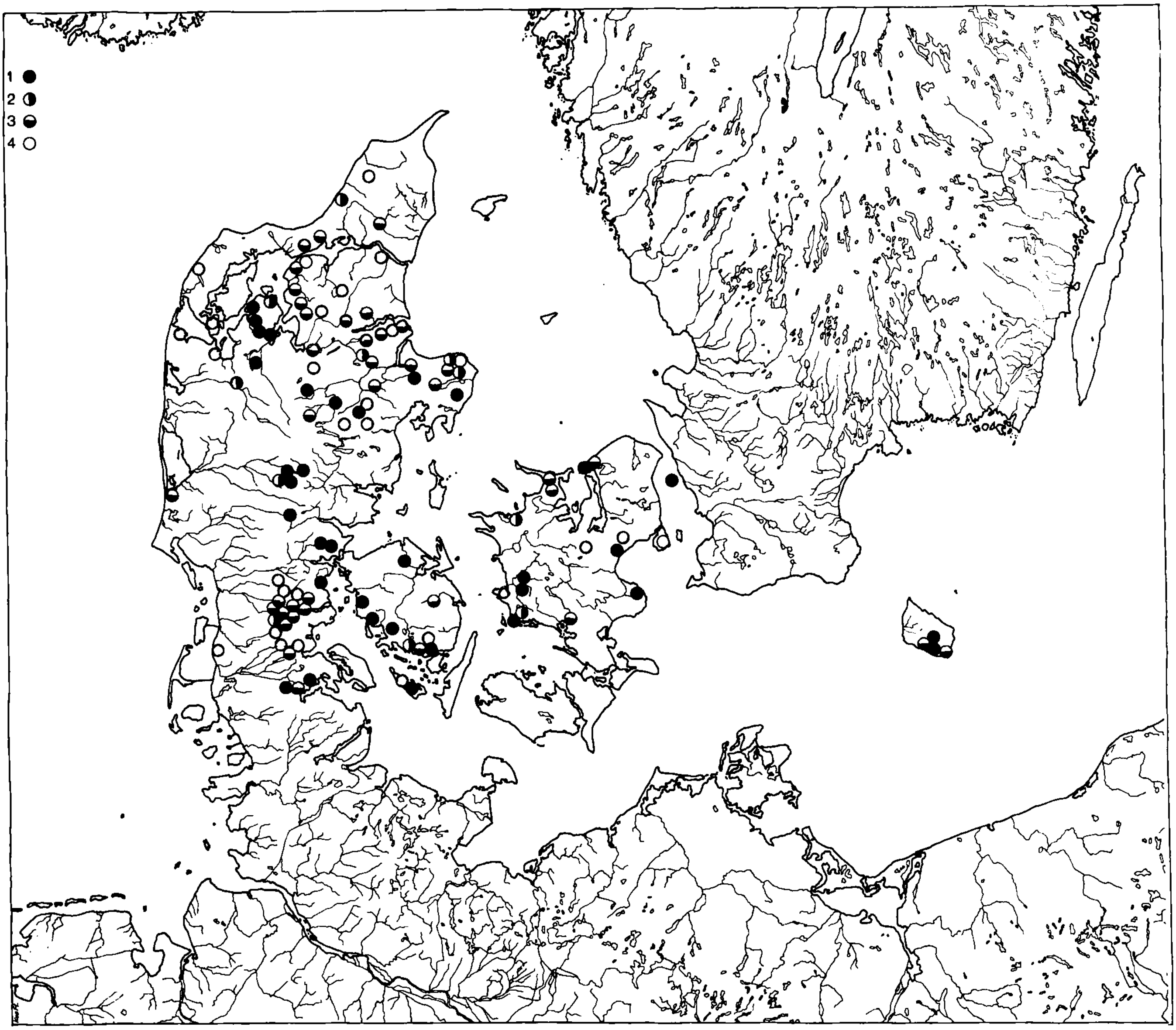

Fig. 6. Distribution of plough-marks from the period between the Bell-Beaker horizont (incl.) and 500 B.C. sub-soil signatures: 1. Clay, 2. Sandy clay/clayey sand, 3. Sand-gravel, 4. Unknown.

graphical range. The earliest known occurrences have for some years remained those found under megalithic long barrows (Thrane 1982). Later periods are all represented, the latest (so far?) being furrows from excavations in medieval cities (Madsen 1980; Noe 1976). Ard-furrows have been observed in Norway (Farbregd 1981), Sweden (Broadbent 1985), Poland, Germany (Gringmuth-Dallmer 1983; Zimmermann 1984), the Netherlands, Switzerland (Zindel & Defuns 1980), Great Britain (Fowler 1981; Lamb & Rees 1981), Italy (Forni 1980), India (Shinde 1987) and no doubt many other countries, so that we may regard the phenomenon as equally widespread as the ards themselves have been up to our present time (Hagen 1985).

The maps of ard-furrows do not indicate much about the genuine distribution of the agriculture of Prehistoric times. The distribution depends nearly one hundred percent on recent excavation activity and the interest in digging dolmens and barrows, which are the potential ard-furrow sources. What we see on the maps are reflections of the existence of these mounds and of the modern excavation activities.

The observation of plough-marks during the period between the date of the construction of the dolmens (and passage graves) and the Late Neolithic mounds largely becomes a local affair as mounds of the intervening (Single Grave) period are only excavated in Jutland (rare exceptions like Emmelev, Funen, have not given plough-marks).

Such factors as the fitness of the humus layer, the subsoil, the time interval between the actual ploughing and the covering of the ploughed area, the nature of the covering layer (turf or otherwise) are still little studied. As they must influence the preservation of the plough-mark, they should be given greater attention, if research into the plough-marks is to develop further.

It is interesting to note that heavy soils were ploughed right from the beginning. No matter whether one adheres to the ritual line or the practical interpretation it remains a fact that these soils were ploughed with ard (on the assumption that the basic interpretation is correct).

If clay soils could be ploughed once, they could be ploughed several times (and sometimes we have proof that they were, e.g. Lusehøj (Thrane 1984a)). This contradicts one of the old truisms of agricultural history, i.e. that primitive agriculture had to stick to the light soil. This dogma has played a vital role in the history of settlement during the Iron Age and for the discussion of the relevance of Bronze Age barrows to the knowledge of settlement patterns (Mathiassen 1948; Jankuhn 1952).

It is not a matter of looking at soil maps and deciding that an area is composed of heavy or light soil. At least on the Danish Isles the moraine left a landscape more like a patchwork quilt than a uniform carpet. It was nearly always possible to find a piece of land of a different quality if one wanted a special soil – for a settlement site or whatever purpose.

The introduction of ploughing into South Scandinavia is a rather crucial point in Danish Agriculture. In spite of recent early dates for the actual ards (Vebbestrup 910 B.C., Hvorslev 1490 B.C., Tauber 1971), the ards themselves cannot contribute much. The ard-marks under long dolmens remain the earliest evidence available. Thus we have a number of dates in Early Neolithic C (Thrane 1982) for this type of agriculture.

In view of the number of unchambered longbarrow

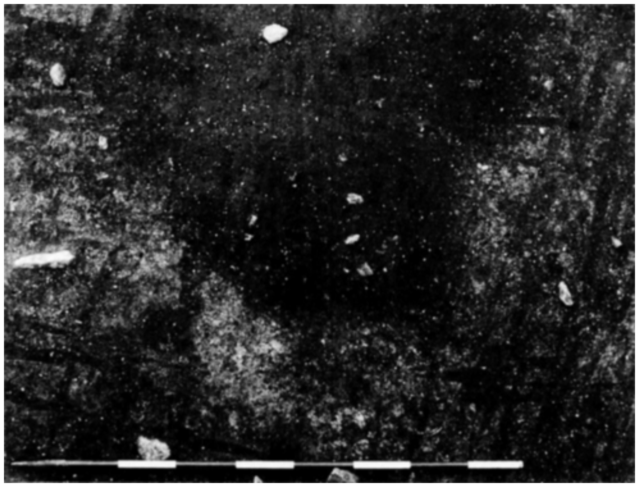

Fig. 7. Details showing ard-furrows cutting through earlier furrows and through earlier pit, Lusehøj, Voldtofte. Fyns Stiftsmuseum phot.

excavations during the last decades it is worth noting that none of these have produced ard-marks. These barrows are the earliest theoretical sources. Before them there were no earthworks able to preserve ardmarks, so we would have to rely on accidental preservation by sanddunes covering fields (so far not available so early). – We need more evidence if we are to decide that the introduction of the ox-drawn plough took place during or shortly before ENC. However, a date around this time could fit with the idea of a secondary Neolithic "revolution" (Sherratt 1981) characterized by oxen as draught animals (cf. the Bytyn oxen model, Piggott 1983, fig. 12 and ox-carts *ibid.* 35f.). A full plough-based agriculture presupposes a period of domestication producing a sufficient number of suitable animals for the purpose, but how long this may have taken is a matter of speculation.

Recent excavations indicate that shifting agriculture was systematic (Becker 1973; Draiby 1985; Thrane 1984a), although the evidence does not indicate the character of the system. The ploughing over of settlements or the placing of settlements on ploughed areas seems just as typical as the placing of burial monuments on ploughed surfaces. Even barrows were occasionally ploughed over (Single Grave mound at Hammel in East Jutland covered by Roman Iron Age enlargement excavated by Søren H. Andersen).

The shifting of fields may not just be result of the exhaustion of the fertility of the soil, although this would seem a likely explanation in some cases (e.g. Fragtrup (Draiby 1985)). This aspect has been given growing attention lately. (Lüning 1980; Rowley-Conwy 1981) while other causes for the moving of fields may be envisaged (Carneiro 1960). A system with alternating crops and fallow may have existed quite early and a total view of the cultivated area may have included the incorporation of deserted settlement sites. This aspect certainly deserves further attention. – Scientific analyses of buried cultivated soils will no doubt be able to contribute new knowledge of this and other problems (cf. Dalsgaard and Nørnberg 1982; Liversage *et al.* 1987; Ashbee *et al.* 1979).

The balance between agriculture and pastural production is another crucial point which has been discussed theoretically (Abel 1970; Poulsen 1980, 1983; Widgren 1979). It is important for the discussion of agricultural productivity (Nielsen 1980; 1984) which again is extremely relevant for our understanding of the role of agriculture in Prehistoric societies.

CONCLUSION

Problems which need to be examined during each excavation and during the continued study of Prehistoric plough-marks concern the ritual or practical interpretation.

The precise date of the furrows, the number of ploughings or at least the orientations of the furrows and the way the plough went – southwards, straight, tilted, lifted at obstacles, criss-cross or otherwise are all issues which must be decided in the field – in plano or in sectione. This is true also if we want to know the state of the field before ploughing – had the stones been removed? Stone holes may be just as visible as furrows – for the same reason. Were the mounds built on freshly tilled fields or at the end of the season after harvest? The surface of the buried ploughsoil may yield important clues but examination means painstaking work which may seem a waste of time. Are there chronological or chorological variations of the intensity of cultivation as indicated by the distance between individual furrows (the size of the squares between furrows)? Were light and heavy soils treated the same way?

If the study of ploughing is to go any further, we need a set of very detailed observations like the Store Vildmose case (Nielsen 1970; 1987) on a buried field under a Bronze Age or Neolithic barrow. This site would have to have good preservation facilities for pollen and preferably more than one criss-cross ploughing as well as good dating possibilities. The investigation would have to be planned as a close cooperation between scientist (palynologist and soil specialists) and archaeologists. If such a site is found, it should be reserved for this purpose.

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NOTES

1. This paper is a version of a MS written in 1984 for a volume of Fundamenta edited by H. Schwabedissen but not yet published. As it is not a general survey of the evidence or of the problems concerning Prehistoric Agriculture, several aspects have not been touched upon. Some I have gone into in ch. 8 of Thrane 1984a which is in Danish. A translation is contemplated.

   I must express my gratitude to all those colleagues who have been bothered by my enquiries for many years but patiently filled out my questionnaires – and hope that they will continue to do so: Niels H. Andersen, Søren H. Andersen, Jens Henrik Bech, Niels Axel Boas, Palle Eriksen, Christian Fischer, Mette Iversen, Erik Johansen, Svend Nielsen, Per Noe, Jens-Aage Pedersen, Anne-Louise Haack Olsen, Hans Rostholm, John Simonsen, Jørgen Skaarup, Niels Sterum, Sven Thorsen, Olfert Voss, Stine Wiell.

   With varying intensity and ardour material has been collected since 1966.

   Plough and ard are here used as synonyms.
2. While this paper were being written Peter Rowley-Conwy has shown me his note 'The interpretation of ardmarks' in *Antiquity* 1987, where he pleads for the ritual interpretation of the ard-furrows. I remain unconvinced. The ensuing discussion in *Antiquity* cannot be included in this paper which was finished in spring 1987.

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Appendix

List of sites

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ENC	Early Neolithic Period C.
MN I-V	Middle Neolithic Periods I-V.
SGK	Single Grave Period.
LN	Late Neolithic Period (Dagger Period).
EBA I-III	Early Bronze Age; Montelius periods I-III.
LBA IV-VI	Late Bronze Age, Montelius periods IV-VI.
?	No date, presumably Bronze Age.
AK	Aner & Kersten 1973 ff.
AUD	*Arkæologiske udgravninger i Danmark,* København from 1986 (1988).
AS	*Antikvariske Studier,* København 1977 & ff.
BOM	*fra Bornholms Museum,* Rønne
FRAM	*Fra Ringkøbing Amts Museer,* Ringkøbing
FyMi	*Fynske Minder,* Odense
HOM	*Museet for Holbæk og Omegn, Årsberetning,* Holbæk
JdA	*Journal of Danish Archaeology*
Pätz.	Pätzold 1960.
SOM	*Årbog for Svendborg og Omegns Museum,* Svendborg

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Parish no.	Site	Parish and site no.	Earlier than	Later than	Year of observ.	Reference	Sub-soil
	Zealand						
1.02.01	Ballermosen 1	Dråby	EBAII		1955	AKIII	sand
1.05.09	Askebakken	Torup	EBA		1952	AKI 254	clay
1.05.05	Præstegårdsjord	Melby	EBAII	Neo	1967	AKI 243I	sand
2.03.11	Broderhøj	Tårnby	?				
2.02.13	Tostrup Vesterby	Torslunde	?	?	1987	AUD 1987 38	
2.02.13	Bondehøj	Torslunde	EBAIII	LN?	1985	AUD 1985 21	
2.04.05	Himmelev	Himmelev 53	TNC		1968	JDA 1	clay
2.05.05	Karlstrup	Karlstrup 4	LN	Neo	1965	AKI 518	clay
2.06.01	Grydehøj	Allerslev	Migr. per.			Pätz. 27	
3.04.01	Asnæs	Asnæs	MNIb		1980	HOM 1980	sand
3.04.05	Drosselholm	Højby 1	?		1986	HOM 1986	clay?
3.04.05	Drosselholm	Højby 71	?		1987		
3.04.05	Sekshøje	Højby 239	EBA		1970	HOA 1983	sand
3.04.12	Jyderup skov	Vig	LBA		1970	NMArb. 1975	sand
3.06.03		Bregninge 13	EBAII		1976	AS2	clay-sand
4.03.01	Nygård	Boeslunde	LN		1986	AUD 1986 71	
4.03.14	Hyllerup	Slagelse	EBAIII	EBA	1985	JdA 5	clay
4.03.15	Galgehøj	Slotsbjergby	LBAIV		1946	Pätz. 26	clay?
4.03.19	Rødhøj	Tårnbjerg	LBA	Neo	1948	Ard&Plov p. 81	
5.02.14	Rosenfelt	Vordingborg land 112	MNIV		1969		sand
5.05.11	Jordehøj	Stege Land 7	MN		1988		clay?
5.06.04	Strandfogedgård	Holtug	EBAII		1966	AKII 1357I	clay
5.06.08	Østerhoved	Magleby 68	EBA		1973		clay
5.06.08	Østerhoved	Magleby 33	EBAII				clay-sand
5.06.12	Fuglebæksbanke	Stræby	MNIb		1968	Årb 1973	clay
5.07.07	Ålestokhøj	Næstved Land 73	EBAIII?		1874		sand
	Bornholm						
6.02.03	Alhøj	Pedersker	EBAII		1958	AKIII 1465	clay
6.02.03	Store Loftsgård	Pedersker	EBAIII	LN	1957	AKIII 1477	sand
6.02.03	Billegravsgård	Pedersker	EBAIII	Neo	1957	AKIII 1466	clay
6.02.04	Jomfrugård	Poulsker	EBAII	LN	1958	AKIII 1482	sand
6.02.05	Runegård	Åker	LN		1985	BOM 1986	sand
6.02.05	Limensgård	Åker	?		1984		
	Lolland						
7.06.08	Frejlev	Frejlev 228	MN		1973		clay
	Funen						
8.02.04	Snave	Dreslette	TNC	Neo?	1976	FyMi 1982	clay
8.02.04	Brydegård	Dreslette	LBA		1974		clay
8.03.07	Kappendrup	Rolfsted	EBAII		1974		sand
8.05.07	Glavendrup	Skamby	EBAIII		1958	AKIII 1874	clay
8.02.05	Lusehøj	Flemløse	LBAIV	EBAIII	1973	Lusehøj	clay
9.04.14	Håstrup	Håstrup			1987	AUD 1988	clay
9.04.26	Hannemosehøj	V. Skjerninge	LBAVI		1981		sandy clay
9.05.04	Højensvej	Egense	EBAIII	EBA	1985	SOM 1985	
9.05.04	Egense	Egense	LBAVI		1972		clay
9.05.07	Capeshøj	Bjerreby 30	TNC/MNI		1977	AS4	clay
9.05.16	Holmebo	Ø.Skjerninge	LBAVI		1985		sand
9.06.14	Hudevad	Søllinge	EBAIII		1988		clayey sand
9.07.04	Lille Rise	Rise 26	LN/EBA		1976		clay
9.07.06	Vesterløkke	Tranderup 13	LN/EBA		1980		clay
	Jutland						
10.01.18	Sønder Vrå	Vrå	ENeo			Pätz 24	clay?
10.02.04	Nørrehede	Hallund 75	?		1966		sand
10.04.04	Grønhøj	Ingstrup 31	EBAII			Pätz 25	clayey sand
10.06.15	Hedelykke	Tornby 23	TNC		1967		sand

Parish no.	Site	Parish and site no.	Earlier than	Later than	Year of observ.	Reference	Sub-soil
10.07.02	Bejstrup	Bejstrup	LBAIV		1984	AUD 1984	sand
10.07.07	Kokkedalsmark	Torslev 19	EBAII	EBA	1982		sand
11.01.13	Vibberstoft	Villerslev	SGK		1984	MIV 13	sand, clay
11.03.04	Dyrhøj Bakker	Nørhå 75	EBA		1961		
11.03.07	Højgård	Skjoldborg 54	SGK		1979		sand
11.04.07	Galtrup	Galtrup	EBAIII		1987	AUD 1987 159	
11.04.09	Skærbæk	Sejerslev 11	NMV		1959		
11.06.03	Oddersholm	Gettrup 84	SGK		1981		clay
11.06.07	Kildevænget	Hvidbjerg 35	ERAIII		1974		
12.01.03	Kongehøjgård	Gudum	?		1981		sand
12.01.05	Kirkelygård	Klarup 219	EBA		1970		
12.02.02	Lille Binderup	Binderup	EBA		1985		sand
12.02.12	Myrhøj	Strandby	EBA	LN		Kuml 1972	sand
12.04.03	Brohøjgård	Døstrup 53	SGK		1974		sand
12.02.04	Fragtrup	Farsø	LBAIV-V	LBAIV-V	1962	Årb 1981	sand
12.04.08	Lundgård	Rostrup 45	EBAIII		1957		sand
12.06.15	Brunmosegård	Åby	ERIA		1984	AUD 1984	
12.07.08	Vadgård Syd	Næsborg	EBAI		1976		sand
12.07.08	Næsborg	Næsborg 34	EBAIII		1977		sand
12.07.05	Tollerup	Løgsted	ERIA		1987	AUD 1987	
12.18.11	Lynnerup II	Skivum	MN Ib		1986	AUD 1986	
12.08.61	Blære	Blære	SGK		1982		sand
12.07.08	Aggersund	Næsborg 20	LN		1974	KUML 1975	sand
13.01.03	Stoholm	Foldingbjerg	?	Neo	1987	AUD 1987, 219	
13.01.07	Snebæk	Kobberup	?	Neo?	1987	AUD 1987, 222	
13.01.07	Lærkenborg	Kobberup 106	SGK		1975	MIV 6	sand
13.01.16	Skibshøj	Vroue 125	EN		1977	SKALK 1977	
13.01.17	Sønderhald	Ørslev Kloster	SGK		1990	MIV 1	gravel
13.02.01	Toustrup	Durup 24	EBAIII		1987		clay
13.02.04	Dalgårde	Harre	LBAIV		1987	AUD 1987, 239	clay
13.02.11	Bodshøj	Åsted	MNI		1980		sand
13.03.04	Ø. Kejlstrup	Gødvad 7	EBAII?	SGK	1971		
13.03.08	Tandskov	Serup	Neo		1984	AUD 1984	gravel
13.04.02	Vikærgård	Dølby	EBA?	LN?	1986	AUD 1986, 286	clay
13.04.05	Hvidbjerg	Hvidbjerg 40	EBAIII		1984	AUD 1984	sandy clay
13.04.06	Vestergård	Oddense 49	EBA		1985		clay
15.05.04	Sortehøj	Gullev 22	LN				clay
13.05.07	Aldrupgårde	Hvorslev	SGK			Kuml 1954	sand
13.05.09	Aptrup	Sahl	SGK		1963	Kuml 1964	clay
13.06.09	Lille Mølle	Levring 24	?		1985		sand
13.06.11	Demstrup	Sjørslev	EBA?		1968		clay
13.06.13	Gråhøj	Vinderslev	EBAIII		1962		sand
13.08.01	Lille Asmild	Asmild	EBAII		1969		?
13.08.08	Dalbæklund	Løvel	?	LBA	1967	MIV 1	sand
13.09.09	Sdr. Borup	Låstrup	SGK	Neo	1965		sand
13.09.15	Lerkenfeld	Vesterbølle 12	EBA?	Neo	1964	Kuml 1964	sand
13.11.01	Breum	Grinderslev	LBA	LN	1986	AUD 1986, 310	?
13.11.03	Jebjerg	Jebjerg	?		1987	AUD 1987, 263	?
13.11.05	Bostrup	Lyby 74	?		1987		sand
13.11.07	Lindum	Selde 51–53	EN?		1976	AS4	sand
13.12.02	Over Hornbæk	Hornbæk	NMIb	TNC	1984	AUD 1984	clay
13.12.07	Rejstrup	Sønderbæk 32	EBA?		1975	AS4	sand
14.01.04	Svapkær	Rimsø	LNA		1968		sand
14.01.06	Marshøj	Gjerrild	LN		1975		
14.01.07	Korup	Kold	EBA		1985	AUD 1985, 241	Sand
14.01.10	Egehøj	Hemmed	EBAII		1969		sand
14.01.10	Hemmed	Hemmed	LNC		1987	AUD 1987, 273	sand

Parish no.	Site	Parish and site no.	Earlier than	Later than	Year of observ.	Reference	Sub-soil
14.01.14	Rimsø	Rimsø	EBAII				clayey sand
14.02.06	Diverhøj	Homå 18	LNA & EBAII	LNA	1983	JdA 6	sandy clay
14.03.14	Lille Tvillinghøj	Ørum 7	EBAII		1967		sand
14.04.09	Vesterskovmark	Udbyneder	EBAIII		1971		sand
14.03.12	Dejrhøj	Ødum	SGK		1985	AUD 1985, 249	sandy clay
14.03.12	Kikhøj	Ødum	SGK		1986	AUD 1986	sandy clay
14.06.01	Asferg Nørremark	Asferg 32	SGK		1970		sand
14.06.06	Greneshøje	Kousted 23	EBA?		1980		sandy clay
14.06.10	Tørslev Sten	V. Tørslev	EBA		1984	AUD 1984	sand
14.07.08	Lindegård	Sem 19	LN	LNA	1984	AUD 1984	?
14.10.03	Kobbelgård	Fausing 45	EBA?		1975		sand
14.10.07	Tvillingehøj	Fausing	SGK		1972		?
14.10.07	Bavnehøje	Koed	EBA?		1979		gravel
15.05.05	Åbenrågården	Skivholme	EBA?	EN A-B	1983	AUD 1985, 265	sandy clay
16.01.04	Grønhøje	Hammel 13	EBAIII	SGK			?
16.01.05	Singelsbjerg	Linå 138	SGK	ENC	1972	NMArbm. 1973	sand
16.05.02	Hanstedgård	Hansted	?		1987	AUD 1987, 349	?
16.05.03	Brørup Skovgård	Hylke 63	SGK		1968		sandy
16.05.09	Gedved	Tolstrup	LBA?		1986	AUD 1986, 398	?
16.06.06	Rosenlund	Them 351	SGK		1971		sand
16.06.06	Løvenholt	Them	ENC		1978	AS4	mixed
17.07.02	Trappendal	Hejls	EBAII		1975	JdA 2, AK IX, 4393	clay
17.02.04	Herslev	Herslev 3	?			AS4	clay
17.02.04	Herslev	Herslev 8			1986	AK IX, 4281	?
17.04.10	Præsthøj	Tyrsted 22	MNIa		1972		sand
17.08.13	Krudhøj	Thyregod 218	EBAIII		1969	AS1	clay
17.08.13	Neder Thyregodlund	Thyregod 98	EBA?		1978		clay
17.08.13	Neder Thyregodlund	Thyregod 97	?		1978		clay
17.08.16	Vesterlund	Vester	EBA	?	1908	Kuml 1967, AK IX, 4493	clay
17.09.02	Damhalehøj	Gadbjerg	EBAII	SGK	1962	Årb. 1967, AK IX, 4517	clay
18.02.09	Sevel	Sevel	EBAII		1947	Kuml 1952	clay
18.03.02	Bukkær	Assing 121	EN		1977		?
18.03.03	Jersild	Aulum	ERIA	BA	1982		mixed
18.03.13	Lustrup	Skarrild 41	SGK?		1977		?
18.03.13	Skarrild	Skarrild	SGK		1978	FRAM 1987	sand
18.04.04	Holmsbos Forstrand	Holmsland	?	LN?	1987	AUD 1987, 384	sand
18.05.05	Hillersborg	Gimsing	EBA		1985	AUD 1985, 320	clay
18.04.14	Langagergård	Torsted	TNC/MN I		1973	FRAM 1987	?
18.09.17	Højris	Hygum 62	LN		1976		?
19.05.06	Nygård	Guldager 219	MNI		1977		sand
19.07.08	Lille Dalgård	Vejen	EBAII?		1977	AK VIII 3982	sand
20.02.02	Jernhyt	Hammelev	LN		1982	AK VII 3241 I	gravel
20.02.03	Jegerup	Jegerup 36	EBA?		1945	AK VII 3432	?
20.02.03	Tingvad	Jegerup 28	EBA	SGK	1978		?
20.02.04	Arnitlund	Jegerup 57	EBA	?	1958	AK VII 3559	?
20.02.07	Lundingsminde	Oksenvad 107	EBAIII		1980		?
20.02.08	Skrydstrup	Skrydstrup 32	?		1944	AK VII 3522	sand
20.02.08	Skrydstrup	Skrydstrup 31	EBAII		1944	AK VII 3521	gravel
20.02.11	Billund	Vojens 68	EBAII		1978	AK VII 3590	sand
20.02.11	Vojens	Vojens 36	?		1953	AK VII 3597	sand
20.02.11	Billund	Vojens 67	EBA		1978	AK VII 3589	sand
20.02.11	Billund	Vojens 69	EBA		1977	AK VII 3591	clayey sand
20.02.11	Vojensgård	Vojens 13	LN		1957	AK VII 3602	?
21.02.03	Hjerpsted	Hjerpsted 49	EBAI		1974	Kuml 1975	clay
21.03.03	Steneng	Døstrup	MN I		1963	Skalk 1963	sand
22.01.02	Tovhøj	Bov 21	EBAIII?		1975	AK VI 2961	?
22.01.02	Frøslev	Bov 116	EBAIII		1975	AK VI 2965	sand

Parish no.	Site	Parish and site no.	Earlier than	Later than	Year of observ.	Reference	Sub-soil
22.01.02		Bov 46	ENC		1982		sand
22.01.06	Vilsbæk	Holbøl 2	EBAIII		1975	AK VI 2988	?
22.02.02	Sdr. Ønslev	Hjordkær 14	EBAIII		1975	AK VI 3025	sand
22.02.04	Søst	Rise 45	EBA		1975	AK VI 3068	clay
23.03.03	Nybøl Nor	Nybøl	ENC		1981		clay

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Early Bronze Age Spiral Ornament – the Technical Background

by PREBEN RØNNE

INTRODUCTION

"There is something eloquent, yet restrained and academic, in the Spiral Style of the Early Bronze Age. The turns of the spirals are close, the punching masterly in its technique, a play of light on the broad surfaces of the bronze; and yet the effect is created merely by means of the fine punch line." (J. Brøndsted 1939, pp. 63–65).

One of the features intimately linked with the Early Bronze Age in Scandinavia is spiral ornament. The spirals, and the jewelry and weapons on which they occur, have become an important element in the popular picture of the Scandinavian Bronze Age. The spirals have intrigued and captivated observers. The belt discs in particular are decorated with innumerable spirals, like the one from Langstrup, which is often depicted, as being one of our finest pieces of ancient metal craftsmanship (fig. 1). The spirals are close and executed with almost incredible precision. They are drawn as a groove, interrupted at the centre of each spiral. The ends of each groove exit at precisely the same angle, it has a uniform width and the coils are equally far apart (fig. 2). As Brøndsted says, the execution of the spiral ornament is masterly in its technique.

Spirals are the absolutely predominant motif on bronze objects in the middle of the Early Bronze Age. In Period I, they begin to appear on a few objects; in Period II they are ubiquitous, being found everywhere where a spiral can be formed, and in innumerable variations and combinations. They continue into Period III, but to play a more modest role.

The very important part played by spiral ornament in the Bronze Age has made it a prime target for study. It has had regional, chronological and technical significance for our perception of the period, and nearly all students of the Bronze Age have in one way or another worked with it and formed an opinion on its origins.

If one works with ornamental detail and style in archaeological material in the modern manner (e.g. Rønne 1987a-b and 1989), the technique behind the ornaments is in principal of no consequence. It is the final form which is important. But only in principle, for if further interpretations are to be put on the style, it is in many cases necessary to know the technique behind the production of the individual details, so as not to confuse technique with art; but there may be other reasons.

It is commonly assumed that the spiral ornament of the Bronze Age has been punched into the surface of smooth-cast bronzes. There are a number of features, however, which suggest otherwise. The great uniformity and consummate precision show that the spirals cannot have been individually punched: another technique must have been used. It must have been one which made possible a standardized production of many uniform spirals on the same object. The only technique which fulfils this criterion is casting "à cire perdue". The geometrical uniformity, seen for instance in the belt from Langstrup, could be obtained only by forming the spirals with the same stamp. A stamp in the form of a spiral must have been pressed into a wax model and the spirals have been already formed in the bronze in the casting.

In the following, some of the points invalidating punching as the only method of producing spiral ornament will be discussed and the case for believing that this ornament was in all probability stamped into the model will be stated.

THE PUNCHING THEORY AND THE RESEARCH-HISTORICAL BACKGROUND

As far as research history is concerned, the technical discussion is closely bound up with the chronological division into three periods: Stone, Bronze and Iron Ages. The acceptance of this division came to hinge on the technique employed to produce Bronze Age ornament. Opponents of the tripartite division argued that the

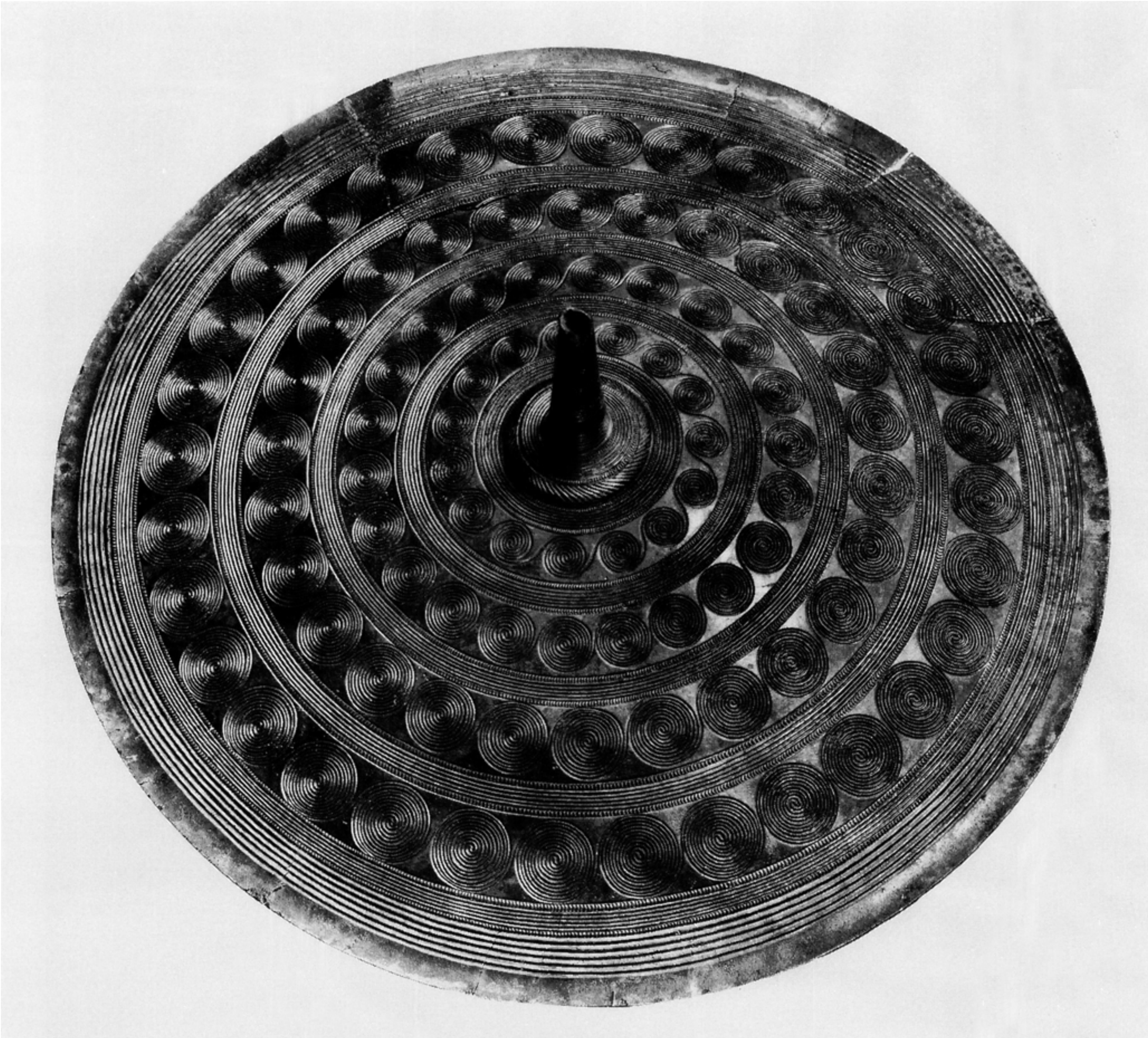

Fig. 1. The belt disc from Langstrup in Northeastern Zealand is one of the finest pieces of craftsmanship known from the Early Bronze Age. (National Museum photo).

coration could not have been made without knowledge of steel, proponents that it could.

Actually, this is not the place to discuss research history, but the research tradition does have a decisive effect on our present perception of Bronze Age technique, and some of the background should be understood. This can be done succinctly by quoting Sophus Müller, who in *Vor Oltid* from 1897 discussed the arguments behind the tripartite division. In European context, the discussion was hardly over, but in Scandinavia the division was accepted without question. The quotation reveals something of the background behind our present chronological system and its dependence on an understanding of the metal technique of the Bronze Age.

"It long remained a mystery by what technique the fine line ornaments so characteristic of the Scandinavian Bronze Age were produced. That they were not made during casting was clear enough: for that they are too sharp-

Fig. 2. Detail of the ornament bands on the Langstrup belt disc. Centres, spiral grooves and coils are absolutely uniform within each band. (National Museum photo).

ly defined. They could not be engraved, because iron was not known in the Bronze Age; and good quality steel is also required to cut hard tin bronze. Opponents of the Bronze Age maintained, on the contrary, that the ornaments could have been produced only with a steel burin. This little tool therefore long remained a dangerous weapon threatening the very heart of the tripartite division: if steel was available for making the ornament, the concept of a Bronze Age would have to be abandoned."

"It was a Copenhagen craftsman, the goldsmith Boas, who solved the problem. He often visited the National Museum, and the curators were not slow to notice that he had a good eye for ancient metal technique. He was asked about the execution of Bronze Age ornaments and urged to discover how they could be produced without using steel, only bronze tools. On the following day goldsmith Boas brought a piece of brass on which he had with a punch of the same metal executed the spiral ornament described. This answered the question posed by both proponents and opponents of the Bronze Age theory: the ornaments have been punched. Bronze can be chased with bronze." (Müller 1897 pp. 257–58).

The perception of the technique behind Bronze Age line ornament which Müller described in the light of research history at the end of the previous century has in this century been generally accepted. Popular archaeological handbooks carefully describe how the bronzes have been chased, and learned theses are based on the assumption that all spiral and circle ornaments have been hammered with great force into the smooth bronze surface. It has now to be asked, however, whether the proof of the theory on the punching of line ornament is still satisfactory, more than a hundred years after it was formulated.

With copper, tin and the alloy bronze, North Europe entered an epoch in which metal and metalwork influenced developments. To Scandinavia, all raw material was imported in a given form, but it could be melted, cast and shaped according to local wishes or tradition. Local metal techniques became important to the community and were prerequisite to the change from Stone Age self-sufficiency to Early Bronze Age dependence on import of raw materials.

The bronze objects were produced by craftsmen who had mastered the technique of melting and casting metal. Their form and decoration were a result of the technique or techniques these bronze-casters had mastered. Our knowledge of technique is crucial to the interpretation. Technique is therefore always an important aspect of Bronze Age research.

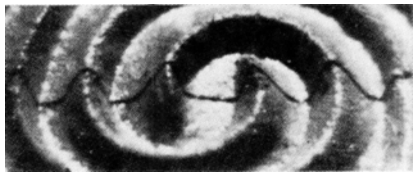

Fig. 3. Enlargement of the centre of one of the spirals on the Langstrup belt disc, photographed from a silicone rubber cast. The black stripe crossing the raised spiral groove impression is a shadow caused by a hair. Even at this strong magnification, not a single punch mark is visible. (After Savage, Lowery & Shorer).

The immediate reason for taking up this subject once more at the present juncture is a recent doctoral thesis from Lund University. This deals with the technical basis for decoration, especially spirals and concentric circles (Herner 1987). Herner bases her work and interpretations on the traditional and widely accepted view that the spiral and circle ornaments were punched. On the basis of this technical belief and a qualitative evaluation of the ornaments, far-reaching culture-historical conclusions are drawn.

The punching technique is thoroughly treated in many places – also in recent works – but as things stand I believe that punching as the predominant technique for forming line ornament in the Bronze Age is no more than a widespread and accepted postulate. As will be apparent from the following, another technical explanation is possible.

PUNCHING AS A TECHNIQUE FOR PRODUCING SPIRAL ORNAMENT

Under the influcence of archaeological tradition, I have previously worked on the assumption that the line and point ornaments were stamped into a cast and smoothly polished bronze surface. But personally, I have never accepted that the spiral lines were hammered in the smooth surface of the bronze. There are several reasons why not, and I will present them briefly here. My argumentation and documentation will concentrate entirely on the spirals.

1. Lack of punch marks. I myself have seen original spiral ornaments only at the magnification provided by an ordinary magnifying glass. Normally the groove is entirely without damage to the sides, and it has a very uniform deep and even bottom without visible damage. One of the spirals from the Langstrup belt disc is illustrated in fig. 3 at a very considerable magnification. There are *no* traces of marks produced by punching.

According to the punching theory, ornaments are produced with continual small blows on the head of a small chisel-like instrument which is slowly moved forward. In this way, continuous smooth lines are supposed to have been chased.

After personal attempts to punch spirals with a steel punch in copper, which is much softer than bronze, Elisabeth Herner writes that the blow has to be extremely heavy to make the deep grooves of which most good spirals are made (Herner 1987 pp. 143–45). She did not manage to make a deep groove by punching, but the slightest blow on the punch made adventitious marks which could not be erased later. It was not possible to produce an even spiral line, and the punched groove mostly consisted of small, short elements.

Herner concluded from her experiments with the punching of spirals that Bronze Age chasers must have been highly skilled, because none of the features she mentions can be observed in the original Bronze Age spirals. Her experiment is very illuminating: it is only in theory that lines can be formed from an infinite number of points. In curved lines, of which the spirals are formed, a punch will always leave marks after each blow as a regular row in the sides of the groove. These must be found all along the groove in its sides and bottom. A curved line made up of many short straight bits would *always* reveal this at a suitable magnification.

Fig. 4. Presumptive punch. (After Sophus Müller, c. 1:1).

It is clear that a broad punch must leave a broad track if the whole tool is hammered down into the bronze surface. The broader the punch, the clearer the marks and notches in the whole groove and its edge. If an attempt is made to make the punch narrow until it is almost a fine point – it has been suggested that awls were used as puncheons (Herner 1987 p. 141 and p. 146 note 23) – then the traces must be seen as unevenness over the whole bottom of the groove. A sharp object hammered with great force into a hard, smooth surface must leave traces after every blow. It would make no difference if punches with curved edges were used, for the curve changes constantly in a spiral.

I have not seen traces of punches showing precise, regular, small blows all along the ornament groove, either in circles or spirals of the Early Bronze Age. Occasional notches may be seen in the centre of some spiral grooves, which have been identified as punch marks and as evidence of punching as a working method, but they are found only in the centre. Have the Bronze Age chasers really been able to deliver so precise a blow that we are unable to ascertain a single mark throughout an ornament groove?

2. Absence of traces of punch blows in the metal matrix. It is not only macroscopically that we should expect to see traces of punch blows: They should also be visible in the structure of the actual metal. With electron microscopes we can see the crystalline structure of bronze. Andreas Oldeberg has had an ornament groove analysed (Oldeberg 1976 p. 89). The metal showed no sign of destruction. Oldeberg attributed the absence of traces to annealing of the metal after punching.

3. No proper punches have been identified, and the curve and constant width of the ornament lines do not accord with punches. A few bronze objects have been identified as punches, but it has not been demonstrated satisfactorily that they have been used to chase line ornaments like spirals and circles. Müller depicts an almost chisel-like bronze implement and suggests that it was used as a punch (Müller 1894 p. 258 fig. 148, here fig. 4). It can naturally not be ruled out that it was used to hammer lines in bronze, but the edge is about 3 mm wide. It cannot possibly have been used to produce such curved

Fig. 5. No punch marks can be seen in the grooves, and the straight lines between the spirals do not meet. This shows that another technique must have been used.

lines as we see in spirals or circles with a diameter which is often less than 10 mm; and the innermost curves are less than 3 mm in diameter. Some scholars have recognized the difficulties and suggested that the corners of the punches or awls were used, but with the strong blow necessary, such fine points or corners would inevitably have been compressed at the very first blow and the width of the groove slowly increased until the punch were resharpened or replaced by another.

4. Flaws in particular parts of the running spirals. Flaws and inaccuracies are not unusual in the ornaments. For example, some spirals do not link in the joining lines, or two spirals overlap. These faults are known even in spiral ornaments with a very precise execution and no traces of punching. Many of these very faults render it extremely unlikely that the grooves were punched so precisely in the hard bronze surface that the blows cannot be seen, and that there are no faulty blows. It can hardly have been possible for the chaser to have concealed every trace of the punch blows, if he could not get two lines over a millimetre wide to meet (fig. 5). It is equally remarkable that it is usually the straight stretches between the spirals which fail to join. A straight line must be easier to punch continuously and without marks than a curved one!

5. Punching of objects which are difficult to support. The very hard and precise blows that punching would have required would also have required a support which could absorb the blow, but at the same time have been firm enough to leave a distinct impression of the punch in the bronze surface. This would have caused serious problems when particular types of artefacts were chased, for example double buttons, tutuli with centre boss and spearhead sockets. They would have been almost impossible to support properly, when the precise and hard punch blows were to be made.

6. Uniform centres. In the centres of spirals there are sometimes one or more small notches in the first millimetres of one or both grooves. It is remarkable that the small marks are often exactly alike in practically all the spirals of the same band. This might have occurred in individual production of the grooves, but it seems unlikely. The marks are not punch marks, and I will return to their origin below.

7. Geometrically uniform spirals. The spirals are commonly geometrically the same in the same running spiral band or spiral group. This applies especially to the innermost coils. There are many exceptions, but these can all be explained. The usual thing is that the spirals, if drawn separately, could nevertheless be superimposed. It is not merely the regular curved lines which are geometrically alike; the same applies to many irregularities in the spirals. This is practically unthinkable in individually punched spirals.

CIRE PERDUE CASTING

Archaeologists have known for a long time that ornaments were cast in the Bronze Age. This applies primarily to the deep ornaments on swords. The few pieces of jewelry with openwork ornament are also generally believed to have been cast with the ornaments. The cast ornaments are – in well-preserved pieces – very sharply defined.

Nor is there any doubt that some of the decoration in many women's accessories must have been cast, for instance the ribbed centre found in many gorgets. Many belt discs and tutuli have a moulded bead or ribbed ornament around the centre spike. Such decoration cannot be produced by blows of any kind.

B. Brorson-Christensen has in the course of conservation worked with the sounding plates of the lures. The backs are not polished and the surface therefore appears as it was when it was removed from the mould. On these and other pieces, fine lines have been observed: "in many places we see... how incredibly sharply fine incised lines in a wax model are reproduced in casting" (Brorson-Christensen 1966 pp. 343–44). It is generally recognized that the lures were cast à cire perdue.

There can be no doubt that the plastic ornaments could be cast in a way to stand perfectly sharp on the finished bronze, also point and line ornaments. The question remains: why should spirals and the other detail not be cast at the same time?

One would already expect to find scratches or other unevenness in the mould on the first pieces cast by the smiths. But people of the Bronze Age were just as inventive and practical as we are: It did not need many scratches for the Bronze Age smiths to realize what they could be used for. Once they had realized how much was to be saved by making the decoration in the wax, they made it there. It would have been easiest to make the spirals in soft wax, and we usually seek the easiest and best solution.

Müller, and others with him, have maintained that casting could not reproduce the detail found on the spirally ornamented objects, but this is not so. There are not only the fine cast lines on the sounding plates, but many more recent cast bronze statues and other small cire perdue cast objects contradict this claim. Even much finer detail than spirals can be reproduced sharply in casting. Photographs from modern casting processes show that very fine details can be faithfully reproduced (e.g. Jackson 1972 p. 81).

We know for certain that cire perdue casting was used in the Early Bronze Age. The horse drawing the sun chariot from Trundholm is a well-known example (Drescher 1962 p. 42), but it is not only that which has been cast using the "lost wax" method. Many other Bronze Age forms cannot possibly have been cast in any other way. Ci-

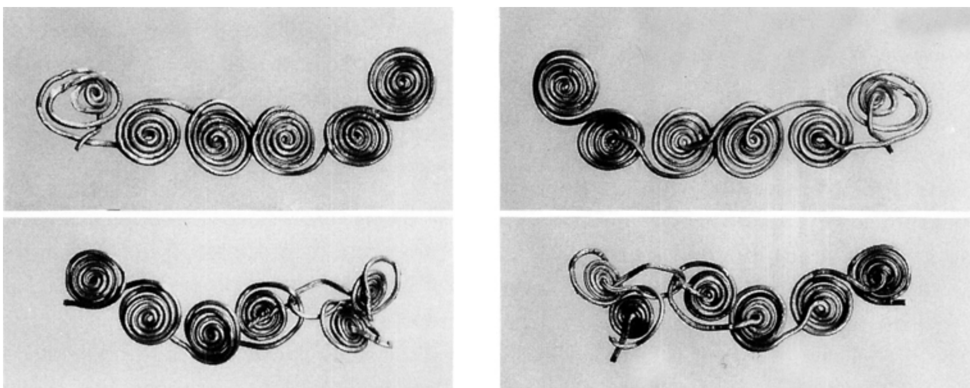

Fig. 6. Coiled gold thread found in a so-called "wizard's bag" in a grave in Hornherred, Zealand. The wire has a mean thickness of about 0.8 mm. (National Museum photo, c. 1:1).

re perdue casting has been a well-known and widely used technique in the Early Bronze Age.

A recent and important technical study has demonstrated that ornament lines – in two cases from the Late Bronze Age at least – were really cast (Knudsen 1978): Two bronze neckrings from Trørød in northeastern Zealand. Svend Aage Knudsen has with metallurgists from the Danish Technological Institute at Tåstrup studied their ornament grooves. It could be clearly demonstrated that the grooves were cut, and microtraces showed that parallel groves were cut with the same tool. The grooves were cut into a wax model on which the mould was made.

There can therefore be no doubt that it was possible to cast line ornaments, as we know them from the Bronze Age, and the technique was known and exploited in the Late Bronze Age and most likely also in the Early Bronze Age.

It must be concluded that it was possible to form the spiral ornaments in the wax model and thus to transfer them to the bronze already during the casting process à cire perdue. This is a far more likely procedure than punching after casting.

HOW WERE THE SPIRALS FORMED IN THE WAX? – BALLERMOSEN AND AN EXPERIMENT

In a soft material like wax, the spirals could have been made freehand, for example be cut or scratched; but there is not much in their form to show that this was the case. Among other things, the uniformity and precision speak against individual shaping. The literature contains several attempts to explain the precision of the spirals, for example string compasses or concentric circles with moving centres (Ringbom 1933 and Savage, Lowery & Shorer 1982). There is perhaps an even simpler explanation: the spirals have been impressed with a stamp, explaining both the accuracy and the uniformity.

In a grave from Ballermosen in Hornsherred, Zealand, a round, spirally wound gold wire 0.8 mm thick with 12 spirals in a row has been found (fig. 6, Ke I 112 A), broken into three pieces. The spirals are about 1 cm in diameter. If one or more of the spirals is pressed down into a plate of wax, an impression of a spiral or several in a row will be obtained.

It will not be claimed here that this piece has been employed to produce spiral ornament, since its spirals are not quite like those we see decorating bronzes; but it inspired a little experiment with a round copper wire and a small disc of beeswax. The wire was wound up in various ways and then pressed into the wax. The impressions were then compared with the original spiral ornaments.

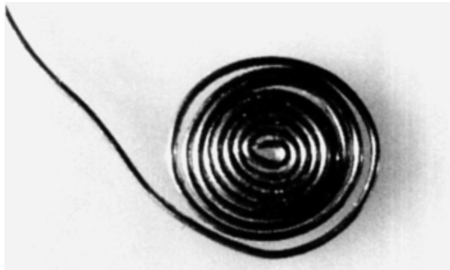

Fig. 7. Spiral 1, coiled copper wire.

Fig. 8. Drawing of a running finished spiral. (After Sophus Müller).

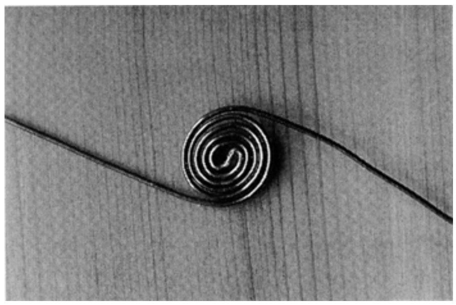

Fig. 9. Spiral 2, coiled copper wire.

Spiral 1. In the first attempt to roll wire into a spiral, a start was made from one cut end (fig. 7). The wax impression yielded a clear spiral, but several placed together did not give a running spiral as known from the Bronze Age. Both the centre and the way the spirals could be joined were wrong in a composite row, whereas the impression corresponded to the outermost spiral in a completed spiral row (fig. 8).

Spiral 2. The next wire was wound up in an attempt to produce a running spiral, i.e. a spiral in which the wire reaches out to two sides. It was bent in the middle and wound about the bend. In this way a regular running spiral (fig. 9) was produced. The individual impressions

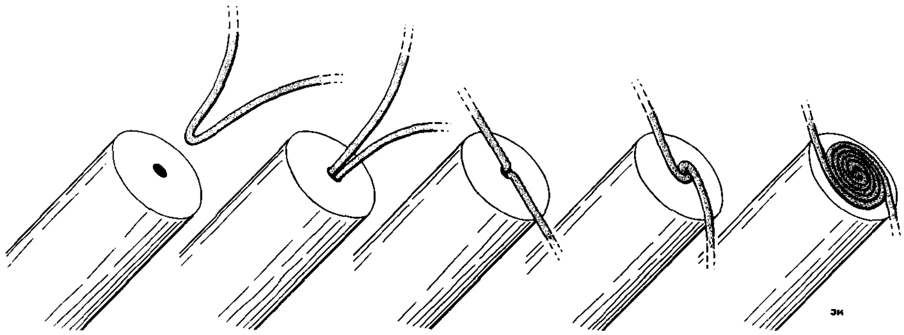

Fig. 10. Spiral 3. The copper wire is coiled as illustrated in the drawing. (J. Kraglund del., after SKALK 1988:6).

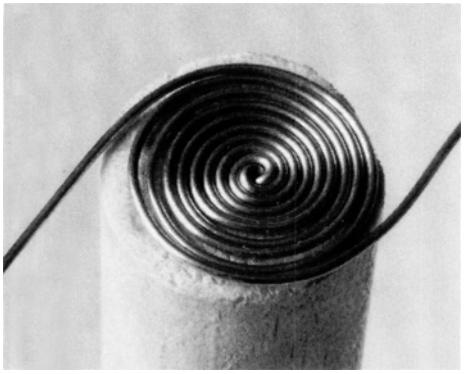

Fig. 11. Spiral 3 as a finished stamp.

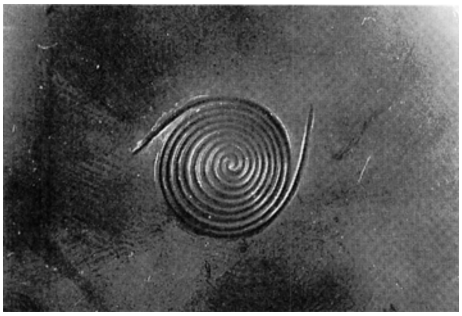

Fig. 12. Impression of Spiral 3 in wax.

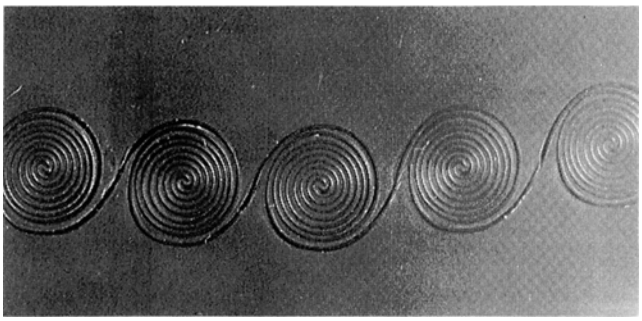

Fig. 13. The individual impressions of Spiral 3 can be assembled to form a running spiral.

could be placed together to form a long row, which could run back into itself. The centres of the spirals, however, differed from practically everything we know from the Bronze Age. The groove continued unbroken through the centre of the spiral. In the original spiral ornaments it continues unbroken only in connection with two interrupted grooves in the centre.

Spiral 3. With Spiral 2, a running spiral could be impressed in one long continuous groove, but nearly all Bronze Age spirals consist of two grooves both of which break in the centre. In order to obtain this picture, the wire had to be broken in the middle and not just bent back. Two single spirals like Spiral 1 could be placed together with the free wire turned in opposite ways. This did yield a running spiral consisting of two grooves which were not joined at the centre, but the two wires were impossible to manage, and the impression in the centre was not like the original one. Distance and angle between the grooves changed, for instance. It was therefore evident that the stamp could only have been formed from one continuous wire, although the wire had nonetheless to be broken in the middle. The only way this picture could be obtained was by not merely twisting the wire at the bend, but also making the wire disappear backwards in the centre of the spiral. Fig. 10 shows how the desired picture was obtained. First, a hole was made in a small piece of wood. Then the wire was bent double and pushed into the hole. In this way one wire becomes two and both wires disappear out of the centre of the ornament. Then both wires are laid on the wood block and wound up to form a spiral. When the spiral has attained the desired size, the ends of the wires are turned in opposite directions, and the stamp can be used (fig. 11).

The impression of Spiral 3 (fig. 12), which gradually turned into a proper stamp during the experiment, is at the centre and in all its features exactly like the original spiral ornaments seen in fig. 2, for example.

The individual impressions of Spiral 3 can be combined in various ways. The joining grooves can be laid as a single groove midway between the two spirals (fig. 13). This gives the impression of an extremely common type of spiral. In nearly all cases in which an attempt was made to combine several impressions, one could see where the wires met. The attempts also gave a few examples of the junction occurring in such a way that it could not be distinguished with the naked eye.

If the impressions of Spiral 3 are staggered a little, as shown in fig. 14, the spirals can fit together anyway, but now with a double joining line. This spiral motif is extremely common as a running spiral in the motif repertoire of the Early Bronze Age.

In the following, both the wire spirals and the impressions formed by them will be called stamps.

THE ORIGINAL SPIRALS, TRACES OF SPIRAL STAMPS

Observations have shown that even the finest lines could have been formed in wax and reproduced by casting in the Bronze Age (Brorson-Christensen 1966). Line ornaments could be formed in wax and cast using the "lost

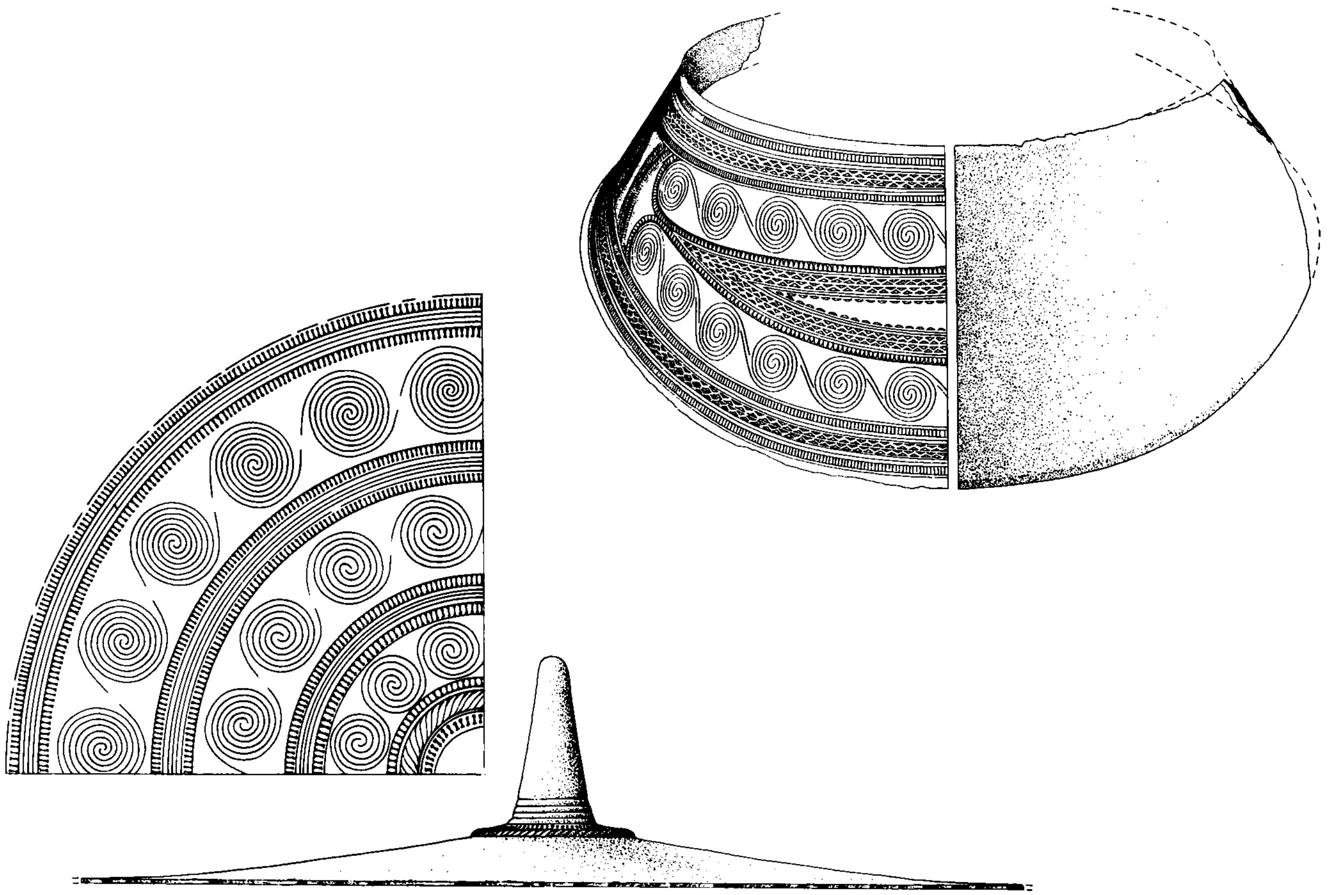

Fig. 14a-b. Impressions of Spiral 3 can be combined in various ways. The drawing shows two common types of running spiral, both of which can be made up of impressions from Spiral 3. (Both after Aner & Kersten).
a: If a row of running spirals with single joining lines is desired, the wire from the second stamp is pressed down so as to meet the groove from the foregoing stamp. The joining very often makes small marks at the junction of the two grooves.
b: If a row of running spirals with double joining grooves is desired, the wire is not pressed down into the foregoing spiral groove. It is displaced so that the wire comes to lie parallel to the groove from the foregoing stamp, and the joining grooves can run tangentially into the outermost curved groove of each spiral.

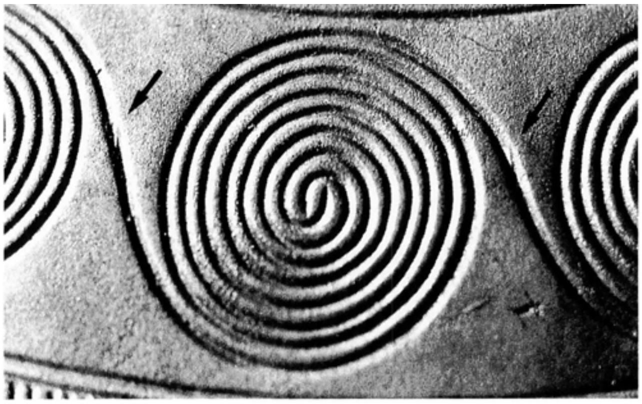

Fig. 15. Spirals from the central band of three on the large belt disc from Vognserup Enge. The junctions between the three spirals are seen in the joining grooves as very small notches. The joins are marked by arrows. The belt disc is dated to Period II. (NM B 17072).

Fig. 17. Spirals from the central band of the large belt disc from Vognserup Enge. The join can in the photograph be seen only in the joining groove to the right. (NM B 17072).

Fig. 16. Spirals from the central band on the large belt disc from Vognserup Enge. The joins are marked by arrows. (NM B 17072).

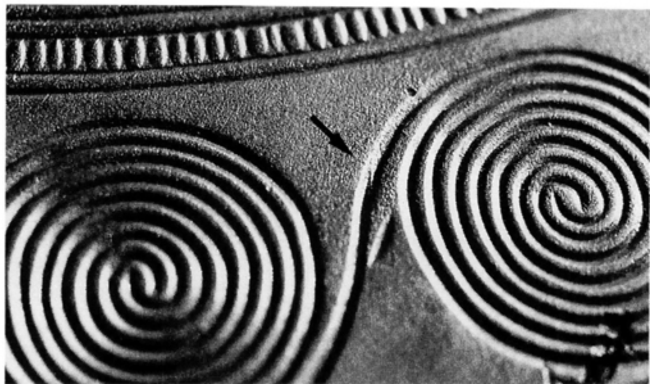

Fig. 18. Spirals from the central band on the large belt disc from Vognserup Enge. The join is distinct. (NM B 17072).

wax" method. With coiled copper wire it is possible to press or stamp the individual units of the spiral ornaments. Running spirals can be imitated in wax by placing the stamps together in rows.

It has been possible to form the spiral ornament in a wax model, and it has been possible to cast it in bronze.

That it is possible to form spirals in wax which resemble the original ones exactly is in fact itself not sufficient evidence to establish that this is how it was done in the Bronze Age. The wax plates with trial stampings showed, however, unmistakable features in the running spiral ornaments which revealed that they were composed of several individual stamps.

It is therefore natural to study the features which were characteristic of stamping in wax and compare them with the original bronzes.

Fitting together of two spirals with single joining grooves

The most difficult part of stamping spirals with single joining grooves was the fitting of the connecting groove between them. The wire from the last stamp had to be pressed down into the groove formed by the wire of the previous one. Optimally, the grooves fitted so it was hardly possible to perceive the join, but in nearly all cases the join was, in fact, distinct. It could vary somewhat, but a common feature was that if the grooves were congruent there was a more or less distinct notch in the wax of the otherwise unbroken groove. This feature was therefore looked for specially in the original bronzes, and corresponding marks found in many of the well-preserved bronzes which I investigated.

Obviously, the fitting of the stamps varied somewhat in

Fig. 19. Spirals in the outermost spiral band of the three on the large belt disc from Vognserup Enge. The joins are more difficult to see in the outermost band than in the central one. They are marked with arrows. The spirals in the two outermost bands of this belt disc are geometrically uniform. (NM B 17072).

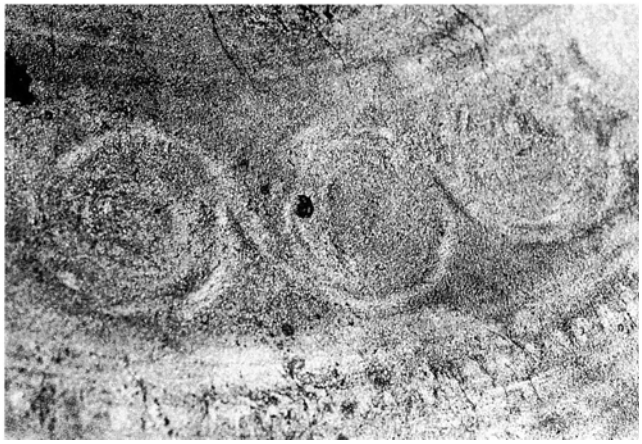

Fig. 20. The back of the large belt disc from Vognserup Enge. The pressure from the stamps has passed through the thin layer of wax and left distinct marks on the back of the model, which have been reproduced on the back of the finished bronze. The picture shows the central spiral band. (NM B 17072).

Fig. 21. On the socket of this spearhead from Valsømagle, there are four completed spiral rows with single joining grooves. In the row shown here the joins are very clearly seen. The stamps have not been fitted so carefully as in the belt disc from Vognserup. (NM B 7523).

appearance in the experiments, and this again is duplicated in the original bronzes.

The marks from joining spirals on the large belt disc from Vognserup Enge (NM B 17072, figs. 15–19) are very small, and very uniform. The joining of grooves is revealed by small "notches" or "angles". In the picture they are marked with black arrows. The fitting of stamps is distinct in nearly all the joining grooves between the spirals, but they are so fine and slender that they have to be looked for specially in order to be seen. The belt disc is from Period II of the Early Bronze Age.

On the socket of the spearhead from Valsømagle (NM B 7523), there are four rows of running spirals. One row is depicted in fig. 21. The junctions between spirals are clear in nearly all the joining lines (see also fig. 30). There can be a long or a short overlap between the grooves, or they may not even meet.

In the archaeological literature, a few spiral ornaments are illustrated in which the join between the stamps is seen, for example Oldeberg 1976 no. 3258, where the joins can be distinguished at a few places in both bands. The frontispiece in Herner 1987 is a composition in which the grooves have a long overlap.

With careful examination of joins it is in many cases

Fig. 22. The joins of the spiral stamps reveal how spirals with two lines were produced. The individual grooves have not been linked. (NM B 9530).

Fig. 23. The two grooves leaving the central spiral do not quite reach the spirals on either side. (NM B 9530).

Fig. 24. Problems in fitting the grooves. (NM B 11308).

possible to see which groove lies above the other and in this way discover in which order the stamps were made.

Only a few pieces are emphasized here, but an examination of the individual pieces has shown that traces of joining stamps are found in very many of the running spirals. Marks of the kind described here are inconceivable in punched ornaments.

Joining of spirals with double joining line

Spirals with a double join were very difficult to stamp in wax. The difficulty was that two grooves both had to run in as tangents at the same time, which means that four grooves have to be correctly placed in the same impression. It was characteristic of the stamping that one of the grooves in many cases did not quite reach the spiral it was intended to meet. In other cases the groove could overshoot the outer spiral groove and run on into the spiral.

If these features are looked for in the original bronzes, it appears that the Bronze Age bronzesmith did not always manage to get all his spirals to fit.

The smith who made the belt disc from Glæsborg, Randers county (NM B 9530), has in nearly all cases managed to get the grooves to fit on each other exactly. In a few places one of the grooves does not meet the outer groove of the next spiral (figs. 22 and 23).

In the little belt disc from Tømmerby, Hjørring county (NM B 11308), there have also been problems with the placing of the grooves (fig. 24).

The fact that grooves do not quite reach each other in the examples shown here is easy to explain, if the spirals are formed by stamping with coiled metal wires, but the lack of a join is almost inconceivable if the spirals were punched with such care that traces of the blows are invisible.

Deep joining-grooves between the spirals

When the stamp is pressed down into the wax, the spiral itself presents a large surface, while the wire making the joining groove between spirals has a small surface. The single wire is therefore more easily pressed into the wax than the spiral itself. In this way the joining line becomes deeper than the spiral in the finished bronze object. This happened in several of the experiments, and it can be observed in several originals. It can be seen, for instance, in one belt disc from Sværdborg, Præstø county (NM I B 1091, fig. 25). The conjunction of impressions is seen in the joining groove.

Had the spirals been punched, this phenomenon would be difficult to explain.

Deeper grooves in the centre of the spirals

Sometimes the grooves are deepest right in the centre. This must be due to the fact that the wires in the stamp were not bent down as soon as they emerged from the back of the spirals.

In other cases the wires can be pressed down so hard that the grooves are shallow in the centre.

Differing ornament depth

In some cases the ornaments are impressed at a varying depth. This can be seen, for example, in a gorget from Bornholm (NM 2884, fig. 26).

Weakly impressed ornaments may naturally be due to ordinary carelessness with the stamps, but there may possibly also be technical reasons. It could be that the wax was too cold and therefore too hard. There are doubtless other reasons. The composition of the wax, and the thickness and closeness of the spiral coils, are other reasons why a stamp leaves too shallow an impression.

Marks from wire coiling

The experiments revealed that when one starts to coil the wire after it has been inserted in the wooden block, it tends to rotate. It is then necessary to fix it. In a soft copper or gold wire one can imagine that the device used to hold the wire in position has left marks in it in the form of very small notches. Experiments showed that it is normally necessary to hold only one wire, rarely both of them, and only at the beginning of twisting. As soon as the coiling begins it can be finished without using anything but the fingers.

The marks to be looked for would then be in the inner millimetre at the bottom of the coils.

Small notches in the centre of the groove were a common observation in the centre of the spirals, often only one small one, but three or four, close in a row, is normal. There can also be several very small and very close notches. They vary in appearance, but it is characteristic that they are not found in the smoothly curved lines. They are often found on a straight part of the spiral. A straight piece like this can sometimes be seen in the innermost millimetre of the spiral centre, just before the

Fig. 25. Sometimes the groove joining two adjacent spirals is deeper than the groove in the spirals themselves. The join is also visible. (NM B 1091).

Fig. 26. The grooves may have different depths. One spiral stamp may have been pressed harder into the wax than the preceding one. (NM 2884).

Fig. 27. A feature often confused with punch marks is the small marks, "notches", sometimes seen at the centre of the spirals.

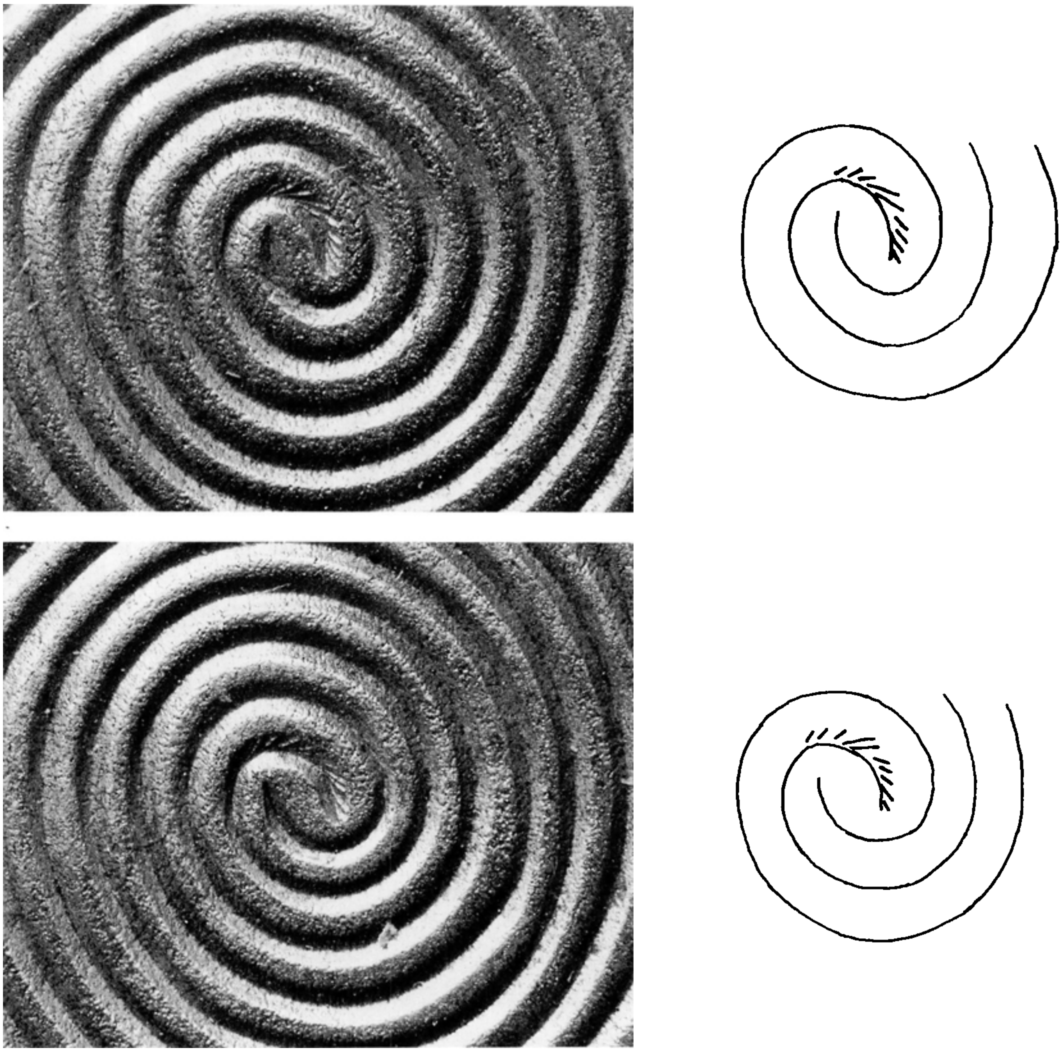

Fig. 28. The marks from the fixed wire are repeated in spirals made with the same stamp. (NM 6633).

groove embarks on a smoothly curved course.

On the spirals from the large belt disc from Vognserup, the notches are very small, hardly visible with the naked eye. They cannot be seen on all of the spirals, but this is of no consequence, because such minimal traces can be erased or slurred in innumerable ways. What is important is that when they are there, they are uniform. On the end which turns down at the centre of the spiral in figs. 16 and 17, there are some very fine notches. On the right spiral in fig. 18 there are also small notches. The marks are the same.

Stronger marks are seen in fig. 27. That the picture seems to show a small difference is due to the slightly different angle and distance of the spiral centres to the camera.

In fig. 28, several small marks are seen close in a row, but as with the others, only in the centre of the spirals (NM 6633).

Such small notches in this position have previously been interpreted as traces of punching. When they occur, they are very uniform in the same spiral band or group, and they are found practically only in the centre of the spirals. It is extremely rare to see similar marks elsewhere in the spiral grooves. The explanation must be that they are impressions of marks in a stamp. The marks must have been produced when the stamp was made.

Overlap in spiral stamps

In some spots the space left in the spiral field was too small to accommodate the number of spirals of the size selected. There are examples of the stamp's final coil being turned up, so that it filled less. The central spiral in fig. 23 contains one coil less than the others in the band. One might also choose to retain the stamp unchanged and increase the distance between two or more spirals, or press them closer together.

On the largest of the belt discs from Særdborg, Præstø county, the bronzesmith has chosen to press the spirals closer together. In a couple of places they have come so close, however, that the stamps overlap (fig. 29, NM B 1090). It is difficult to believe that a chaser would allow several carefully punched curves to overlap in this manner. On the contrary, this "overstamping" in fact suggests stamping. The manner in which the last stamp erases the grooves in the first could be replicated in the wax experiments.

The overlaps can be interesting in that they may show in which order the smith has worked. On the spirals of the belt disc shown here the smith has stamped the spirals from right to left.

Fig. 29. Sometimes spirals overlap. (NM B 1090).

Interruptions in the running spiral wire

In rare cases, breaks are seen in the spiral groove. A very good example is seen in the spearhead from Valsømagle (fig. 30, cf. fig. 24). In the smooth, continuous spiral grooves there are short breaks, which in a couple of places contain lentiform impressions. This phenomenon can occur when there is a kink or twist in the wire, just as when one presses a piece of twisted wet rope slightly down into a soft material: if the rope is not pressed too deeply, a row of lense-shaped impressions will be formed. The impressions in the Valsømagle spearhead have been made by a wire with local twists which interrupt the otherwise smooth course of the spiral groove. They are not punch marks.

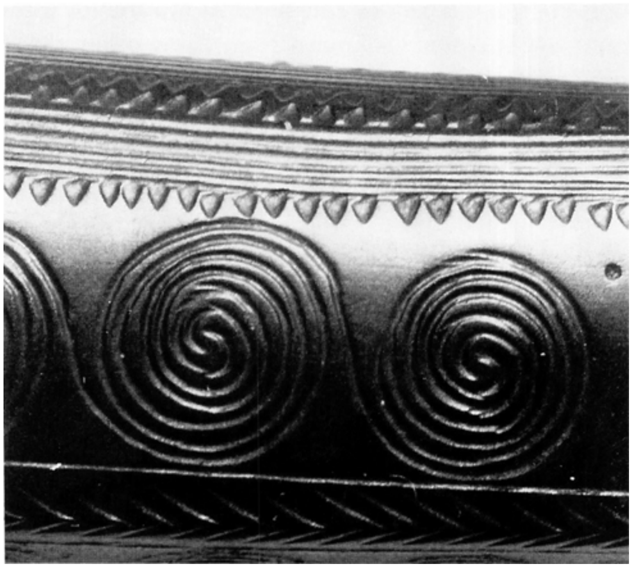

Fig. 30. Two spirals in one of the four spiral bands on the large decorated spearhead from Valsømagle. At a few spots in the groove there are interruptions. These can occur if the wire was not absolutely straight. If it has had any kinks, lentiform impressions can be formed, as seen in this groove. The smith apparently preferred to unwind the wire in order to straighten it out, since the two spirals are not geometrically alike. The centre remains unaltered, however, so that there is every likelihood that the same wire was utilized. (NM 7523).

The spiral on the Valsømagle spearhead is also interesting, because the smith has apparently attempted to fill in the breaks by unwinding the wire, straightening it out, and again winding it into a spiral. The make-up of the stamps is clearly seen in fig. 24. In the enlargement fig. 30, the wires in the joining grooves have passed each other, and the groove from the left spiral sticks down somewhat under the groove from the right spiral. The end of the right spiral groove is seen on top and adhering to the outer groove of the left spiral. This means that the left spiral was the first of the two to be stamped. It could be that the artist was dissatisfied with the many interruptions found in two of the innermost coils. He has rolled the stamp up as far as the first two millimetres of the spiral. The centres are the same and therefore unchanged. It is logical that he stopped here. It was not necessary to continue, because there is no mistake in the centre, and the centre actually presents the greatest difficulty when the spiral is wound up. The faults have been partially repaired, but minor interruptions can still be discerned, or irregularities in the groove at the same places where the major interruptions were seen before the stamp was repaired.

Unrolling a stamp and then winding it up again can alter its geometry, but it can often be decided from the centre whether it is the same wire which has been used. It is a moot point whether it is still the same stamp.

It is interesting that the artist who decorated the Valsømagle spearhead has used the same stamp for the final spiral as for those running in the spiral row. This gives a problem with one groove which does not get a natural ending. He lets this groove end between two spirals. If the spiral row is closed, as known from many other closed spiral rows, the last spiral must have been stamped with a wire rolled up as in Spiral 1.

Stamp marks on the backs of the bronzes

On the thin bronzes it is quite common to see the spirals and their joining lines on the back (fig. 20). The impression is naturally slurred, but it does show what ornaments have been pressed into the face. The wax plates used for the experiments showed exactly similar traces, when they were of the same thickness as the original bronzes. If they were thicker, however, there were no marks from the impression. This was a phenomenon which was not manifested until late in the trials. To start with, thicker plates were used in the belief that it was easier. Just after the thin wax plate set, it was almost leather-like and could to some extent be bent and pressed. At this stage it proved to be easiest to work with. These marks on the backs of the thin bronzes have previously been identified as traces of punch marks.

OTHER WAYS OF MAKING SPIRAL ORNAMENT

There were probably other ways of producing spiral ornaments. It cannot be completely ruled out that spirals or other ornaments were punched in the Early Bronze Age. There is one spiral in Denmark, however, with possible punch marks. This is a brooch of Bornholm type from Olsker, Bornholm county (NM B 80, Ke III 1454 B). The spiral grooves are discontinuous, and here and there re are marks which might derive from a chisel-like instrument. It cannot be decided, however, whether the marks were made directly in the metal or in a wax model. The latter possibility seems the most likely, because the rest of the ornament must have been formed there.

It has been demonstrated that ornament grooves were drawn or cut into the wax model in the Late Bronze Age (Knudsen 1978). I know of no proper drawn spirals; but false spirals drawn into the wax model are known, e.g. Oldeberg 1976 no. 3305.

The ornament of the Early Bronze Age is naturally more than just spiral stamps. There is very great variation in the composition of details and perhaps methods. The aim in the present paper has been restricted to those techniques which may be linked to spiral ornament.

CONCLUSION

Based on the above, it can be established that the spiral ornament of the Scandinavian Bronze Age has not been produced by punching. On the contrary, the running spirals must have been produced by repeated stamping with coiled metal wire. The spiral ornaments must have been impressed in a wax model and cast "à cire perdue". Spirals which could have been produced by another means must be regarded as the exception.

Translated by P. J. Crabb

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Photographs

Where nothing else is stated, the photoes have been taken by the author.

NOTE

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Offa	Berichte und Mitteilung aus dem Schleswig–Holsteinischen Landesmuseum für Vor- und Frühgeschichte in Schleswig und dem Institut für Vor- und Frühgeschichte an der Universität Kiel.
PACT	Journal of the European Study Group on Physical, Chemical and Mathematical Techniques Applied to Archaeology.
PPS	Proceedings of the Prehistoric Society.

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European Textiles in Later Prehistory and Early History

A Research Project

by LISE BENDER JØRGENSEN

In volume 3 of this journal a research project concerning North European textiles in the 1st millennium AD was presented (Bender Jørgensen 1984). Since then, the project has continued, thanks to generous grants particularly from the Carlsberg Foundation, and by now all of Europe north of the Alps has been included in the investigation. Chronologically, the project ranges from the Mesolithic to the Viking Age, i.e. more than 5,000 years.

A main result of the textile research project is that it has proved possible to define a number of cloth types, which can be attributed to geographical and/or chronological groups, in most instances are well-known archaeological cultures, like the Jastorf culture, the Hallstatt culture, etc. In 1984, a survey of the cloth types found in Scandinavia and NW Europe was given; today this can be extended to all of Europe north of the Alps, except the Soviet Union. Due to lack of space, however, this paper will focus on two periods, the Pre-Roman Iron Age and the Post-Roman Period (the Merovingian and Carolingian Periods), where a large body of Central European textiles recorded in 1987 has shed new light on textile history and on ethnic and cultural differences in the textile material.

THE PRE-ROMAN IRON AGE

As far as the technology of making textiles is concerned Pre-Roman Iron Age Europe falls into a number of regional groups: Scandinavia forms one region, whose southern border can be traced across Jutland between the towns of Vejle and Varde. This region is characterised by having a textile technology based on the tubular loom, s-spun wool yarn, and the weaves tabby and 2/2 twill. The common cloth type, 2/2 twill s/s, has been named the Huldremose type (Bender Jørgensen 1984, 1986, 1987b). A second group is region occupies the North European Lowlands. Here z-spun yarn is the rule, flax as well as wool is a commonly used fibre, and starting borders and loom weights indicate the use of the warp-weighted loom. The common cloth types are Haraldskjær twill (2/2 wool twill z/z), Haraldskjær tabby (wool tabby z/z), and the Weyhausen type (linen tabby z/z, very open, veil-like weave). This group is closely related to the Jastorf culture (Bender Jørgensen 1988, and forthcoming).

In Central Europe, the Hallstatt and La Tène cultures also each have their characteristic cloth types. Up to now, the works of H.-J. Hundt have been almost the sole source of knowledge of these textiles, and have been directed mostly at three groups of discoveries, princely graves of Hallstatt date in south Germany, textiles from the salt mines of Hallstatt, and textiles from the saltmines and cemetery at Dürrnberg, all three in Austria. The material from the salt mines is mainly of Hallstatt date, while the cemetery of Dürrnberg mainly contained textiles of the La Tène period (Hundt 1959, 1960, 1961, 1962, 1963, 1967, 1969, 1970, 1974a, b, c, 1981, 1985). It is now possible to add a substantial number of finds from Czechoslovakia, Hungary, Austria, the former duchy of Krain (now Slovenia in Yugoslavia), Switzerland and France to what is recorded by H.-J. Hundt; and even in Germany, several unrecorded textile remains of Hallstatt or La Tène date have now been located. This new material not only indicates that there are differences between the Hallstatt and La Tène textiles (which H.-J. Hundt has already shown), but also that there are considerable regional differences, especially between eastern and western Central Europe.

In the West Hallstatt area, i.e. South Germany and parts of France, the most characteristic feature is the use of wool fabrics with plied yarn in one or both systems (fig. 1). The most common cloth type of this group is 2/2 diagonal twill Sz/z, i.e. the warp consists of two-ply yarn, the weft of single yarn. Around one third of all Hallstatt Period fabrics from South Germany and France belong

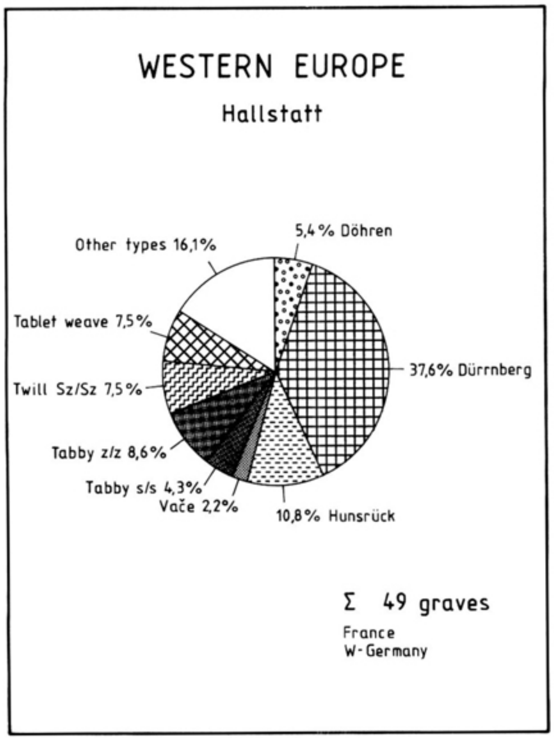

Fig. 1. Pie Diagram of main cloth types in west Central Europe in the Hallstatt Period.

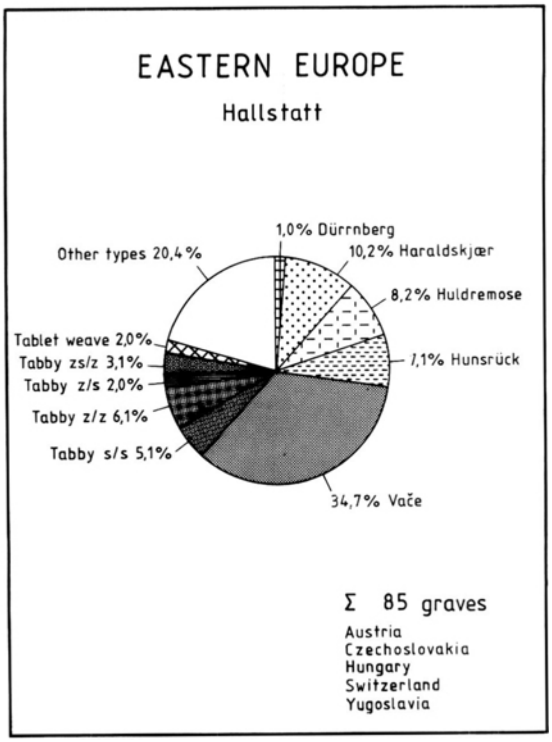

Fig. 2. Pie diagram of main cloth types in east Central Europe in the Hallstatt Period.

to this type, which has been named the Dürrnberg type. A variant of this is diamond twill Sz/z, found once, and diagonal twill Sz/z,s, i.e. with spin-patterned weft, of which four pieces are found. Tabby Sz/z has been found in some 10% of the finds of this group; as the majority of this group derives from graves of the Hunsrück-Eifel culture, this type has been named the Hunsrück type. Tabby Sz/Sz, i.e. with plied yarn in both systems, has been found in 5 pieces (5.4% of the material); this has been named the Döhren type, and is also known from a Hallstatt grave in the Netherlands, two Polish sites, one Spanish, and possibly a Belgian and a French site. It too is represented at the salt mines of Hallstatt and Dürrnberg. Finally 2/2 twill Sz/Sz should be mentioned; however it has only been found at one site in the Hunsrück-Eifel. Taken together this means that more than 60% of all finds of textiles of Hallstatt Period South Germany and France are made with plied yarn in one or both systems.

Plain tabby z/z, i.e. wool or linen tabby in single z-spun yarn, only makes up 8.6% of the textiles in South Germany and France; to this can be added another 4.3% consisting of tabby s/s, a small but significant group to which we shall return later. Tablet braids have been found at several sites in this area, most notably the princely grave of Hochdorf, which contained several very elaborately patterned examples of tablet weave, the best parallels of which are more than a millennium later (Hundt 1985).

The Vače type is diagonal wool twill z, s/z, s, i.e. single yarn, but arranged in groups of s- or z-spur yarn so that a subtle shadow- or spin-pattern is established. The vače type is only represented in a few specimens from South German and French Hallstatt graves. As we shall see below, this pattern changes drastically in eastern Europe. Finally a number of fabrics are termed “other”; they are mainly indeterminable as to weave and/or spin.

In East Central Europe, i.e. Czechoslovakia, Hungary, Austria, Switzerland and Krain/Slovenia, the Hallstatt Period textiles show a quite different range of cloth types than are found in South Germany and France (fig. 2). The textiles summarised here are all from graves, i.e. the fabrics from the salt mines of Hallstatt and Dürrnberg are not included. In eastern Europe, the Dürrnberg, Döhren and Hunsrück types together make up less than 10% of the material, and instead fabrics of single yarn

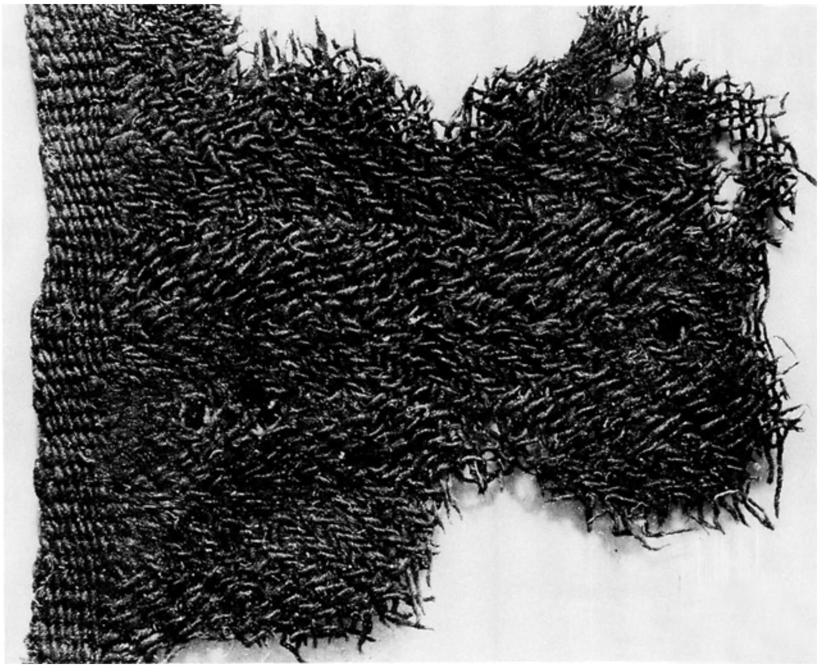

Fig. 3. A sample of cloth of the Vače type, found in a grave at Haastrup, Funen, dated to the final Bronze Age (Montelius phase VI). The fabric is imported from the East Hallstatt culture.

form the great majority, particularly the spin-patterned twills of the Vace type, which comprise more than a third of the material. Tabby of single yarn make up 16%; but this group must be divided into four sub-types: tabby z/z, z/s, z,s/z and s/s, each amounting to 2–6%. Diagonal twill (z/z, the Haraldskær type, and s/s, the Huldremose type taken together) make up 18,4%, the two almost equally represented. Diagonal twill z/s was only found once, and is counted with the group "others". Tablet weave was found twice, and finally the group "other" includes 5 basket weaves and 3 half-basket weaves, which also deserve some consideration, along with some indeterminable fabrics.

The picture offered by the two groups of Hallstatt textiles from South Germany/France and from Czechoslovakia/Hungary, Austria, Switzerland and Krain, clearly indicates that there is a marked difference between the western and eastern regions. In this respect textiles follow the general pattern of the Hallstatt culture, which falls into an *Osthallstattkreis* and a *Westhallstattkreis.* The border between the two textile groups seems to be around the site of Hallstatt itself.

In the west Hallstatt area plied yarn was a basic feature, either alone or combined with a single yarn weft; in the east single yarns are the rule, and spin-patterned fabrics are an especially popular feature. Twill is the basic weave in both regions, the majority simple 2/2 diagonal twill, but a few examples are twill variants like diamond twill or 2/1 twill. Tabby is the second common weave in both areas, and tablet weave similarly appears both in the west and in the east.

Tabby s/s, and in east central Europe 2/2 twill s/s as well, form a small but important group. Generally, s-spin is a feature of Scandinavian textiles of this period, whereas z-spin is the basic feature of the European Continent. The group of Hallstatt fabrics s/s form almost the only exception to this rule; nevertheless, z-spin is clearly the most common form of Hallstatt Europe. The possibility exists that the s/s-spun Hallstatt textile remains may derive from spin-patterned fabrics, where by accident only the s-spun sections have survived; but few as they are, the 17 samples found are too many to allow this explanation. Another possibility, and probably the most likely interpretation of the s/s-spun Hallstatt fabrics is that they represent the last vestiges of the Central European Bronze Age wool textile technology. Only a handful of Bronze Age textiles have survived in Central Europe. Of these, a number are of flax, and are made of 2-ply yarn. A few

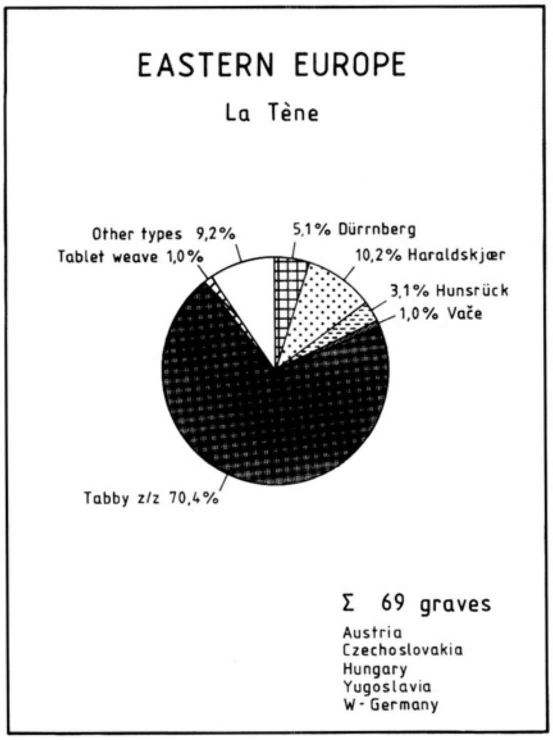

Fig. 4. Pie diagram of main cloth types in east Central Europe in the La Tène Period.

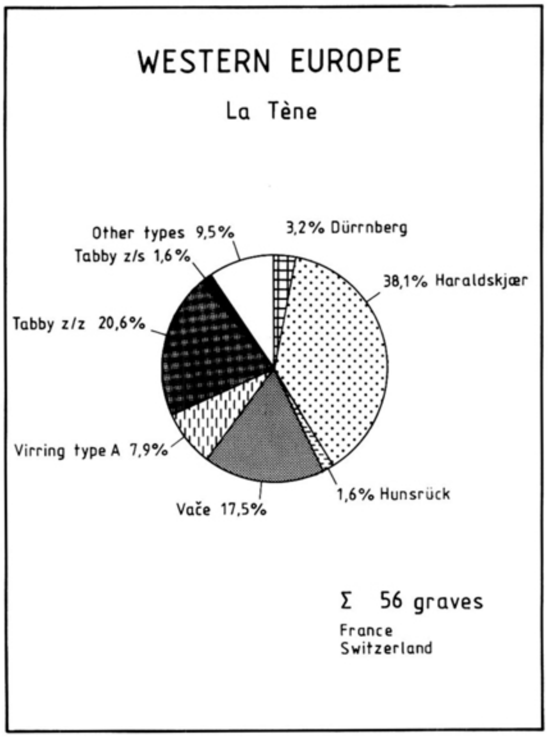

Fig. 5. Pie diagram of main cloth types in southwest Central Europe in the La Tène Period.

pieces, however, are of wool, and these are generally made of s-spun, single yarns.

Basket and half-basket weaves, which appears in small but distinctive numbers among the Hallstatt textiles, were until recently considered to be a Mediterranean cloth type, which only reached central and NW Europe with the Roman conquest. The eight samples found among the east European Hallstatt Period textiles indicated that this type of cloth, with paired warp and/or weft, was known in central Europe from the beginning of the Iron Age.

In Denmark, a single sample of the Vače type has been found in a grave from Haastrup, South Funen, dated to Montelius' period VI of the Bronze Age (Albrectsen 1951, Munksgaard 1974, Jensen 1965). In the same grave was found a glass bead which has close parallels in the Balkans, i.e. in the area which must be considered the homeland of the Vače type (Jensen 1965, p. 59). Fig. 3.

In the La Tène Period the recorded material shows marked changes compared to that of the Hallstatt Period described above; regional differences are distinct, but do not follow quite the same boundaries as in the Hallstatt Period. In the La Tène Period the main regional difference is between Switzerland (and France), which form one block, and the rest of Central Europe, i.e. Czechoslovakia, Hungary, Austria, Slovenia and Germany, which are treated as another block.

In East Central Europe (fig. 4), tabby z/z is by far the most common cloth type comprising around 70% of the total material. The group tabby z/z consists of two main types, wool and tabby. No clear distinction between the two types has as yet been made, but both have been frequently found. There is perhaps a tendency that the finer fabrics are flax, the coarser wool. In Slovakia, some fine linen tabby with traces of embroideries in red wool deserves special mention (Furmanek & Pieta 1985).

Compared to the Hallstatt Period the strong proportion of tabby z/z in the La Tène period is very striking; in the Hallstatt Period, only about 6% of the East European textiles belong to this type. Linen tabby had been common in Central Europe since the Neolithic (Vogt 1937), but both the Neolithic and the Bronze Age linens were woven from 2-ply yarn; perhaps the large proportion of tabby z/z indicates that with the Iron Age it had become possible to weave fine linen cloth in single yarns.

Other cloth types of the east and central European La Tène Period are among others the Haraldskjær type, 2/2 wool twill z/z, which makes up almost the same proportion of the material (c. 10%) as in the Hallstatt Period, and the Dürrnberg and Hunsrück types, i.e. twill and tabby with plied warp, single weft. These were the dominant types in Hallstatt Period Germany and France, and are still present in the La Tène material in more or less the same quantity as in Hallstatt period East Europe, i.e. some 8%. The dominant cloth type of the east central European Hallstatt period, the Vače type (spin patterned twill), has only been found in 1% of the eastern La Tène Period graves with textiles.

In Switzerland (and France) the pattern shown by the La Tène Period textiles is quite different (fig. 5). Here, tabby z/z only amounts to one fifth of the material, whereas the Haraldskjær type, wool twill z/z, amounts to more than one third and is the most common cloth type. The Vače type is the third most common type, with 17.5%, and thus the situation is quite different than earlier, when the Vače type was more dominant in eastern Europe. The Dürrnberg and Hunsrück types are rare, being less than 5% taken together.

THE POST-ROMAN PERIOD

Several regional groups can be observed among the textiles from the Merovingian and Carolingian Period graves in North and Central Europe. Scandinavia forms one such group; Anglo-Saxon Britain is a second group; on the West European Continent the Frankish area (i.e. modern France, Belgium, the southern Netherlands, the Rhinelands, Thuringia and South Germany) make up a third group; in North Germany Frisia and Saxony each forms a separate group; in eastern Europe a Slavonic area can be distinguished; finally in East Central Europe Awar and Magyar groups, and some Germanic ones like Gepids, Langobards etc. can be distinguished. In the following pages, a brief summary of the main trends will be given.

THE MEROVINGIAN PERIOD

Starting with 5th and 6th century Scandinavia, two thirds of all textiles from 5th and 6th century graves in Denmark belong to the Haraldskjær type (2/2 twill z/z), and half of the remaining third are tablet braids (fig. 6a). In contemporary Norway and Sweden the picture is almost the same (fig. 6b). Few other cloth types are represented, and only in very limited numbers.

In 7th and 8th century Scandinavia this picture has changed. The Gerlev-Draaby type (tabby z/z) has gained much in importance, particularly in Denmark, where it is the most common type. A new type is the Birka type, a fine worsted diamond twill z/z, which appears in the 7th century and continues to the end of the Viking Age (fig. 6c-d).

In Anglo-Saxon England and Saxon Germany the textiles show some definite affinities to contemporary Scandinavia (fig. 7). The Haraldskjær type is a common cloth type, forming between 26.9% and 45.5% of the material. Tablet weave is also a major technical group in England; in Saxon Germany it is missing. The Gerlev-Draaby type (plain tabby z/z, mainly linen), which was only barely represented in the Scandinavian material, makes up between a quarter and one third of the Anglo-Saxon and Saxon textiles. The Hessens/Elisenhof C type (diamond twill z/s) is rare in Anglo-Saxon England, as it also is in Scandinavia; in Saxon Germany, it makes up 15% of the material.

In the northern Netherlands or Frisia (fig. 8) the importance of the Haraldskjær is dwindling, whereas the Gerlev-Draaby type constitutes a quarter of the material, much as in Saxon Germany and Anglo-Saxon England. Tablet weave is absent, but instead we may note the appearance of the Gudmingegaard type. This is a tabby with spin-pattern, i.e. differently spun yarns have been used to give a subtle pattern, normally stripes, but occasionally checks. Most noteworthy among the textiles of the northern Netherlands is the Hessens/Elisenhof C-type – diamond twill with z-spun warp and s-spun weft – which constitutes a quarter of the material. This marks the culmination of this type, which gradually declines in importance with distance from the northern Netherlands or Frisia. In the author's opinion, this type is a likely candidate for the title of *pallium fresonicum* or Frisian cloth; for further arguments see Bender Jørgensen 1986, 1987.

Next in line come the areas around the English Channel: Kent, the southern Netherlands (the Lower Rhine), Belgium and France (fig. 9a-d). The French material derives almost exclusively from Normandy. Here, it is striking that the Gerlev-Draaby type makes up about half of the material and is the most common type by far. Another noteworthy feature is the Hessens/Elisenhof C-type,

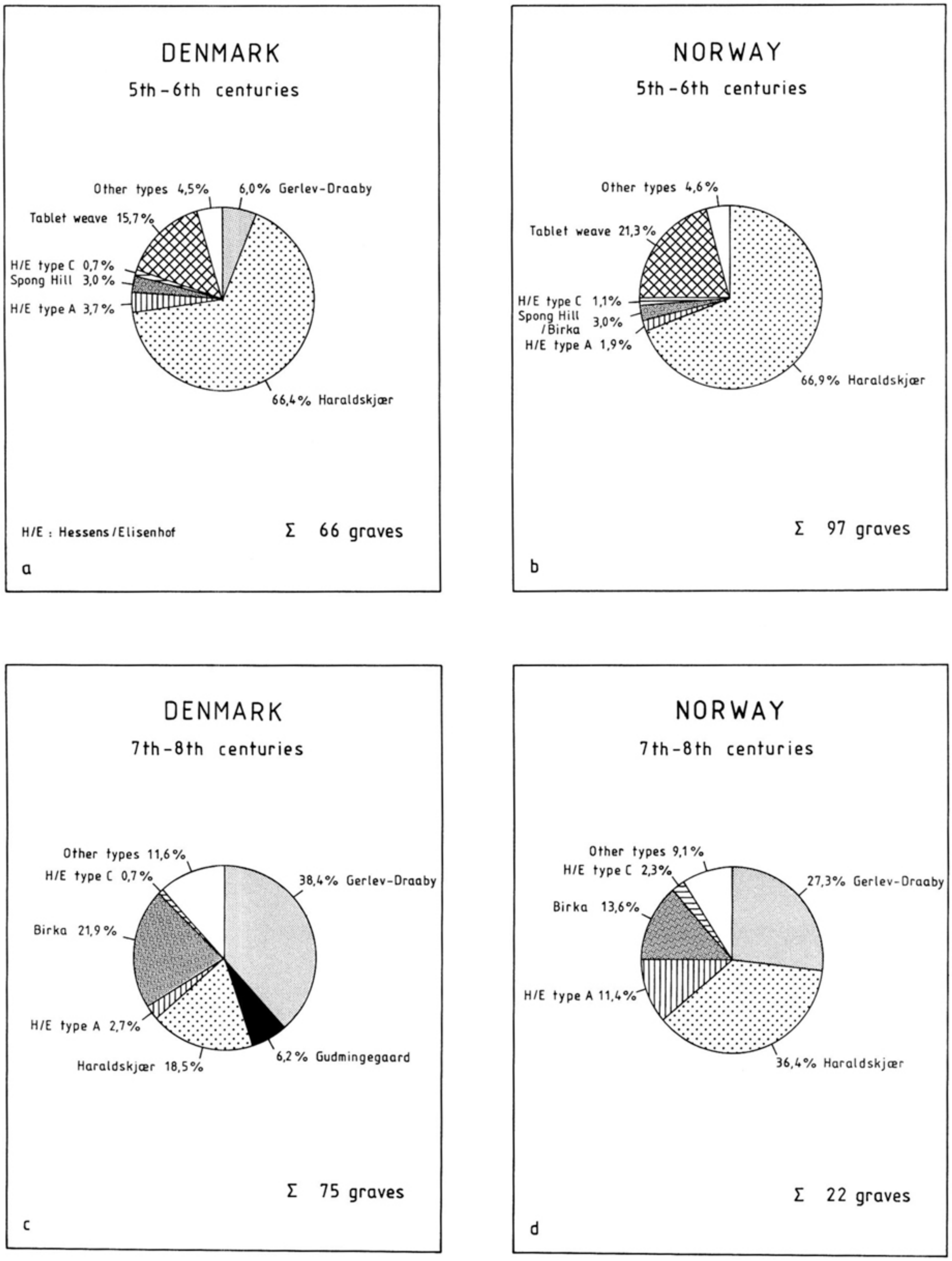

Fig. 6. Pie diagrams of main cloth types in Scandinavia in the 5th-6th and 7th-8th centuries AD.

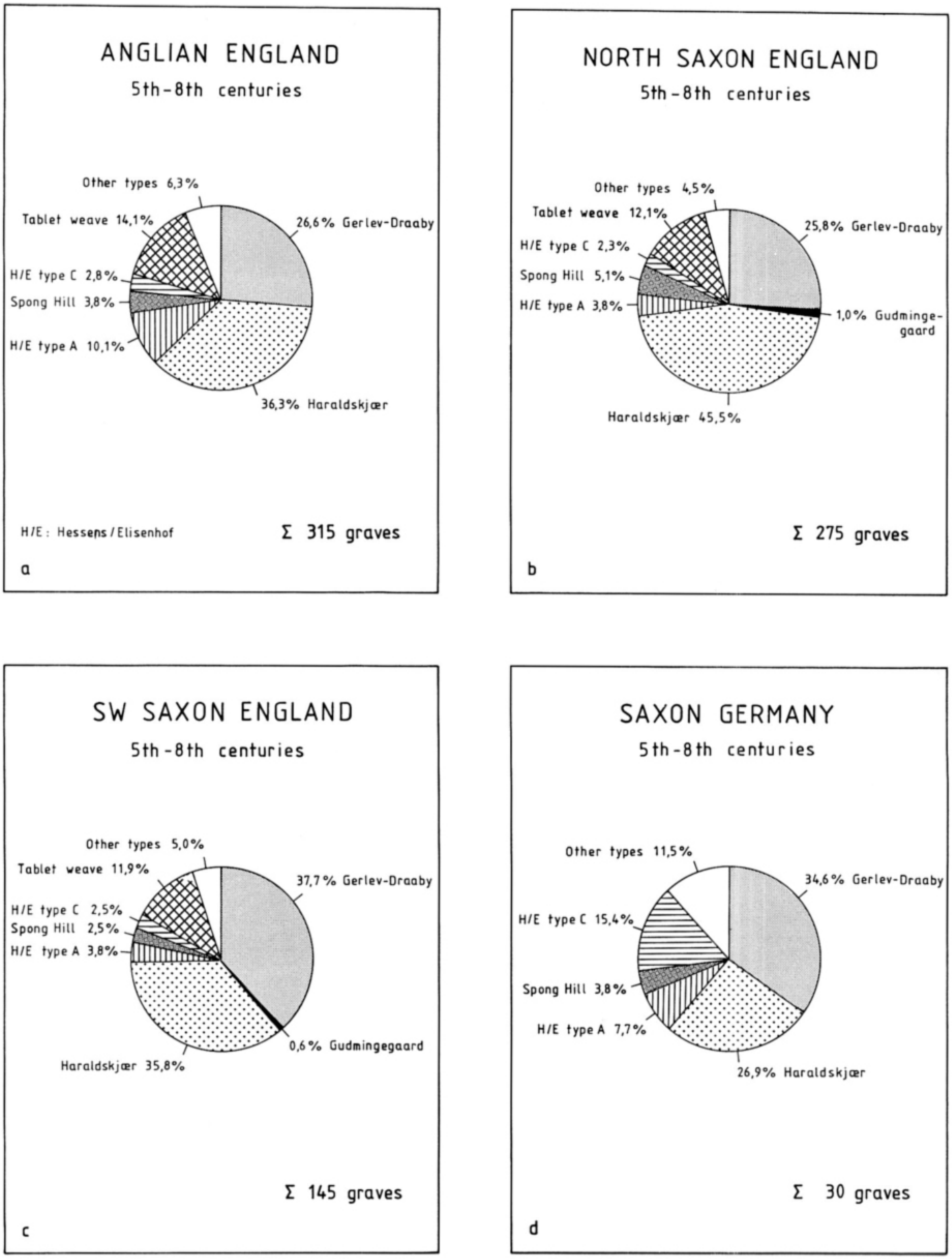

Fig. 7. Pie diagrams of main cloth types in Anglo-Saxon England and Saxon Germany in the 5th-8th centuries AD.

which makes up about 15% of the material on the continental side of the Channel and 10% in Kent, which is a quite substantial proportion and something that distinguishes Kent from the rest of England. However, Kent also has a good number of tablet braids (10%); these are generally lacking on the Continent. The spin-patterned Gudmingegaard type forms a minor proportion all along the Channel coast, except in Normandy.

In south and central Germany another pattern can be seen (fig. 10). In the Rhine Valley, i.e. the *Länder* of Nordrhein-Westfalen and Rheinland-Pfalz, the Haraldskjær type has fallen to 12%, the Hessens/Elisenhof C-type to 9%, while the Gerlev-Draaby type makes up one-third of the material. Two other features are particularly noteworthy: the Gudmingegaard type here constitutes 10%, and "other types" one quarter of the material (fig. 10a). In Baden-Württemberg, the Alamannic area, the pattern indicated in the Rhine Valley is emphasised: the Hessens/Elisenhof type has fallen to less than 5%, the Haraldskjær type makes up 15%, the Gerlev-Draaby type a quarter – but the Gudmingegaard type makes up no less than 22% and "other types" 21 1/2% (fig. 10b).

In Bavaria the proportion of the Gudmingegaard type has been reduced to 8%, but "other types" here constitute more than a third of the material. The frequency of the Haraldskjær, Gerlev-Draaby and Hessens/Elisenhof types is about the same as in the other South German areas (fig. 10c). Finally Thuringia has a higher proportion of the Gerlev-Draaby type than south Germany; the Hessens/Elisenhof type is more common. "Other types" make up a quarter, and the Haraldskjær and Gudmingegaard types are both rare (fig. 10d).

Summing up, in southern Germany a centre for the Gudmingegaard type is found in Alamannic Baden-Württemberg, exactly as one for Hessens/Elisenhof C type is found in the northern Netherlands and for the Haraldskjær type in Scandinavia and the Saxon and Anglo-Saxon areas. The Haraldskjær and Hessens/Elisenhof types both seem to be of less importance in southern Germany. The Gerlev-Draaby type provides a major proportion of the material here, but except in Thuringia definitely less than on the English Channel coasts.

The group "other types", which forms between a quarter and a third of the material in South and Central Germany, comprises a range of different cloth types which are worth considering in some detail. Among them the most important are *Rippenköper* or ribbed twill, rosette twill, tabby with warpfloat pattern, honeycomb weave, Coptic tapestry, and silk. *Rippenköper* is a type which was first noted by Hans-Jürgen Hundt, and in 1983 he presented a distribution map of this type and suggested that it was of Alamannic origin (Hundt 1983). The research here described has made it possible to put a few more dots on Hundt's map, but the general tendency of having a centre in south Germany remains unaltered. Rosette twill, tabby with warp-float pattern and honeycomb weave were similarly first found by Professor Hundt (see e.g. Hundt 1978). The first two types follow the same pattern as *Rippenköper* – southern Germany forms the centre, and the scattered occurrences in northern Europe can probably be considered Alamannic/Frankish imports.

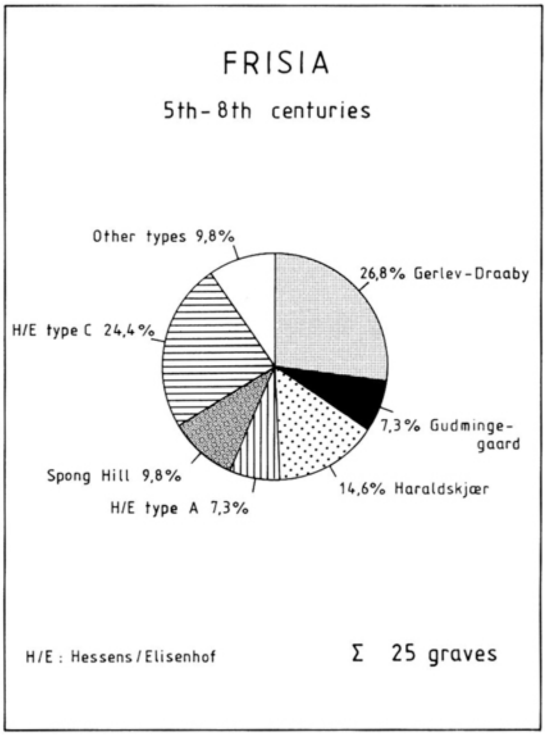

Fig. 8. Pie diagram of main cloth types in the northern Netherlands in the 5th-8th centuries AD.

Honeycomb weave is more rare, and has a different distribution pattern. It has been found in one Frankish, one Saxon (Hundt 1980), one Slavonic (Bender Jørgensen 1988) and two Swedish graves (e.g. Arwidsson 1954), and once in Anglo-Scandinavian York (Walton 1989). The ethnic provenance of this type is therefore difficult to ascertain, although a technical relationship to tabby with warp-float pattern may indicate an origin similar to that of this cloth type.

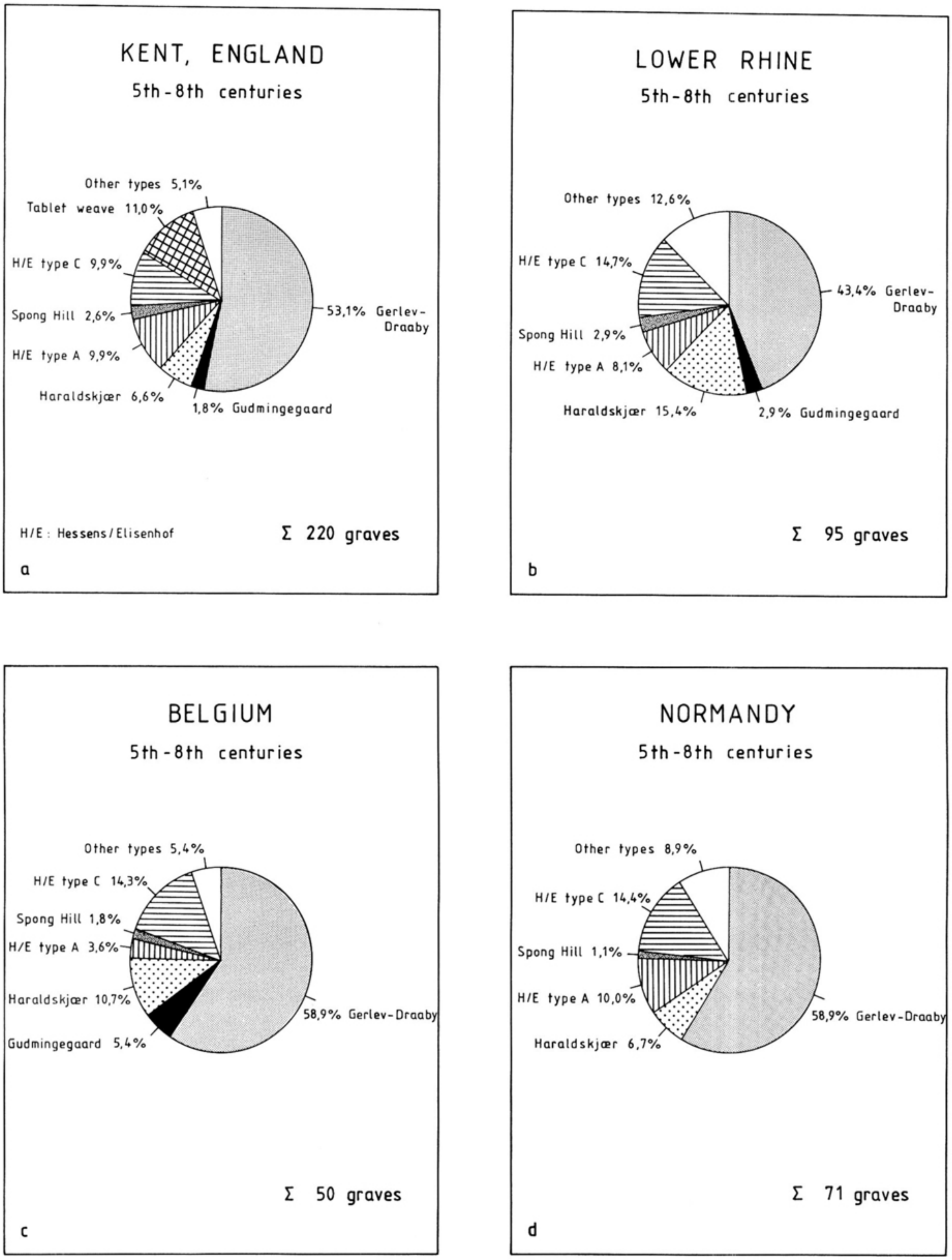

Fig. 9. Pie diagrams of main cloth types along the English Channel in the 5th-8th centuries AD.

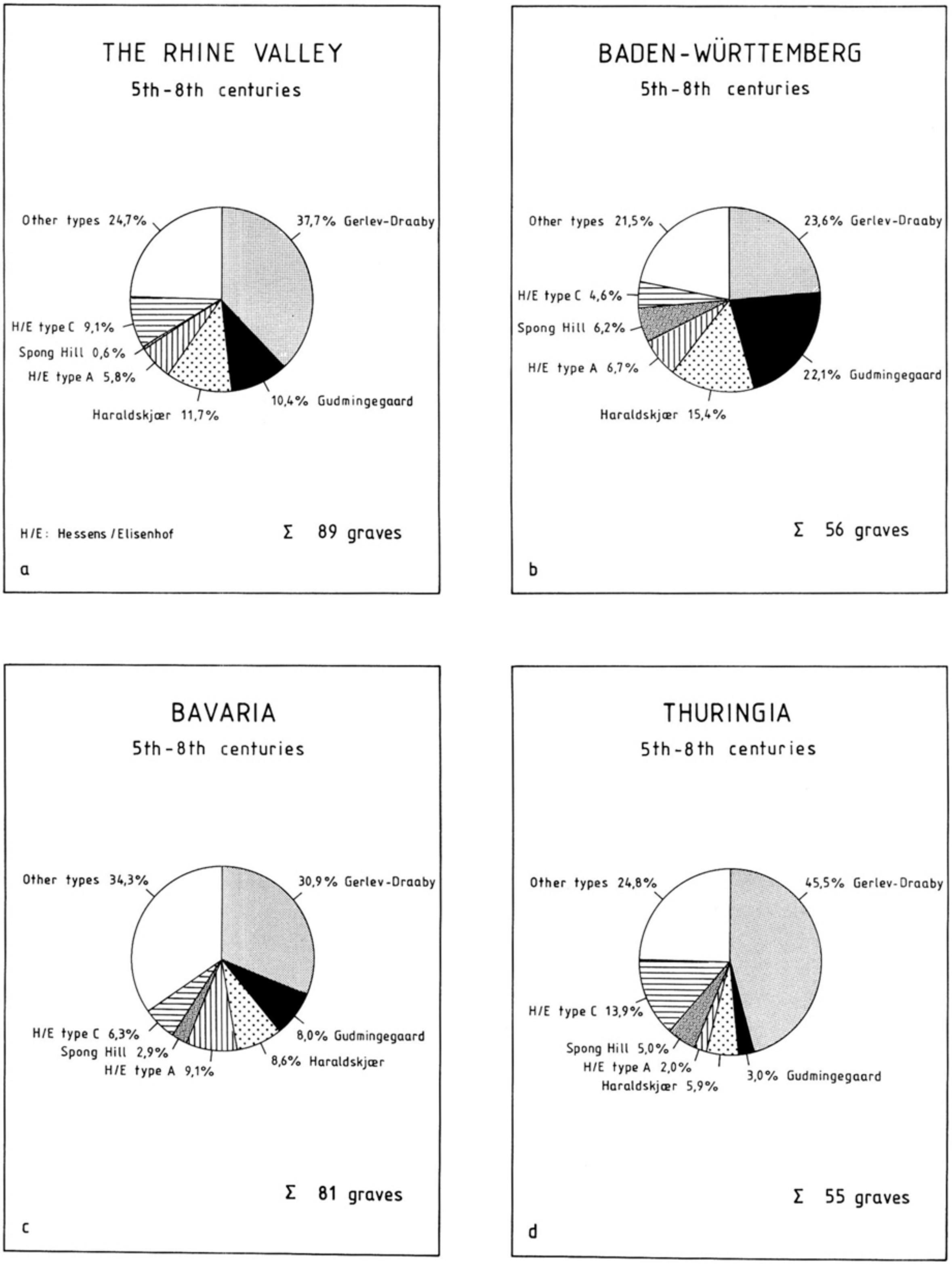

Fig. 10. Pie diagrams of main cloth types in west and south Germany in the 5th-8th centuries AD.

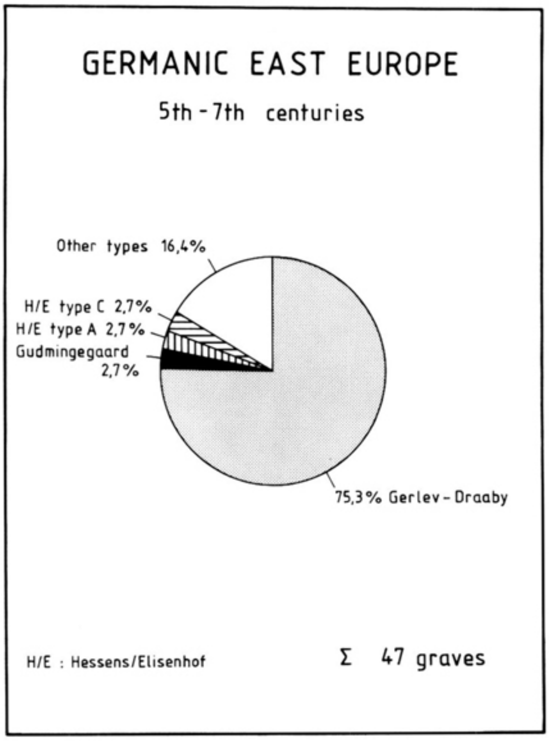

Fig. 11. Pie diagram of main cloth types in Germanic East Europe in the 5th-8th centuries AD.

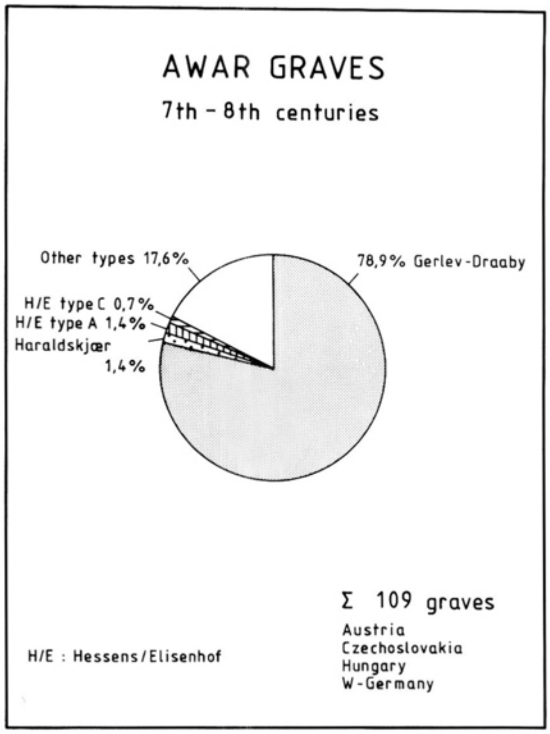

Fig. 12. Pie diagram of main cloth types i Awar contexts in east central Europe in the 5th-8th centuries AD.

Coptic tapestry has been found in a small number of graves in the Rhine valley (Bender Jørgensen 1987a). Silks similarly are rare; they seem to be limited to royal or princely graves, such as that of Queen Arnegunde in St. Denis, the Frankish Royal Lady's grave under Cologne Cathedral, and a number of male graves all containing a helmet, which according to Frankish law was a prerogative of only the highest ranks (Doppelfeld & Pirling 1966). The silks and Coptic fabrics have undoubtedly been imported from the East Mediterranean or from further east; but the other textiles may be considered to be of European origin.

East European textiles of the Merovingian Period fall into two groups: those from Germanic graves (i.e. Gepid, Langobard, Bajuwar etc.) and Awar graves (fig. 11–12). Both the Germanic and Awar textiles have the Gerlev-Draaby type (tabby z/z) as the most common type, providing about three quarter of the material. Other common types like the Haraldskjær type, the Hessens/Elisenhof C-type, and the Hessens/Elisenhof A-type (2/2 twill z/s) each provide only a small percentage of the material; the spin-patterned Gudmingegaard type is represented among the Germanic textiles, but only sparingly; "other" types are mainly indeterminable fabrics.

The distribution patterns outlined here suggest that there were several textile-producing centres in Europe during the 5th to 8th centuries. Southern Germany seems to be the centre for spin-patterned linen tabby (the Gudmingegaard type) and for a number of patterned fabrics such as Rippenköper, rosette twill, tabby with warp-float pattern and possibly honeycomb weave. When fabrics of these types appear in the Baltic area in the early 7th century, as they do on Bornholm or in the princely burials at Vendel and Valsgärde, they must undoubtedly be considered as Frankish or Alamannic imports (cf. fig. 6c and d). Frisia seems to have been another area of textile production, with the Hessens/Elisenhof C-type as the most characteristic product.

THE CAROLINGIAN PERIOD

Carolingian Period textiles of North Europe, i.e. the 8th-10th centuries AD, are divided into four ethnic groups:

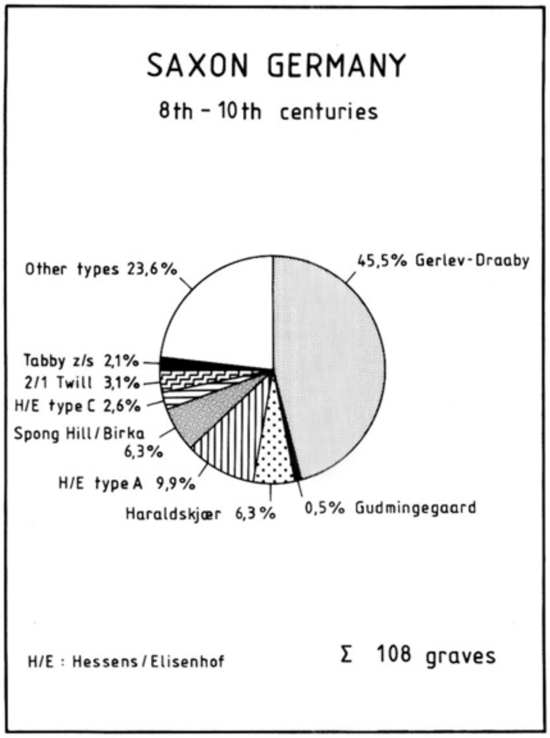

Fig. 13. Pie diagram of main cloth types in North Germany in the 8th-10th centuries AD.

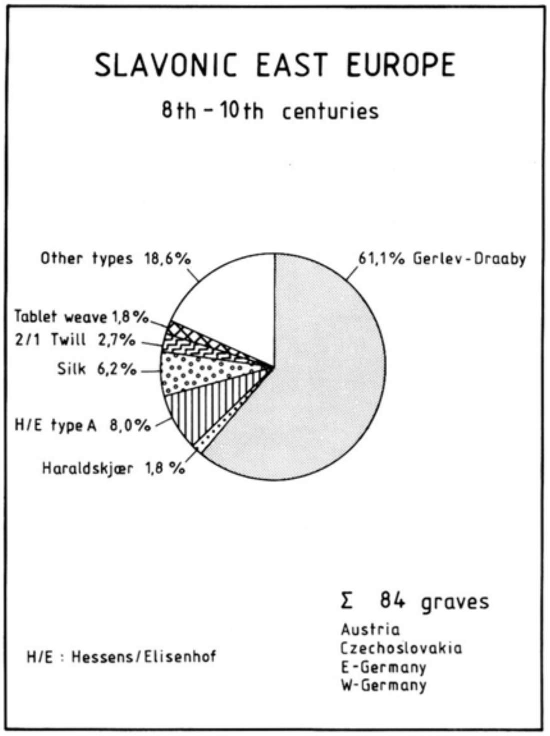

Fig. 14. Pie diagram of main cloth types in Slavonic East Europe in the 8th-10th centuries AD.

Germanic (mainly Saxon) North Germany, Slavonic eastern Europe, Magyar Hungary, and Scandinavia (figs. 13–16).

In all four groups, the Gerlev-Draaby type (tabby z/z) is a main cloth type making up between 38% and 61% of the material. In the Slavonic area, in the sense of Slavonic graves from the DDR, parts of the BRD, Czechoslovakia and Austria, the Gerlev-Draaby type amounts to 61.1% of the material; about 10% of the remaining fabrics are 2/2 wool twills, most of these the Hessens/Elisenhof A-type (2/2 twill z/s), whereas the Haraldskjær type (2/2 twill z/z) is rare; a noteworthy feature is that silk form an important new group, with some 6% of the material. Silk was known earlier, in fact since the Hallstatt Period, but only as singular pieces (Wild 1984). The Carolingian Period is the first where silk becomes so common that it constitutes a major part of the textile material found.

The Germanic material in many was resembles that from the contemporary Slavonic graves. The Gerlev-Draaby type makes up almost half of the finds, the wool twills of the Haraldskjær and Hessens/Elisenhof A-type comprise 16% of the material, the Hessens-Elisenhof A-type being the more common; the Hessens/Elisenhof C-type (diamond twill z/s), which had a strong hold on NW Germany and Frisia in the Merovingian Period, now is only 2.6%; diamond twill z/z is found in two categories – the Spong Hill type, which is of medium quality, and the Birka type, which is a very fine worsted. The 6.3% diamond twills z/z can be almost equally divided between the two types. Silk has been found only once, and is grouped with "others".

In Magyar Hungary silk provides more than 40% of the material, where the Gerlev-Draaby type is only 38% and "others" 20%. The material consists of only 20 graves with 29 textile fragments, so it should be viewed with some caution.

The Scandinavian Viking Age textiles (9th-10th centuries) are illustrated in fig. 16. As there are marked regional differences in Viking Age Scandinavia, the diagram should be used with caution. It is shown here to put Viking Scandinavia into a European perspective.

Again, the Gerlev-Draaby type is the most common, some 44%, and there are some 30% diagonal twills; this latter group should be divided into several sub-types: the

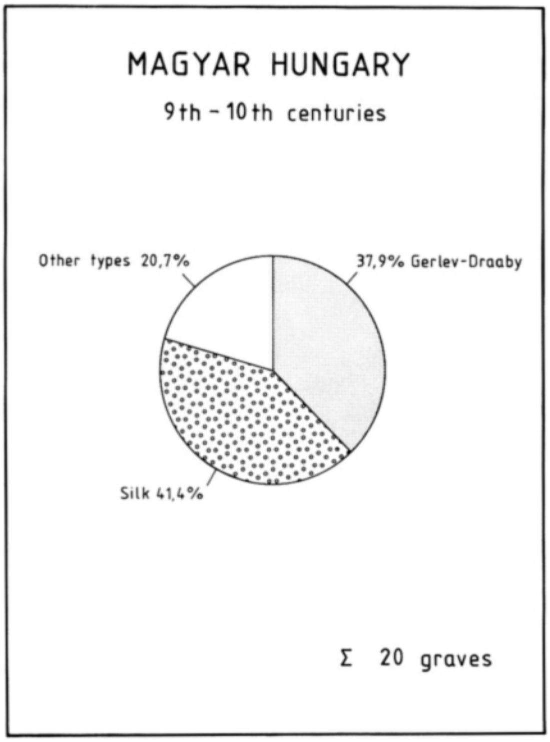

Fig. 15. Pie diagram of main cloth types in Magyar Hungary in the 9th-10th centuries AD.

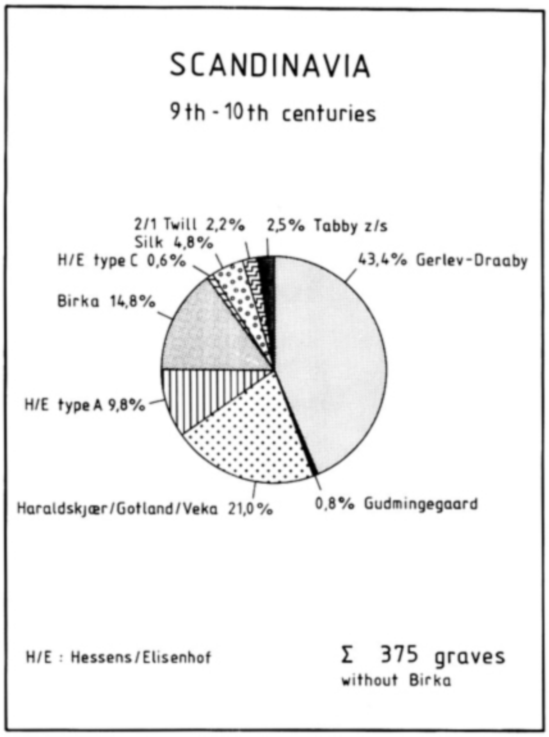

Fig. 16. Pie diagram of main cloth types in Viking Age Scandinavia.

Hessens/Elisenhof A-type, amounting to some 10%, and then the Haraldskjær, Veka, and Gotland types with together 21%. The Veka or Norway type is specific for Norway in the 7th-10th centuries, the Gotland type represent another regional type (Bender Jørgensen 1986, p. 186f./357 and Bender Jørgensen forthcoming); only a few fabrics can be termed the traditional Haraldskjær type. The Birka type (fine worsted diamond twill z/z) is the third most common type, but again, regional variations must be considered, as this type is much more common in West Norway than in the rest of Scandinavia. Silk has been found in 17 graves, and, as in east Central Europe, the 9th and 10th centuries are the period where silk is first found in Scandinavia. The princely boat grave cemetery of Valsgärde in Uppland, Sweden, is a good example of the sudden increase of silk. Throughout the period c. 550–1100 at Valsgärde one male of each generation was interred in his boat, and with rich furnishings including many textiles. The Vendel Period (7th-8th centuries) graves are among the richest of the whole series, and this also applies to textiles (Arwidsson 1942, 1954, 1977); but there are no silks. The Viking Age graves are much more poorly furnished, and textile remains are fewer; but the few found are almost all silks. At the Viking Age trading centre of Birka in Mälaren, Sweden, silk has been found in no less than 45 graves (Geijer 1938, p. 58ff.); the Birka material is omitted from the diagram of Scandinavian textiles of the Viking Age as this material in many ways differs significantly in character from that in more ordinary graves.

The appearence of silk in Scandinavian Viking graves can probably be linked with the establishment of Scandinavian connections with the Byzantine world via Russia. Scandinavian graves have been found at many sites in Russia – at Staraja Ladoga, at Novgorod, and along the Dniepr and Volga. The earliest Scandinavian find in Russia dates to around 760, and many more are dated to the 9th and particularly the 10th century (Stalsberg 1988, Rjabinin 1985, p. 56f., Kirpicnikŏv, Rjabinin, & Petrenko 1987). However, as indicated above, it was not only in Scandinavia that silk became more common in the Carolingian Period (see also Pritchard 1988, Maik 1988, p. 198f.).

In this presentation of European textiles north of the Alps in the Pre-Roman Iron Age and the Post-Roman

Period only the main outline has been given. A detailed discussion of the origin of the various cloth types presented here, the reasons for their distribution pattern, and the information on textile technology etc. that can be extracted from them, fall outside the scope of this preliminary paper, but will be considered later, in a major study that is to emerge from the present research project.

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The Germanic Iron Age and Viking Age in Danish Archaeology

A survey of the literature 1976–1986

by ULF NÄSMAN

INTRODUCTION

It is, of course, an impossible task to survey in a few pages all the results presented and the new ideas put forward during the last 10 years on the Late Iron Age in Denmark (in Danish terminology covering the Germanic Iron Age and the Viking Age, *i.e.* the 5th-11th centuries A.D.). A quick selection of relevant literature in *Nordic Archaeological Abstracts* covering publications during 1974–1986 yilded c. 750 relevant titles. Naturally, not all of these are really important, but all are relevant in one respect or another. This last phase of Danish prehistory has previously – apart from the Viking Age – been rather neglected, due to the paucity of finds. Research in Norway and Sweden has always been more lively, due to the richer finds of both the Germanic Iron Age and the Viking Age in these countries. The general impression of the last 10 years of Danish Late Iron Age and Viking Age research is, however, one of growing interest and steady progress.

Reasons for this change in Danish archaeology can be found in the new methods and theories adduced by the New Archaeology and its successors. This has increased interest in social transformation, where the protohistoric Germanic and Viking periods have some advantages over earlier prehistory; the processes of state formation, in particular, are a challenge. Contacts to English and American archaeology and to social anthropology have also focused archaeologists' attention on exchange and trade systems, on craft specialisation, economic and political centres, and urbanisation; again this period, which encompassed embryonic and early towns, was an obvious research field. Traditional contacts with the archaeology of Norway and Sweden are important stimulants, as well as the challenges offered by Continental, primarily German, scholars, who are continuously making considerable contributions to the study of the Scandinavian Late Iron Age.

The methodological breakthrough most important for the new stimulus of Late Iron Age research was, however, the large settlement excavations initiated by C. J. Becker. Here a new and important material was explored, mostly comprising Viking Age sites. The Early Germanic Iron Age is also represented, but the Late Germanic Iron Age is still a weak link. The excavations in 1970–76 in Ribe, when urban remains of the 8th century were found, resulted in new interest in the process of urbanisation, also among scholars unaccustomed to a social anthropological perspective.

Starting with the sensational date of the earliest rampart of Danevirke to A.D. 737, new dendrochronological results have stimulated a reappraisal of Danish Viking Age history that is far from concluded. Dendro-dating has given archaeologists a tool that will sometimes give more precise results than can be obtained from the sparse written sources.

CHRONOLOGY

Oscar Montelius's periodisation (1885–97) is still in use, but the absolute datings of this periods VI–VIII have been adjusted according to new results (Lund Hansen 1988b surveys the chronological problems of the Roman and Germanic Iron Ages).

The definition and dating of the transition between the Late Roman (per. V) and Early Germanic (per. VI) Iron Age is still problematic, and consequently we still employ Montelius' dating, c. A.D. 400, which is probably too late. There is no consensus about how to subdivide the Early Germanic Iron Age in Scandinavia, and the source material makes this a Norwegian task. In Denmark, a ceramic chronology is under development (S. Jensen 1978; 1986b; Ethelberg 1986) and several important pottery assemblages await publication, such as Vorbasse and Sejlflod (S. Hvass 1983; J. N. Nielsen 1982; 1987; Ringtved 1988).

The absolute dating of the transition between the Early and the Late Germanic Iron Age is controversial. The date c. 575 given by Mogens Ørsnes 1966 is thought by some to be a generation or two too late (*e.g.* Arrhenius 1983 & Høilund Nielsen 1987, who both prefer a date in the 1st half of the 6th century), but others accept a late chronology (*e.g.* Hines 1984 and Welch 1987).

A functioning subdivision of the Late Germanic Iron Age into three phases was presented in 1966 by Ørsnes, and a recent revaluation of this relative chronology using multivariate correspondence analysis resulted largely in a confirmation (Høilund Nielsen 1987).

Pottery was omitted by Ørsnes and Karen Høilund Nielsen, being extremely rare in Late Germanic Iron Age graves. The settlements of the period are still very few, and the pottery is very difficult to date, but work is going on to solve this annoying problem (S. Jensen 1986b; S. Nielsen 1985), and a seminar on this chronological topic was organised by Palle Siemen in 1987 in Esbjerg.

The chronological boundary between the Late Germanic Iron Age and the Viking Age was difficult to define and date for Montelius, and still is. The excavations in Ribe of urban layers containing much pottery, dating sceattas, and moulds of Late Germanic Iron Age and Viking Age jewellery are of significant importance in this connection (Bencard 1979; Bendixen 1981; S. Jensen 1986a; Frandsen & Jensen 1988). Becker is of course right when he recommends (1986: 143) that archaeologists await full publication – in principle, but there can today be little doubt that the archaeological Viking Age, *sensu* Montelius' per. VIII, started before the Vikings sailed to Lindisfarne in A.D. 793.

It is a paradox that the rich find materials in Sweden and Norway have still not resulted in a firm, subdivided relative chronology of the Viking Age. Most scholars still refer to the loose and today outmoded concepts '9th century', '10th century' and '11th century' as used by Jan Petersen in his famous publication (1928). An attempt to present a new chronology based on grave finds has been presented by Johan Callmer (1977), but his subdivision into 9 phases supported by a bead seriation has not won acceptance. Recently, Ingmar Jansson (1985, 1987) has presented a full argument for his earlier subdivision of the Viking Age into three phases, Early Viking Age (= Early Birka Age), Middle Viking Age (= Late Birka Age), and Late Viking Age (for a critical appraisal, see Capelle 1986), and he has given absolute dates according to primarily Danish archaeological results.

Most important for all those working with Viking Age chronology is Jansson's observations on the copying of bronze ornaments, because they raise doubt about the possibility of ever reaching a fine subdivision of the period based on bronze jewellery. This is further emphasised by the new dendro-datings of the style-denominating finds at Mammen and Jelling, not made when Jansson wrote. They are so close to each other in the 3rd quarter of the 10th century that a chronological separation of the two styles seems a dubious affair. The lack of a good Viking Age chronology is a serious drawback in the study of the profound social transformation of the period.

Where to place the end of the Viking Age and the beginning of the Scandinavian Middle Ages is also a controversial question. The disappearance of the oval brooches, *i.e.* the end of Scandinavian women's traditional dress, at the end of the 10th century would be a limit in accordance with Montelian chronological methods. Surprisingly, Montelius used instead the Conversion of Sweden c. A.D. 1050, which in Denmark ought to correspond to c. A.D. 960, and is most unpractical. A dividing line between 'prehistoric' and 'Medieval' archaeology, placed where a domestic written record, disregarding the runestones, starts to flow, *i.e.* at the end of the 11th century or c. A.D. 1100, is not convenient, being completely detached from the material evidence. Moreover, there are great difficulties in defining a periodic transition in the 11th century in archaeological terms, because well-dated find complexes of this century are very rare outside urban Lund (Mårtensson 1976). The stratified ceramic sequence of urban Viborg (Krongaard Kristensen 1982; 1988) will be helpful in this respect, and the rural sites Gl. Hviding and Vilslev investigated at Ribe are important, due to both house types and pottery (S. Jensen 1987a).

THEORY AND METHODS

Most achievements that can be labelled theoretical or methodological news are treated below in connection with the relevant subject of study. Only more general works are mentioned here.

The book by Jørgen Jensen (1979; 2nd rev. ed. in Engl. 1982) has been most influential as an alternative to the dominant views on the Scandinavian Late Iron Age based on traditional European archaeological thinking. Jensen advocates an anthropological perspective on an internal and continual social evolution. The greatest shortcoming of the book is, in my view, that Denmark is treated in isolation from the rest of Europe.

An interesting sequel to Jensen's presentation of Danish prehistory is the attempt by the legal historian Ole Fenger (1983) to delineate prehistoric and Viking law in Denmark (cf. criticism by N. Lund 1985a).

The book on Viking Age Denmark by Klavs Randsborg (1980) must also be mentioned here. It raises many new questions and tries to approach the answers with new methods and new source combinations. Its stimulating effect on Scandinavian Viking Age research (archaeology, that is) can already be noticed, but the lasting impact cannot yet be evaluated, since it has not so far been taken up for serious discussion by Danish scholars (except in a critical note by N. Lund 1985a; cf. Becker 1986: 143).

In an important contribution to the archaeological source-criticism, Evert Baudou (2nd ed. in Engl. 1985) discusses the effect of later agricultural history on the archaeological record. After this no one should use distribution maps of any archaeological phenomenon on Denmark without first paying attention to his argument.

New methods have been adopted to permit the handling of large amounts of data. In analyses of chronological seriation or social stratification, multivariate correspondence analysis has demonstrated its efficacy (T. Madsen 1984; 1986; Høilund Nielsen 1987).

The dendro-revolution in Viking Age chronology has already been touched upon. Hopefully, the thermoluminescence dating of pottery and fired stone will prove to give equally important results, once the sources of error are controlled (Mejdahl 1985).

Archaeometric prospecting methods (Møller *et al.* 1984) have certainly a future in Late Iron Age research, since the settlements are so difficult to locate by ordinary reconnaissance. Phosphate mapping, for instance, ought to be more systematically tested; the results from Germany, Norway and Sweden have often been rewarding. One reason why Late Iron Age settlements are so difficult to locate is the rapid destruction of the pottery, as demonstrated in a brilliant study by Stig Jensen (1985).

The use of metal detectors is naturally a problem when they are in the hands of amateurs, but many important discoveries made by amateurs have come to the museums. The most important finds have been made in the Gudme area, where Henrik Thrane (1987a) could recently produce a statistical analysis of Late Iron Age finds before and after the introduction of metal detectors, demonstrating that there were many finds from the Late Iron Age, in areas where earlier very few finds were known. A conclusive demonstration of the usefulness of metal detectors in settlement archaeology has been presented by S. Jensen (1987b). It is necessary to sample the topsoil before it is stripped away to obtain the small metal artefacts that both date and characterise the sites.

ARCHAEOLOGY AND OTHER HUMANISTIC DISCIPLINES

Onomastics

Place-name research is not firmly integrated into Danish settlement research, as noted by Olaf Olsen some years ago (1975). There are naturally great difficulties involved in using place-names in an archaeological context, but they cannot be ignored by the archaeologist as a source for understanding the cultural landscape and social organisation. In Swedish settlement research, onomastics play a much greater part, exemplified by studies in early territorial organisation (Andersson & Göransson 1983). In Denmark, an archaeologist has with some success used place-names to discuss the problem of settlement continuity (H. Nielsen 1979; cf. Kousgård Sørensen 1981), and this matter has been in continued focus for some time, cf. the proceedings of a symposium ed. by Vibeke Dalberg *et al.* 1984, in which Stefan Brink emphasised the importance of distinguishing between the concepts site continuity and settlement continuity (cf. also Brink 1988). In any case, the so-called early names *-lev, -løse, -inge, -hem,* and *-sted* evince a considerable number of continuously settled resource areas, and the so-called late names *-by, -tofte, -torp, -bølle,* etc., the changing settlement pattern of the Late Iron Age and Middle Ages.

John Kousgård Sørensen (1978) and Bent Jørgensen (1980) have discussed territorial administration in the Danish Viking Age on the basis of place-names; this evidence ought to receive far more attention in the current archaeological debate on regionality and political territories (see below on the significance of theophoric place-names at Gudme). In the study of communication, too, the onomastic sources might be useful, as indicated by studies by Bent Jørgensen (1979) and Bente Holmberg (1980). Research in communication and transport will be discussed below, and when looking for Iron Age ports and harbours it should not be forgotten that place-names may furnish valuable indications (e.g. Snekkebjerg at Fribrødre Å, Skamby Madsen 1984; 1987).

Runology

In *Runes and their origin*, a text-book that will be consulted again and again, Erik Moltke (1985) published the results of a lifetime of research. Marie Stoklund has taken over after Moltke. Runology in Denmark is in a somewhat tenuous position today, nevertheless, due to an almost non-existent recruitment of new students. This is, of course, partly explained by the low accession of new finds. In the last 10 years, only two new runestones, have been published (Stoklund & Moltke 1979; Knudsen & Thuesen 1988), and few runic inscriptions on small objects have been found. Runes are, however, so important for the understanding of Danish Iron Age societies that it is absolutely necessary that a continuous specialist study be maintained.

The use of runestones by Randsborg (1980) in social and political analysis has triggered off a new interest in runestones as documents. An important contribution was recently presented by Birgit Sawyer (1986; 1988).

One crucial point in Randsborg's interpretation is that the absolute datings suggested by Jacobsen & Moltke 1942 of the relative phases, early (= Helnæs-Gørlev and pre-Jelling), Jelling, and post-Jelling stones, are correct (for the most recent presentation, see Moltke 1985). The necessary revaluation of runic chronology is not a matter for archaeologists, but one that requires a philological competence, and in a forthcoming paper, Stoklund opens the discussion with an examination of the relative and absolute chronology of the Jelling and post-Jelling stones.

A stimulating paper by a new archaeologist on old runes was written by the late Carl-Axel Moberg (1985), who recommends that archaeologists study the introduction and use of runes in their archaeological context.

Numismatics

Coins and non-monetary currency are not unusual small finds in Late Iron Age contexts. For a numismatic study, adequate training in this field is needed, which few archaeologists have. But they can contribute considerably to numismatics with respect to both chronology and function by treating coin finds in the archaeological context.

The most conspicuous development in the study of the media of exchange in the Late Iron Age is the discovery that sceat coins were used in South Scandinavia in the 8th century (Bendixen 1984; Callmer 1984). From the context of the coins found at Ribe and Åhus, it can be deduced that they were used in trade, the implication being that a kind of market economy was introduced at some places much earlier than anyone had imagined 20 years ago. D. M. Metcalf, the numismatist, has even advanced the hypothesis that the so-called Wodan/monster sceattas were minted in Ribe or elsewhere in Denmark (1984; cf. the rejection by Malmer & Jonsson 1986, the cautious comments by Bendixen 1986 and Frandsen & Jensen 1988, and the reply by Metcalf 1986).

The new sceat finds were made in Ribe by the time the dendro-dating of the first Danevirke to A.D. 737 was published (H. H. Andersen *et al.* 1976). In this new archaeological light, Alcuin's odd story about the missionary Wilibrord's visit to a Danish King Ongendus in the early 8th century was suddenly of significant interest (Skovgaard-Petersen 1981).

A monetary market, a nucleated trading station, a fortified border, a king – suddenly it was obvious to all that the necessary prerequisites for the Viking Age could be studied in the 8th century! This is one of the most exciting archaeological revelations in many years.

The introduction of sceattas did not mean, however, that a Scandinavian market had developed. A long time was to pass before a Danish coinage was firmly established. When Islamic silver started to flow into the Baltic in the 9th century, silver bullion became more important than minted currency in most parts of Scandinavia until the end of the Viking Age (a convenient research survey is presented by Steuer 1987b). Birgitta Hårdh has made several studies of the south Swedish silver hoards (most recently in 1978), and a corresponding study of hack-silver in the area of present-day Denmark is a desideratum.

Brita Malmer has contributed a long series of important papers on Viking Age coinage and monetary circulation (cf. Malmer 1985). Recently, Becker has launched a series of papers on a complicated numismatic material (1981; 1985) that changed Danish history. He gives a new and detailed version of the struggle between the Norwegian Magnus and the Dane Svend Estridsen over the Danish throne during the 1040s.

With these new results, it should be possible to give a new outline of the monetary history of Denmark during the 8th to 11th centuries. But the exciting new discoveries at Smørenge in Bornholm and Gudme in Fyn remind us that it should not be forgotten that there also existed money in the Early Germanic Iron Age. Old denars were evidently still in use alongside Late Roman solidi as some kind of special-purpose money (Kromann 1987). A new study of Danish solidus finds is needed to bring the evidence on the level with recent Swedish results (Herschend 1980; Kyhlberg 1986).

History

There are, apart from Jordanes, Procopius, Gregor of Tours, and the Venerable Bede, no written sources relating to Scandinavia in the 5th to 7th centuries, and even in the 8th century and the Viking Age, the written evidence is scarce and difficult. In an excellent text-book written by Inge Skovgaard-Petersen (1977), the sources are presented and interpreted in a traditional historical perspective. However, Erik Ulsig, the historian, is probably right when he at a symposium in 1986 said that historians cannot continue to scrutinise the old sources and find new aspects without the support of other disciplines. And indeed, new data have demonstrated the ability of archaeology to make a rereading of the sources rewarding.

Already mentioned is the new edition of the sources relevant to the port and market at Ribe (Skovgaard-Petersen 1981). The dendro-datings of Danevirke, the Kanhave Canal (A.D. 726, unpublished, information by Else Roesdahl), the bridge over Ravning Enge (c. A.D. 979, Ramskou 1980) and the Trelleborg forts (A.D. 980/981, Bonde & Christensen 1984; H. Andersen 1984) provide arguments for a reappraisal of the Danish Viking kingdom, centred on the role of Harald Bluetooth (*e.g.* N. Lund 1980; Randsborg 1980; Roesdahl 1980 & 1987b; H. H. Andersen 1984; Hoffmann 1984; Weibull 1984; P. H. Sawyer 1988). The controversy about the so-called Swedish dynasty of Hedeby in the early 10th century has certainly also received new impetus from archaeological discoveries (N. Lund 1982 *vs.* Moltke 1986; cf. Laur 1983; H. H. Andersen 1986).

H. H. Andersen has, inspired by the new chronological data and by a publication by Michael Müller-Wille (1976a, see also Ellmers 1980), tried to reconstruct the royal lineages in Viking Denmark and to identify the graves on pagan royalties (1986, cf. Müller-Wille 1983a). He maintains that Denmark was a united realm long before King Harald Bluetooth. Skovgaard-Petersen discusses in a paper (forthcoming) the Viking kingship of Denmark, and has a more pessimistic view on the possibility of obtaining a clear picture from the written sources.

The archaeological investigations at Danevirke, Hedeby, Ribe, Jelling, Ravning Enge, Kanhave Canal and the Trelleborg forts demonstrate today without any doubt that the social and political organisation of Denmark was much more sophisticated in the 8th-10th centuries than believed only a few years ago. For example Erik Lönnroth, the historian, described the Scandinavian kingdoms as "concentrations of seapower rather than territorial dominions, and their fiscal organization was that of a self-supplying body of mercenary troops rather than a properly constituted state" (1963:364). I doubt whether he would now apply this sentence to Viking Age Denmark, while another historian, Niels Lund, seems prepared to admit that "one might attribute state organization to the king who in 737 built the first Danevirke" (1985b:108).

At the same time, the 8th century evidence makes it clear that Viking society can no longer be explained by a retrogressive application of written sources to Scandinavian Medieval society, mostly later than the 12th century. Late Iron Age society, including the Viking kingdoms, can better be understood in its contemporary European context and by use of historical analogy (Näsman 1988a), and a similar opinion is expressed by Patrick Wormald (1982).

In an archaeological perspective, Peter Sawyer's *Kings and Vikings* (1982) makes too little out of the archaeological material. This plays a more prominent part in his popular Danish Viking history (1988). Niels Lund's contribution to Danish social history (1980) is almost entirely based on the fragile written evidence and his views on archaeological sources are quite depressing for an archaeologist.

Historians have paid little attention to the Scandinavian Germanic Iron Age, but Wood's short survey of the Merovingian North Sea (1983) has to be mentioned. In a Scandinavian perspective his emphasis on the importance of Danish power in the North Sea in the 8th century is interesting.

It must, however, not be forgotten that many archaeologists are far too uninformed in the continental and insular history of the 5th-11th century and that they often use written sources in an uncritical way and without consulting a historian. Knowledge about, for instance, the historical situation in Europe during the 4th-6th centuries is necessary for any Scandinavian archaeologist wanting to contribute to the history of these centuries in Scandinavia, and the study on tribal societies by Reinhard Wenskus (1977), the survey of England from the Roman to the Norman period by P. H. Sawyer (1978), and the history of the Goths by Herwig Wolfram (1988) are good examples of indispensable reading.

ARCHAEOLOGY AND SCIENCES

The long tradition of co-operation with the natural sciences has been especially rewarding in earlier prehistoric periods, but contributes little to solve a number of problems in Late Iron Age and Viking Age contexts. But there are both economic and organisational difficulties involved, and the situation today in Denmark cannot at all be compared to that of Norway, Sweden, England or northern Germany, where archaeologists and scientists together work in a number of well-organised interdisciplinary projects (for instance Kossack *et al.* 1984; Jankuhn *et al.* 1984). It is a great handicap for Danish archaeologists in discussions with colleagues from neighbouring regions not to be able to quote relevant Danish investigations of climate, vegetation, soils, cultivation techniques, etc. A number of investigations have, however, been performed and published.

Vegetational history and climate

The most important work in the period is a paper by Aaby (1976) on cyclic climatic variations reflected in Danish raised bogs. The changes occurred at intervals of c. 260 years, and in the period relevant here a change to moister and/or colder conditions is seen in the 5th century and again around A.D. 1000, which means that the change expected in the 8th century is lacking. The climatic deterioration in the 5th century could partly explain the decreasing number of 6th-7th century finds, not only in Denmark, but also in other parts of North Europe. The lack of a climatic change in the Late Germanic Iron Age could contribute to the growth of European societies in the 7th-13th centuries, but the deterioration around 1000 cannot be found in the archaeological record. Randsborg (1980; 1981) uses these results and observations made in the Greenland ice-cap (Dansgaard *et al.* 1975) in a rather detailed model of correlation between climate and settlement, while J. Jensen (1982) reaches an opposite conclusion: "Comparison of these climatic fluctuations with the archaeological record shows surprisingly little analogy", but his time perspective is longer, it should be pointed out.

An attempt to make use of the climatic changes observed and the evidence of pollen analysis is presented by Lotte Hedeager (1988a). She doubts whether the climatic changes necessarily meant an agrarian crisis and suggests instead that land-use changed to meet the new conditions. The growth of the beech forests in the Late Iron Age consequently does not necessarily mean a decrease in population.

The lack of pollen-analytical support in Danish settlement archaeology is a serious obstacle preventing an understanding of land-use and a reconstruction of the cultural landscape. Fortunately, an initiative has recently been taken to procure pollen-analyses of a series of characteristic Danish landscapes and it is to be hoped that some of these can be situated close to excavated settlements.

Only one analysis has been made in direct connection with an archaeological investigation, at Vorbasse (Brorson Christensen 1981), but the material used and its context could give only a rather vague picture of the surrounding landscape. A number of analyses of bogs have been made, but they are unfortunately situated far from well investigated Late Iron Age settlements, for which reason the information they give in a Late Iron Age context are of a rather general character (*e.g.* Th. Andersen *et al.* 1983; S. Th. Andersen 1985; Odgaard 1985; Aaby 1985).

There is furthermore some uncertainty about the interpretation of pollen diagrams indicating the human influence on vegetation. Does a decrease in human impact mean that cultivation was reduced, or that land-use changed? Co-operation between archaeologists and palaeobotanists is needed to solve this intricate problem.

Carbonised grain is an important source in the study of agricultural practice, but few macro-fossil analyses have been made in Late Iron Age contexts. Most important is a study of grain found at Fyrkat by Hans Helbaek (1977). He finds it most probable that the rye found in Fyrkat was imported, and not cultivated in Denmark. Analyses of corn from Øster Ålum, Jylland (Rowley-Conwy) and Ejstrup, Jylland (D. Robinson & K. Kjer Michaelsen 1989) seems, however, to imply that rye was cultivated as a main crop already in the Late Germanic Iron Age, and samples from a Late Roman Iron Age site at Kosel, Schwansen (Kroll 1987) and a Late Roman-Early Germanic Iron Age site at Esbjerg, Jylland (Robinson & Siemen 1988), indicate that its cultivation as a separate crop was established as early as that period in south Jylland, barley still being the most important summer-sown cereal. These rye finds may imply that a rotation of winter and summer sown crops was introduced in a more efficient production. The Hedeby material is published by Karl-Ernst Behre in what may be the handbook of Viking Age plant food (1983). He finds very little evidence of trade in vegetable food (*i.e.* the surroundings must have provided for the urban inhabitants).

Probably the introduction of a winter crop is part of the expansion of agricultural production that was necessary to support urbanisation and state formation. Whether it also implies the introduction of a two-field system, succeeding the one-field cultivation of the Early Iron Age, is still a matter of discussion. Whatever the case, sampling of macro-fossils is a valuable tool in the study of Iron Age cultivation.

Charcoal found in settlements is another type of macro-fossil that bears information about the landscape, and also informs us about wood technology, but wooden remains preserved in wet layers as at Hedeby are more informative, *e.g.* Eckstein (1977), who is able to identify 27 species. Information on wood technology may also be derived from corroded metal objects in graves (Wagner 1978).

Physical anthropology and osteology

In the acid soils of most of Denmark human bones are seldom preserved in graves. What is preserved has now been published in a large monograph (Sellevold *et al.* 1984), but 9 skeletons from 4 sites dating to the Early Germanic Iron Age and 30 skeletons from 11 Late Germanic Iron Age sites are, of course, not representative samples. 320 Viking skeletons from 38 sites can, however, give a reliable picture of the physical stature of the population. In addition, a special study has presented the pathology of Danish skeletons (Bennike 1985). The large population buried in the 11th century at Lõddeköpinge, Skåne, is not included in the Danish studies, but the 1431 skeletons there give an interesting insight into a Danish parish shortly after the Conversion (Persson *et al.* 1984).

Palaeozoology and osteology

It is a great handicap to Danish archaeological study of Late Iron Age economy that animal bones are usually not preserved in rural settlements. This is easily seen in the literature, in which publications of materials from the water-logged layers of Hedeby dominate, a paper by Strömberg (1981) on rural sites in Skåne being an exception. The Hedeby papers will not be separately listed, as they are all to be found in the series *Berichte*, but it may be mentioned that volumes on fish (10, 1977), dogs (13, 1978), pigs (15, 1980), and cattle (17, 1982) have been published, and one on birds is in preparation.

The significance of animal bones is evident, which can be illustrated by the attempt by Randsborg (1980) to use statistics of bone fragments to characterise different settlement types. In spite of my scruples about the representativity of some of his selected samples, I think that his find that the material allows rural and urban sites to be distinguished from each other is important. This observation helps us to understand the relation between rural production and urban consumption. It will be interesting to see how the materials of 8th century Ribe and 11th century Viborg fit into his diagram (publication in preparation by Tove Hatting).

SURVEYS

Apart from the popular books by Lone Hvass (1980) and Hedeager (1988b), there is no written survey of the Germanic Iron Age in Denmark, and the explanation is simple. The source material has been too meagre to tempt any scholar or publisher. In fact there is no textbook to replace Brøndsted's survey (1963), which, however, is completely outdated. The chapters in Hedeager's book are the best summary available. On the Continent and in England, the situation is different (*e.g.* the Anglo-Saxons: Campbell *et al.* 1982 and Ahrens 1978; the Alamanni: Christlein 1979; the Lombards: Menghin 1985; the Franks: Périn & Feffer 1987 and Feffer & Périn 1987).

German archaeology offers a number of outstanding research surveys that often directly involve the South Scandinavian area. Suffice it to mention the publications by *Deutsche Forschungsgemeinschaft* (Kossack *et al.* 1984 and Jankuhn *et al.* 1984), which provide good, concise information. They are a must for any Iron Age archaeologist working on the North Sea.

There is, in contrast, no shortage of surveys of the Viking Age. Randsborg's book is already mentioned. Roesdahl's more systematic survey of Denmark (1982) is necessary reading – being the only handbook with refeces. Viking specialists, too, will often find reason to consult it, so it is a pity that it is out of print – P. H. Sawyer's new popular Viking history of Denmark (1988) or Roesdahl's own new Nordic survey (1987a) are no substitutes. A work edited by Joachim Herrmann (1982) is also popular, but is valuable as an attempt to draw the Slavic, Baltic, and Finno-Ugrian peoples around the Baltic into a discussion that is often too Anglophile and focused on the North Sea region.

TRADE & EXCHANGE OF GOODS

One of the most important approaches for understanding the social development of the Late Iron Age is to study trade or the exchange of goods. J. Jensen's book mentioned above made most Danish archaeologists familiar with the concepts presented by Karl Polanyi, *i.e.* reciprocity, redistribution, treaty trade, and market economy, and a similar theoretical background is found in Randsborg's Viking book. In the popular book by Hedeager (1988b), her research is summarised and many interesting issues raised.

For an elaborate model, based on anthropological theory and archaeological data, see Richard Hodges' survey of *emporia* along the North Sea and on the Baltic (1982). It is almost inevitable that a survey of this kind should include controverial points (see review by Astill 1985), and as a Scandinavian, one can sometimes see that Hodges is not too well informed on Nordic archaeology (and his use of written sources is criticised by English and German historians). But he gives a stimulating overview and a model against which to test new Danish discoveries, for instance, the new port found at Lundeborg, Fyn (Thomsen 1987; 1988).

Together with Whitehouse, Hodges has tried to reappraise the famous Pirenne thesis once again and, as a matter of course, their study (1983) includes a discussion on trade between the North Sea and the Baltic, and the central position of Hedeby. It is odd to note that they largely accept Bolin's 50-year-old discussion of Pirenne. His ideas have been relinquished by most Scandinavian scholars, and recently Jansson concluded (1987) that "the idea of an 'inter-continental' east-western trade route via Russia and Scandinavia should in all probability be abandoned". A model emphasising plunder, and tribute, and not trade and exchange, has been advanced by P. H. Sawyer (1982; cf. Lindkvist 1988).

Among many useful contributions by the German archaeologist Hayo Vierck to the study of the connections between Western and North-Eastern Europe, the paper on Staraja Ladoga (1983) is perhaps the most interesting. According to him, long-distance trade in the pre-Viking period was characterised by an indirect distribution of luxury goods, and middlemen and itinerant polytechnic craftsmen were the main agents. The increasing specialisation of the crafts and the concentration of trade innucleated sites are important elements in the development towards a market economy, with direct long-distance trade, early towns, and specialised merchants as a result during the Viking Age (cf. also the concise survey by Steuer 1987a). These thoughts are not unfamiliar to those who work on the problems of pre-Viking Ribe (*e.g.* Bencard 1979; Brinch Madsen & Nielsen 1984; Frandsen & Jensen 1988), but what about the 400 years older Lundeborg? Another contribution to this discussion is based on the 8th century trading port at Åhus (Callmer 1982), but applicable also to Dankirke-Ribe and Gudme-Lundeborg.

The perspective of Hodges & Whitehouse is conspicuously English and, thinking of the substantial results presented by archaeologists working in Scandinavia, around the Baltic and in the Soviet Union, a welcome alternative could be a joint publication by Scandinavian, Finnish, German, Polish, and Soviet archaeologists on the interaction of the different ethnic groups in the area between the North Sea and the Black Sea – the time is ripe for a northeast European synthesis to balance the northwest bias.

The Polanyi terminology is now found inadequate by many scholars. In a recent contribution to the theoretical discussion, Berta Stjernquist (1985) tries to find alternative concepts and to construct a new framework for understanding prehistoric exchange. Focus has again to be on the find material and its contexts, *e.g.* glass vessels in the Germanic Iron Age (Straume 1987 & Näsman 1984a; 1986). Glass shards are now found in many Danish settlements (Stavad in Jylland, Lundeborg and Gudme in Fyn, Næstved in Sjælland, Gårdlösa in Skåne, and Sorte Muld in Bornholm), demonstrating that the lack of glass vessels in Danish Late Iron Age graves is unrepresentative of the true picture – Denmark was an important distributor of wealth, also after the Roman Iron Age (cf. Lund Hansen 1987, 1988a).

The contribution by Hines to the question of the relations between Scandinavia and Anglo-Saxon England in the Early Germanic Iron Age is interesting in this context, and I quote: "The North Sea in the 5th and 6th centuries seems to have been a web of routes for migration, trade and the diffusion of craftsmen's skill" (Hines 1984: 278).

It is, anyway, clear that the character of trade changed during the Late Iron Age; in the Early Germanic Iron Age, luxury exchange dominates; in the 8th century, the first evidence of long-distance trade in cheaper commodities can be observed; and through the three Viking centuries trade in simple household utensils such as pottery, soapstone vessels, whetstones, and quernstones grew considerably (Resi 1979; Myrvoll 1985; Steuer 1987a). This archaeological evidence of bulk cargo transport indicates that also essential subsistence commodities were now traded (cf. Clarke 1985; Crumlin-Pedersen 1985a; 1987a; 1987b: 227).

It is probable that the 8th century increase of trade and the development of a more sophisticated exchange system was stimulated by the Merovingian impact on the North Sea region, and especially the Frisians are in focus as entrepreneurs (Wood 1983; Hodges & Whitehouse 1983; Ellmers 1985; Näsman 1986; Verhulst 1987). Consequently early Ribe, Hedeby South and Åhus are very important sites for understanding how Danish society reacted to this external influence. Obviously, a network of trading stations or gateways was now needed to meet the new situation, but is 4th-7th century Lundeborg something similar?

Curt Weibull (1977) and others postulate that trade with West and East Europe was the background for the plundering raids and piracy of the Viking Age. This idea presupposes that a developed trade network existed before the first Viking raids, A.D. 789 on Wessex and 793 on Lindisfarne. Style analysis (*e.g.* Ørsnes 1966) and studies of imports (*e.g.* Näsman 1986) demonstrate close relations to the Merovingian and Anglo-Saxon kingdoms as early as the 6th-8th centuries. The sites investigated at Ribe, Hedeby South and Åhus now provide indisputable evidence of organised trade before the Viking Age. This, I believe, is one of the most important contributions to Late Iron Age archaeology of the 1970s and 1980s. The start of the Viking Age was not so abrupt an event as the popular view often implies.

Viking Age trade is treated in numerous books, and to avoid a wearisome listing, only a few will be mentioned here. Still going strong is Herbert Jankuhn's Hedeby publication, now in its 8th edition (1986). A popular book ed. by Jansson (1983) and the proceedings of a symposium in Visby (ed. by Lindquist 1985) give good surveys of Viking trade in the Baltic, an area too neglected by Danish archaeologists. P. H. Sawyer (1982) points in fact to the western bias in Viking research and he tries, as does Randsborg (1980), to compare events in the North Sea and the Baltic (see also Roesdahl 1987a, who devotes 81 pp. to West Europe and only 18 pp. to the Viking expeditions into East Europe). Danish archaeologists are, however, in general too unfamiliar with the archaeology of Germany, Poland, and the Baltic and Russian Soviet Republics. The studies by Michael Andersen (1984) on the West Slavic imports is consequently most opportune. The interaction between Scandinavians and the West and East Slavs is a most important task for future research, Zak's survey (1977) being a starting-point.

An example of the relevance of an eastern perspective in Danish Viking Age research is a paper by Bálint (1981) on the Arabic dirhams. His description of a primitive economy in Scandinavia and the Slav area and the discussions by Randsborg (1980), P. H. Sawyer (1982), Hodges & Whitehouse (1983), Noonan (1985), and others raise the question, whether it is feasible to see both Viking Scandinavia and the Slav regions as peripheries of a Carolingian hegemony in the West and a dominant Caliphate in the East (the maps in Steuer 1987b are illuminating). From both quarters, one could imagine that Scandinavians and Slavs obtained not only silver and luxuries but also knowledge of military strategies, social and economic administration, etc. Part of the impetus of the Scandinavian state formation certainly came from these contacts, and the differences in the Danish and Swedish trajectories may be explained by variations in influence sources.

URBANISATION

The *emporia* mentioned above, Lundeborg, Dankirke, Ribe, Hedeby South and Åhus, are not to be characterised as towns, but as more or less transient centres of trade and production. In their variation, they mirror important traits of the origin of the Medieval town in non-Roman Europe. They demonstrate changes in the nature and form of human settlements and evidently also in social structure. As Clarke & Simms (1985) happily put it: "The processes that lie behind the origin and early growth of these towns were evolutionary by their nature, but revolutionary in their effect."

Clarke & Simms suggest the term proto-town be used to cover periods before the chartered town is established, *i.e.* all towns are in fact proto-towns, so long as they can be studied only in the archaeological record. In Danish practice, this implies all pre-Viking centres and all Viking 'towns' (cf. O. Olsen 1975, who differentiates between *by* and *købstad*). For the archaeologist viewing the subject from the perspective of the Roman and Germanic Iron Ages, this is no problem. On the contrary, it relieves him/her of the pressure of historical definitions of towns. In the following, proto-town will be used to mark the distinction between the urban centres of the Late Iron Age and the true towns of the Middle Ages. Space does not allow an attempt to deploy Clarke's & Simms' four subcategories: trading settlements, stronghold settlements, cult settlements, and market settlements, but they present an obvious approach to understanding the diversity and parallelism between sites like Dankirke, Lundeborg, Gudme, Sorte Muld, Ribe, Åhus, Hedeby, Århus, the Trelleborgs, Odense, Viborg, Löddeköpinge, etc.

The proto-town of Ribe was probably the most important trading centre of South Scandinavia in the 8th century, and the localisation of the site on the north bank of the river, opposite the medieval town clustering around the cathedral, is a great achievement of Danish urban archaeology (Bencard 1979). The archaeological evidence of the later *vicus*, where Ansgar was allowed by King Haarik to build a church c. A.D. 860, is unfortunately very slight, and most scholars agree that Hedeby probably took over as the leading centre in the early 9th century.

Hedeby South was in the 8th century not comparable to Ribe, but seems to have been a rather modest trading place. It must, however, be remembered that the shore area has not been investigated at this site. It is from the written sources, the archaeological evidence, and the earliest dendro-dates obvious that it was King Godfred who 'founded', *i.e.* reorganised, the proto-town of Hedeby in A.D. 808, and for that purpose he moved merchants from the Slavic *emporium* Reric, still not localised in north-east Germany, to Hedeby. Despite the fact that Reric had paid taxes to the king, he obviously found it better to move the trading station to Danish territory. Certainly this was a great and brave action in the face of the mighty Charlemagne, and obviously Godfred was aware of the dangers, for at the same time he ordered the southern border of his kingdom to be fortified, in reality a refortification of Danevirke.

Indirectly, Godfred's decision probably also moved activities from Ribe, and consequently Hedeby grew to be the most impressive proto-town of Viking Scandinavia. The textbook by Jankuhn (1986) is the most comprehensive survey of the long archaeological research there, and under the editorship of Kurt Schietzel, new results are continuously being published in the series *Berichte*, in which Schietzel himself has discussed the research status concerning Hedeby (1981; cf. Jankuhn *et al.* 1984). The end of Hedeby in the mid-11th century and the transfer of its activities to the town of Schleswig/Slesvig symbolise in a way the transition from the Viking proto-towns to the Medieval town. The causes of this shift remain obscure, but it is sometimes explained by the end of the long-distance transit trade (*e.g.* Randsborg 1980), sometimes by more practical things such as harbour facilities and new types of ship (e.g. Roesdahl 1982).

An important question is the relation of the proto-town to its hinterland. Proto-towns have to be understood as rooted in and interactive with the surrounding landscape and a relatively dense population was needed to support the proto-town (S. Nielsen 1983). This problem has been neglected far too long – also in studies of the Medieval chartered town – and for instance Hedeby seemed for many years to have been founded in a no man's land, as a transit trading station. Recent surveys of the surroundings have revealed a dense settlement pattern (Müller-Wille & Willroth 1983; Willroth 1987; Müller-Wille 1988), and the relation between Hedeby and the rural settlement is one of the objectives of the excavations at Kosel in Schwansen/Svansen (Meier 1987). The recent study of the settlement pattern in the Ribe area will inevitably contribute to our understanding of the Germanic Iron Age manor at Dankirke and the proto-town and chartered town of Ribe (S. Jensen 1984).

Imported Mayen lava quernstones, and Norwegian soapstone vessels and schist honestones, are regularly found at Viking Age rural sites, and a quantitative study of this material would undoubtedly give a deeper understanding of the exchange between countryside and proto-towns.

The evidence of other Danish Viking proto-towns is summarised by Randsborg (1980) and Roesdahl (1982). The research project *Middelalderbyen* has on its programme some of the towns that began as proto-towns, and of these, the series has presented Ribe (I. Nielsen 1985), Viborg (Krongaard Kristensen 1987) and Odense (A. S. Christensen 1988); Århus and Roskilde are in preparation and Lund has been published in the corresponding Swedish series (Andrén 1980; 1984). In these volumes, the pre-Medieval evidence is summarised and discussed. It is to be hoped that it will be possible to synthesise these results in a form provoking archaeologists, historians, historical geographers and others to discuss the urbanisation of Denmark in a broader context, including the interaction of urban centres with their surroundings. The thesis by Andrén (1985) on Danish medieval towns is one starting-point, and the approach found here – comparison and generalisation – is necessary if we are to reach results of interest beyond the local topographical issues. In fact, the time and space of comparison in Danish research must widen to include all non-Roman Europe and the whole Late Iron Age; the urbanisation of the Slav regions, for instance, are important as a parallel but somewhat different trajectory.

COMMUNICATION & TRANSPORT

Parallel to the development of trade, an increase in transport capacity must be presupposed, but the source material is only to some extent willing to answer our questions.

The study of land transport is poorly developed, hampered by the idea that most transport went by water. In fact, any study of cultural regionality indicates that open water divided, whereas land held together, for which reason land communication ought to be investigated in greater detail. Recent results demonstrate that this is an important and rewarding research field, with wide implications for our understanding of society (Schou Jørgensen 1988).

During the last ten years, a number of important sites have been excavated (a gazetteer of roads and bridges is presented by Schou Jørgensen 1988), *e.g.* the road system crossing a stream at Risby, Sjælland, where also wooden parts of various vehicles were found (Schou Jørgensen 1977). The river crossings investigated in Stevns, Sjælland, are important for the understanding of the Late Roman Iron Age centre there and its later development (Hansen & Nielsen 1979). Remains of a very impressive wooden bridge were found crossing Ravning Enge, and the dendro-date c. 979 places it in the reign of Harald Bluetooth (Ramskou 1980). Remains of another bridge were damaged when a gas pipeline was laid down at Skindersbro, Jylland, but a dozen posts could be saved and dendro-dated to the 990s, c. 1070 and later (Iversen & J. Nielsen 1987). It is important that provincial museums follow contractors' work at old river crossings in the future.

Schovsbo has published a monograph on carts and waggons (1988) and his results will be important in future discussions about the role of land communication in the economic and social development of the Danish countryside. He also gives a survey of Iron Age roads.

Landlubber archaeologists are today more aware than some years ago of the considerable advances made by maritime archaeology and acknowledge fully the importance of studying ships and shipping. Our knowledge about boats and ships of the Germanic Iron Age is still poor, but those of Viking Age are fairly well known today.

It is evident that the 4th century ships found in the Nydam bog represent the vessels used in Danish waters. The Gredstedbro ship, Jylland, is ^{14}C-dated to the Late Germanic Iron Age, but good finds from the Germanic Iron Age are still so rare that we have to rely on the 6th century Gotland picture stones when discussing the introduction of the sail in Scandinavian navigation (Crumlin-Pedersen 1987a).

Most important is the development in the Viking Age of a range of specialised cargo-ships alongside the famous war-ships. The new find of a merchantman wrecked in the harbour of Hedeby in the 11th century is exciting, for its cargo capacity has been calculated to c. 40 tons. Early Viking ships may have carried 15–18 tons and the capacity of one of the 10th century Skuldelev ships is estimated to be c. 25 tons. The datings of these ships indicate a rapid growth in transport capacity during the Viking Age (Crumlin-Pedersen 1985a; 1987a; 1987b: 227), which corresponds to the changes in trade commodities mentioned above. And as Schovsbo has pointed out, the growing long-distance trade by sea must have provoked more land transport.

The excavation in the port of Hedeby ranks among the most significant achievements in recent years (Schietzel & Crumlin-Pedersen 1980; cf. Jankuhn *et al.* 1984). The recovery of a wooden quay structure reminiscent of that in Dorestad gives good evidence of the elaborate shipping facilities of a major Viking port.

But we have also to reckon with a diverse typology of smaller Late Iron Age ports along the coast to serve the inland settlements, not least because of the need of internal traffic in Danish waters, *e.g.* at Skuldevig, Sjælland (Liebgott 1979) and Fotevik, Skåne (Crumlin-Pedersen 1984). This is now becoming manifest in Dan Carlsson's investigations of ports in Gotland (1987), so it will be interesting to follow the harbour project on Fyn conducted by Crumlin-Pedersen. His astounding prediction that the port of the centre at Gudme, SE Fyn, might be located at Lundeborg (Crumlin-Pedersen 1987a) proved to be correct in a rescue excavation in 1986 (Thomsen 1987). This new site with its very rich material indicating trade and crafts in the Late Roman and Germanic Iron Age will furnish new information in the debate on the character of trade and craft organisation in the 3rd-7th centuries A.D.

Because of its wide implications, the 11th century shipyard excavated on Falster (Skamby Madsen 1984; 1987) is important; ship remains and pottery indicate a Wendic colony.

CRAFTS & TECHNOLOGY

The study of handicrafts and production is important for the understanding of the economic and social processes of the Late Iron Age. The interaction with urbanisation and agro-production are of significant interest.

In the Early Germanic Iron Age, craft production was obviously associated with magnate residences, such as Helgö in the Swedish province of Uppland. In Denmark, similar patterns can be observed at Dankirke, Jylland (Thorvildsen 1983) and Gudme, Fyn (Thrane 1987a; 1988). In the Gudme region, the port of Lundeborg, mentioned above, is a new phenomenon in this early period, a seasonal port with craft production, but as similar sites seem to occur in large numbers on Gotland (see above), it is likely that such ports are more common than so far believed.

In the light of present evidence, it is difficult to see the significant differences between 4th-5th century Lundeborg and 8th century Ribe and Åhus. This indicates that the new craft organisation, developing in proto-towns like 9th century Hedeby with their more permanent structure, was preceded by a long phase when many craftsmen were detached from rural production, but still depended on a structure of magnate centres. How urbanisation developed from these Germanic Iron Age roots is a fascinating problem for discussion in the years to come. Finds indicating the presence of craftsmen in the Viking fort of Fyrkat (Roesdahl 1977) and at the magnate farm in the Vorbasse village (Hvass 1980) demonstrate continued bonds between crafts and the upper echelon, parallel to the urban production.

The manufacture of jewellery in the Germanic Iron Age is still characterised by the unique pieces made; no two brooches are exactly alike (Axboe 1984; Näsman 1984b). By examining tool marks, it has been possible to study the work of one jeweller (Benner Larsen 1984), and one may hope that further studies along these lines can contribute to our understanding of craft organisation.

In the Viking Age, jewellery is usually much more standardised, but this is not the effect of an industrialised mass production, but the result of a developed copying technique (Jansson 1985). This bronze-casting technology could be studied in detail based on the excellent finds made in Ribe (Brinch Madsen 1984). It is obvious that the lower quality and larger quantities of Viking jewellery indicate changes in the organisation of production, distribution, and consumption.

A problem that deserves more attention is the supply of iron in the Late Iron Age. The slag-pit shaft furnace is clearly not in use after the 6th century, but whether iron was later on imported from Norway and Sweden or an as yet unknown furnace type replaced the shaft furnaces in the Late Iron Age is an unsettled question (Voss 1986). A long series of ^{14}C-dates of seemingly uninteresting slags would be an appropriate tool to solve this problem, as demonstrated by a Swedish study (Magnusson 1986).

In the field of textile and dress research considerable results have been reached. New finds and revaluations of old finds have given us a deeper insight into the production and supply of cloth. A catalogue and survey have been presented by Lise Bender Jørgensen (1984; 1986), and the excellent dress finds made in the harbour of Hedeby have been published by Inga Hägg (1984), who gives us a new and vivid picture of Viking costume, including animal masks! Shoes and other leather products are primarily known from urban deposits: so Hedeby (Groenman-van Waateringe 1984), Ribe and Viborg.

In Denmark, with mostly acid soils, bone and antler is only rarely preserved until the Late Iron Age, when the thick urban deposits create better preservation conditions. The Ribe material is interpreted as evidence of itinerant comb-makers serving the market there (Ambrosiani 1981). Also the larger and later Hedeby material is seen as remains of seasonal activity (Ulbricht 1978). An attempt to group bone and antler waste in the late Viking town of Lund, Skåne, into three phases of craft organisation (simple household production, itinerant specialists, and developed market production) has been made in order to study the relation between craft specialisation and urbanisation (Christophersen 1980). Criticism has been raised on the background of the Lund material (Wienberg 1982; Ryding & Kriig 1985), and it can be stated that Christophersen's model does not take into consideration the very long process of development between Lundeborg and Lund, but his work is still the only bid to understand the early urban craft organisation.

Certainly the new materials of Ribe and Åhus (prelim. notes by Bencard 1979 and Callmer 1984) will result in new studies of the development of craft organisation. Good references to European research are given by Hodges (1982), and in a number of German publication (Jankuhn *et al.* 1983; Jankuhn *et al.* 1984; and Kossack *et al.* 1984).

SMALL FINDS

Numerous grave and settlement finds have been published, Roesdahl's publication (1977) of the artefacts found in the fort and cemetery of Fyrkat being the best example, while large monographs on specific artefacts are rare, *e.g.* Bender Jørgensen's on textiles (1986). Above, some imported artefact types were mentioned in the discussion about trade and exchange, and other small finds were touched upon in the section on handicrafts and technology. Suffice it here to note some more important contributions to artefact studies. The catalogue of Viking artefacts exhibited in London in 1980 is a useful introduction to its subject (Graham-Campbell 1980).

Women's brooches hold a special place in Late Iron Age chronology, and some publications deserve mention. Cruciform brooches are the most common Early Germanic Iron Age brooch type in Denmark. The publication by Joachim Reichstein (1975) includes a detailed discussion of the chronology of the period, but the typology used is difficult to apply in practice. A complete study of the Danish and South Swedish finds is a desideratum. At all events, it is obvious from Reichstein's distribution maps that Denmark in the Early Germanic Iron Age belonged to a North Sea interaction zone. A more functional classification system is used by Mechthild Schulze (1977) in her study of cross-bow brooches.

The dress ornaments of the Late Germanic Iron Age were studied in the thesis of Ørsnes (1966), and in a recent paper on the Bornholm womens' graves Høilund Nielsen (1987) could use Ørsnes's typology with only minor adjustments. The jewellery distribution now demonstrates that Denmark was part of a large South Scandinavian region including South Swedish provinces on the Baltic.

The Viking Age jewellery has been dealt with in Sweden in the publication of the Birka finds (Arwidsson 1984), and the monograph on the oval brooches by Jansson (1985) has already been mentioned. An up-to-date publication of the Danish finds would fill a long-felt need.

Gold is characteristic of the Early Germanic Iron Age, evincing the close contacts to Germanic troops along the Roman *limes* (Herschend 1980; Kyhlberg 1986). The use of metal-detectors has in recent years resulted in a rapid growth in the number of gold finds, most conspicuous at Gudme on Fyn (Thrane 1987a). As part of a larger study on the gold-finds of Denmark, so important for the understanding of the social and economic development in the period, a paper on the representativity of the material and another on weight-systems have been published by Eliza Fonnesbech-Sandberg (1985; 1988).

The iconographic catalogue of all Nordic gold bracteates edited by Karl Hauck (1985; 1986) will without any doubt be a cornerstone in the study of these exciting pictorial pendants, and from his long series on their interpretation I have selected a paper on the Gudme finds (1987). He concludes that there existed a sacral kingship in Fyn, and suggests that Gudme was a *villa regalis.* When reading Hauck certain stanzas of Beowulf inevitably come to my mind.

Hauck's brave theses call for an archaeological discussion about the character of the Gudme centre and other contemporary core areas in South Scandinavia (cf. Thrane 1988), *e.g.* archaeological and onomastic studies of other sites with similar cult-indicative place-names (cf. Kousgård Sørensen 1985). Undoubtedly, the possible cult centres also performed administrative functions, for which reason they are of interest even to the profane archaeologist.

There is no firmly established ceramic typology of the Late Iron Age, and this is a serious problem in settlement archaeology, for most sites are ploughed down and only a little pottery is normally found. The great number of new sites gives, however, reason for some optimism, since house typology and ceramic studies are mutually supportive. But too many undocumented datings are advanced in short papers. Some relevant papers on Early Germanic Iron Age ware were referred to above, and the important and well-dated ceramic stratigraphy of 8th century Ribe has also been mentioned. We eagerly await the publications now in preparation.

Archaeologists are also beginning to have a firmer chronological grip on the so-called Baltic ware, earlier known as Slav pottery. The problem of the origin of this pottery is complicated – imports, migrations, itinerant Slav potters or a Danish-Slav acculturation? (Gebers 1981; Hedeager 1982; M. Andersen 1984).

STYLE STUDIES

This topic is not in the focus of new archaeologists, and when they try to use its information they are not always very successful. The best that can be said about Arne B. Johansen's attempt (1979) to see animal style in a social context is that he has pointed out the importance of that aspect (cf. the critical comments following Johansen 1981 by Böhme, Magnus, Ilkjær & Lønstrup, and Horn Fuglesang).

The use of numerous style concepts is heavily criticised by Lennart Karlsson (1983), and of course it is ridiculous that he is able to list c. 100 'styles', and a reconsideration of the archaeological style concept is obviously needed. Karlsson's own survey of the stylistic development between 400 and 1100 is unfortunately conventional; only the style names being left out, and his chronology is too crude. The long lines of stylistic change he is able to follow are, however, a very positive contribution.

The major opus by Günther Haseloff on Salin's style I (1981) will for a long time be the standard reference. His discussion on the origin of the Nydam style and its development to style I emphasises that Denmark, primarily Jylland, was an innovative region in the Early Germanic Iron Age. It is a challenge to Danish archaeology to accept or reject this idea, and a publication of all Danish objects representing Nydam style and style I is a natural way to go. The chronological relation of the sequence Sösdale style – Nydam style – style I – style II is also discussed (Näsman 1984b).

The style II-III (Vendel styles A-B-C-D-E) has in South Scandinavia been treated by Ørsnes (1966), and at present Høilund Nielsen is working on style development in the Late Germanic Iron Age. A handy review of current research concerning Salin's styles I-II-III is given by Haseloff (1984).

Signe Horn Fuglesang has published a large number of studies on Viking Age styles (*e.g.* 1980, 1981, 1982, and forthcoming), where she considers the feasibility of the various Viking style concepts and when confirmed, their definition. The traditional scaffold of the Oseberg-Borre-Jelling-Mammen-Ringerike-Urnes style sequence seems to me more and more shaky. The new dendro-datings of the Jelling and Mammen graves support earlier suspicions that the different styles largely overlapped. We desperately need new style definitions that consider social contexts, technology, workshop areas, etc. (cf. also Jansson 1985).

SETTLEMENTS AND CULTURAL LANDSCAPE

Following the initiative of Becker in the 1960s, Danish settlement archaeology has made tremendous progress and ranks today, when focusing on house function and intra-settlement structures, among the best in the world. The seminars on settlement studies organised by Thrane in Odense have contributed to the high level, with annual information exchange and debate.

In Denmark, excavations of dwelling sites have given the most significant results, while interdisciplinary projects aiming at understanding the cultural landscape are lacking, mainly because of the source situation. In the cultivated Danish landscape, traces of past land-use are rare, and remains of field systems dating to the Late Iron Age are extremely sparse (Ramskou 1981; Steensberg 1983). A lucky find of a wooden ploughshare dendro-dated to the early 9th century found at Gl. Hviding, Jylland (S. Jensen 1987a) gives, however, indirect evidence of a developed cultivation technique.

In Sweden, and also in Norway, agrarian history and studies of the cultural landscape hold a prominent position, and a number of interdisciplinary projects could be mentioned, *e.g.* the now current project at Gårdlösa, Skåne (Stjernquist 1981). The contributions by historical geographers have been of decisive importance for the development of Swedish settlement archaeology (*e.g.* Widgren 1983); nothing of the sort is seen in Denmark. One of the significant results is the elucidation of the concept of continuity in the analysis of the rural landscape. Earlier archaeologists centred their opinion about social development on site continuity-discontinuity, but now we speak of continuity at different levels: site, settlement and region, as well as of continuity of cultivation (Becker 1977). This has been most useful in the discussion about the so-called crisis of the Early Germanic Iron Age (Carlsson 1984; Näsman & Lund 1988). In Denmark, it seems as if the continuity problem has been solved, *i.e.* many settlements permanently used the same resource area since the 4th century and often still do so today. A settlement discontinuity strongly supported by the evidence is the exception, like the hiatus during the 6th-7th centuries in Angeln and Schwansen (Willroth 1987).

The rich results of Swedish settlement archaeology are exciting and ought to inspire Danish archaeologists to find appropriate methods to attack the neglected study of the Late Iron Age agrarian system. Lacking preserved remains of ancient field systems, an ecological approach should be given priority, but so far very few studies of macro- and microfossils have taken place in Late Iron Age contexts (see above), and Denmark is underdeveloped when it comes to scientific analysis of Iron Age settlements.

The basis of Danish settlement archaeology is thus the dwelling sites, and the largest excavations have taken place at Vorbasse, where a periodically moving village can be followed from the late Celtic Iron Age until the early Middle Ages, when it became stationary in its present position (S. Hvass 1983; 1987a). Settlement continuity is a fact, but it is still a matter of debate whether the development constituted a steady increase in production and population or whether there were serious fluctuations. It is especially important that settlements of the 3rd-7th centuries have been found at Vorbasse and Nørre Snede. The publication of preliminary village plans (S. Hvass 1988) – four phases at Vorbasse and five at Nørre Snede (cf. Egeberg Hansen 1988) – demonstrates a rather stable number of farms.

The lack of finds in Denmark dating to the Germanic Iron Age has normally been interpreted as an expression of a more or less dramatic crisis, and various hypotheses have been put forward to explain the phenomenon (the discussion is surveyed by Näsman 1988b). Today there is reason to play a waiting game in this topic; an easy explanation of all observed changes in the 4th-7th centuries is not in evidence, but the suggestions presented by Hedeager are a starting-point (1988a).

New settlement sites are found each year, and it is most satisfying to note that evidence has also been wrested from the clay soils of east Jylland and the islands. Especially the many sites found when the gas pipelines were laid down have changed the picture, but Late Iron Age sites are still grossly underrepresented (Näsman 1987). A source-critical test performed in Jylland (S. Jensen 1985) has clearly demonstrated that the settlements are difficult to find due to the destruction of the pottery of this period in cultivated fields. New prospecting methods must be found, and aerial photography (used with remarkable results in the Ribe area) and phosphate mapping ought to be employed more systematically.

The main traits of house typology (Näsman 1983), and farm and village structure (S. Hvass 1985b; 1988) during the Early Germanic Iron Age and the Viking Age are today well documented, but the Late Germanic Iron Age is still problematic. There are houses of this period represented at Vorbasse (S. Hvass 1987a; 1988, Nørre Snede (Egeberg Hansen 1988), Foulum (Jensen & Willemoes 1982) and other sites. A good example of a house that typologically ought to be from the 7th-8th centuries is, for instance, found at Ragnesminde, Sjælland, but the available ^{14}C- and TL-datings say Roman Iron Age! (Mahler 1985).

The many preliminary papers on Vorbasse published by Steen Hvass have been an invaluable contribution to the development of Danish settlement archaeology, and more notes on other *well-dated* houses must be published if we are within a reasonable time to solve the problems. But what we need most is a publication of a methodologically stringent analysis of all already known well-defined house-plans of the 3rd-8th centuries.

A funny example on the relevance of source-oriticism is the debate on the Late Iron Age pit-houses in Skåne. Leif Chr. Nielsen (1981a) and following him Tom Ohlsson (1982) suggested that in east Denmark (including Skåne) pit-houses were used as dwellings, in contrast to Jylland, with dwellings in long-houses and workshops in pit-houses. This opinion was based on many years of excavations in Skåne where crop-marks (= pit-houses) have been excavated, and not until the recent introduction of the technique of stripping off large areas of top-soil, did the post-holes of long-houses appear (Björhem *et al.* 1983; T. Christensen 1983; Tornbjerg 1985; Rønne 1986). Evidently settlement structure in Late Iron Age Denmark was fairly similar in the west and east (including Bornholm, Watt 1983). The most spectacular houses illustrating an architecture very remote, indeed, from pit-houses have been excavated at the famous Viking site of Lejre, Sjælland (T. Christensen 1987). One house is 48 m long and 11 m broad, covering a floor space of 500 square m.

The recent excavations at Gl. Hviding and Vilslev, Jylland, are important contributions to the discussion about house development between the Viking and Middle Ages and dendro-dated wells and rich small finds make them fix-points (S. Jensen 1987a). These houses emphasise again the strong connection between Danish house-building tradition and the development in north Germany (Zimmermann 1981) and Drenthe (Waterbolk 1982).

Much research is needed before we can profit fully from all these new excavations (cf. surveys by J. Lund, S. Hvass and L. Hedeager, all 1988), but it can already be concluded, as J. Jensen (1982) and Randsborg (1980) have done, that the production of the single farm must have increased considerably. More people must have worked on each farm, *i.e.* a socially significant division of labour has taken place. Many people were now without proprietary rights, and the distribution of power was more uneven. The preconditions were created for the growth of an aristocracy based on land. This process obviously started in the Late Roman Iron Age and Early Germanic Iron Age (Donat 1985; 1987; Hedeager 1987; 1988a-b). In the Viking Age, the development had gone further and the concept magnate farms has been used by Randsborg (1980) to characterise large farms at Vorbasse and Omgård (L. Chr. Nielsen 1981b).

A project in Fyn has aimed at elucidating the history of the medieval (11th-15th centuries) village. One question was when the villages of the Middle Ages were founded. The results are presented in two monographs, and it is concluded that the historical villages were permanently occupied from between the late 10th and the early 12th century (Grøngaard Jeppesen 1981 & Porsmose 1981) and that settlements were earlier moved at irregular intervals. A similar result was reached on Stevns in Sjælland (Hedeager 1982). Concensus about the origin of the medieval village has not been reached, however. It is still possible to question whether it is reasonable to apply results from Fyn to other parts of Denmark (see important criticism in Callmer 1986).

An alternative hypothesis is that conditions varied considerably in different parts of the country, and that we have to reckon with a long phase between the Late Germanic Iron Age and the Early Middle Ages, when settlements for various reasons either moved or stayed pat.

A case to the point is the village at Sejlflod, northern Jylland. Within an area of c. 425 x 360 m, a settlement existed with only short dislocations from the Early Iron Age to Viking Age (J. N. Nielsen 1982; 1987; and the popular exhibition pamphlet J. N. Nielsen & Rasmussen 1986). Also in Bornholm, similar long continuous use of a settlement site is known, *e.g.* Sorte Muld (= Black Earth) (Watt 1987; 1988).

The medieval settlement pattern was possibly not introduced within one or two generations all over the country, and it is perhaps reasonable to explain its origin as a long process of adaptation of traditional land-use to a new mode of production with its roots in early medieval West Europe.

Myrdal (1988), the economic historian, has studied this process in the perspective of farming technology and has presented a model of cyclical co-variation between technological innovations and social change that is a challenge to archaeologists.

GRAVES AND RELIGION

One of the causes of the earlier limited interest in the Late Iron Age is that the rich burial customs of the Roman Iron Age ceased rapidly in the 4th-5th centuries. Graves of the 6th-8th centuries and very rare (except on Bornholm where a rich funerary ritual continued throughout the pagan period (for instance a new site, L. Jørgensen 1987). In the 10th century, rich graves are again more common but restricted to a limited social group.

A survey of Viking Age graves is given by Roesdahl (1982). A number of papers on smaller excavations have been published, but it is difficult today to review Germanic Iron Age grave customs.

Some larger cemeteries with graves dating to the Early Germanic Iron Age have, however, been excavated in recent years. The cemetery at Hjemsted, Jylland, contained 88 inhumations, 35 of which date to the Early Germanic Iron Age, 17 are Late Roman and 6 Early Roman Iron Age; 28 are undated (and probably most of them are late). The orientation was E-W. The grave goods consist of dress accessories, pottery and wooden buckets (Ethelberg 1986).

At Sejlflod in northern Jylland, another larger burial ground has been investigated, and more than 300 men and women were inhumed in E-W oriented graves during c. 200 years of the 4th-5th centuries. The grave goods are similar to those found at Hjemsted, but some are richer (J. N. Nielsen 1982; 1987; J. N. Nielsen *et al.* 1985; J. N. Nielsen & Rasmussen 1986). The material of this cemetery is large enough to make a social analysis rewarding (Ringtved 1988), and the possibility of relating graves to settlement makes the site most interesting. A full publication must be given high priority.

In a few graves at Sejlflod, glass vessels or shards were found, and at Stilling in central Jylland a polished beaker with a Greek inscription "Drink and you will live well" was found (N. H. Andersen 1977). In general, however, imports disappear from the graves around A.D. 400, but, as already stated above when trade was discussed, this does not mean that glass and bronze vessels were no longer brought to Denmark.

Late Germanic Iron Age cemeteries are extremely rare outside Bornholm (Høilund Nielsen 1987). Lindholm Høje at Ålborg, Jylland, a large cemetery well known for its many ship-settings, is preserved thanks to a cover of wind-blown sand. Here a continuous use from the Early Germanic Iron Age to the Viking Age has been established. Most of the 589 graves are cremations, for which reason the grave goods are effectively fragmented (Ramskou 1976). In an excavation for the natural gas company at Søndervang at Horsens, Jylland, a number of shallow pits were found filled with fire-cracked stones and some charcoal. In the stone fill, some few splinters of burnt bone were found, and in two graves, beads and brooches dating to the Late Germanic Iron Age. The ornaments had evidently not been on the pyre. If this type of cremation was common in Denmark, it may explain why so few graves are known today (O. Madsen 1987). Cremation pits are found i Skåne, too (Strömberg 1982(, but well equipped inhumations are also known from the early part of the period (Larsson 1982), reminiscent of nearby Bornholm.

All the same, based on the rich results of settlement research, it is today safe to conclude that graves, because of the funerary ritual, are a bad source for understanding Late Germanic Iron Age society in South Scandinavia outside Bornholm.

Only one cemetery of the early and middle Viking Age has been uncovered, at Overhornbæk, Jylland (B. H. Nielsen *et al.* 1986). The graves are inhumations with rather poor equipment, *e.g.* dress ornaments or a single weapon.

In a series of papers, Müller-Wille has studied primarily the rich 10th century graves: horsemen's graves (1978a), richly furnished graves (1978b), royal graves (1983a), graves with blacksmith's tools (1983b), graves with a waggon-body as coffin (1985), and chamber-graves (forthcoming). The points of departure are the ship-chamber grave at Hedeby (1976a) and the cemetery at Thumby-Bienebek (1976b; 1987). These papers summarise this rich and important material in an excellent way, and a conception of an exalted atmosphere among the upper echelons of Danish Viking society emerges. Obviously something had changed in the late 9th century that released a social display in funerary ritual that had been superfluous for about 600 years.

The cemetery excavated at Stengade, Langeland, illustrates very well the great distance between the rich graves (here at the smaller burial ground Stengade I) and the burials of common people (Skaarup 1976), most of which probably pass unnoticed when touched by ploughing or contractors' work.

The explanation of the 10th century rich interments is a matter of lively debate. Randsborg (1980) presented a developed model in which he tries to explain the graves as an expression of the relationship of the dead to the 'Jelling' kings, primarily their military obligations along the borders of the state. This has been questioned, and horsemen's graves situated in 'the wrong place' have been used as counter-evidence (L. Chr. Nielsen 1984; Stoumann 1984).

Another interpretation is given by Roesdahl (1982; 1983), who suggests that they are evidence of the Valhalla belief of men (and women) in the royal retinue. For chronological reasons, she rejects the connection to only the Jelling kings, and certainly the ship-chamber grave at Hedeby, c. 900 A.D., holds a significant position in the understanding of the warrior graves. Ellmers has given a vivid picture of the role of beliefs in Odin and Valhalla in the Danish court ceremonies (1983), and his idea that the three men buried in the Hedeby grave were a king and his cupbearer and groom is in fact convincing. H. H. Andersen's work on the royal graves gave reason to the re-excavation of the mounds at Mammen (Iversen & Vellev 1986; Iversen *et al.* forthcoming) and Søllested (H. H. Andersen 1987).

If it is a Valhalla cult that is expressed in the grave ritual of these rich graves, it is of interest to discuss the background. The use of a Valhalla ceremony at the Danish court may be seen as an attempt to legitimise a new dynasty internally and to strengthen and characterise Danish kingship in relation to external threats. The same pattern can be discerned when the so-called Jelling dynasty takes power. Still it was a pagan kingdom and the long discussion about the Germanic 'sacral' kingship is far from concluded as evinced by a paper (forthcoming) by Schjødt, the historian of religion.

It is to be wished that the interdisciplinary research project now initiated by the Nordic humanistic research councils will be successful in establishing a new understanding of pagan religion. Undoubtedly, collaboration between archaeologists, historians, and historians of law, religion and literature will give new results, and archaeological data on funerary rituals and their changes during the Iron Age are a rich and largely unexploited source.

Interest in the Jelling grave and the so-called Jelling dynasty is exaggerated in Danish archaeology. H. H. Andersen (1986) puts the Jelling monuments into perspective, when he states that the monuments are in the tradition of the earlier dynasty represented by the ship graves at Hedeby and Ladby (Ladby has recently been discussed by Thrane 1987b). Andersen's thesis about this dynasty is now supported by the new dendro-datings of the Jelling mounds, indicating that King Gorm died c. 958/59 and not in the 930s as some have believed the written sources indicated. The excavations in Jelling Church have revealed a series of wooden predecessors, the earliest probably built by King Harald Bluetooth in the 960s or 970s (Krogh 1983). In a chamber in the church, the bones of a secondarily buried man were found, possibly the remains of Gorm translated by Harald from the pagan mound to a Christian burial. Only rarely is archaeology so close to writing personal history (H. Andersen 1988 doubts the interpretation, however).

The Hedeby and Jelling graves probably lay close to the start and end, respectively, of the rich funerary customs. The Mammen chamber that is dendro-dated to 970/71 contained the remains of a man, but without the full weaponry of the warriors' graves of the earlier part of the century (a re-publication including a paper by H. Andersen on the dendro-date is in preparation, Iversen *et al.* forthcoming). It is probably significant that the cemeteries at Trelleborg and Fyrkat do not include rich weapon graves (Roesdahl 1977; 1982). The small cemetery at Søndre Onsild, close to and more or less contemporary with Fyrkat, contained no rich graves, but a couple of graves with axes (Roesdahl 1978). In the last phase of pagan funerary ritual, an axe sufficed as symbol of rank (Trotzig 1985), the Mammen axe being one of the most splendid. The rich Hørning chamber-grave must also be mentioned as one of the latest rich graves, dated by Voss to c. A.D. 1000 (forthcoming). The interpretation of iron mountings and nails as remains of a waggon body indicates that pagan ritual was followed in the funeral, as do the rich grave goods. That the relatives of the buried woman soon adopted the new state religion is demonstrated by the wooden church built on the site of the levelled barrow in the 11th century.

The Christian graveyards of the 11th century are only rarely met with in archaeological non-urban contexts, the best example being the Löddeköpinge cemetery in Skåne (Cinthio 1980; Persson *et al.* 1984), where 1431 inhumations in wooden coffins have been excavated (the estimated number is c. 2500 graves). Traces of a wooden church with two *patronus* graves were found in the enclosed graveyard. A new era had begun.

The conversion of Scandinavia is discussed by the Swedish archaeologist A. S. Gräslund in a number of papers (1985; 1987 & forthcoming) and was the subject of an interdisciplinary symposium in 1985 (Sawyer *et all* 1987), where Roesdahl led the archaeological session. For the archaeologist working with grave finds, the great difficulty is to distinguish between graves arranged according to genuine pagan rituals (if something of the kind existed after centuries of contact to Christian regions), rich pagan graves influenced by Christian beliefs, poor pagan graves, and graves of Christians. Is the occurrence of Christian symbols in a grave evidence of a Christian convert? a pagan with a souvenir from abroad? or a syncretic religious conception? This theme was one of several discussed at a Mammen symposium in 1987 that was based on the new dendro-datings (publication ed. by Iversen *et al.* forthcoming). The Mammen man was buried in a grave chamber, the timber of which was cut in the winter of A.D. 970/71, that is to say some years after the Conversion of Denmark by King Harald. He was unquestionably of the ranks from which the king's retinue was recruited, but was he still pagan? Was the burial ceremony a protest against the Christianisation? Is the grave an expression of syncretism? Was he a prominent Christian buried by pagan relatives? The problem will probably never be solved, but the confusion marking the scholarly discussion illustrates very well the mental state of the late 10th century.

WARFARE

Iron Age Denmark is often presented as a peaceful rural society, which undoubtedly fits very well the current view on Danishness and makes it easy for the Danes today to identify with their cultivating, producing and consuming forefathers and -mothers. In fact the archaeological record tells a quite different story, in which the dangers of war and violence were important factors of daily life. It is consequently reasonable to suggest that warriors and army leaders played an significant role in the development of the Danish kingdom, perhaps even the decisive one.

In the Early Germanic Iron age, the last large offerings of spoils-of-war took place. The custom is restricted to Danish territory and south Sweden, and the first finds date to the late 2nd century A.D. and the last to c. 500 A.D. They are evidence of successful defence against incursive enemies, and most bogs have been used more than once, for example the famous Nydam bog, where three offerings took place in the Late Roman Iron Age and a fourth in the 5th century. This cult continuity demonstrates the presence of a stable military organisation in these areas and the, at times, enormous number of weapons in one single offering gives an indication of the number of troops involved in the battles.

The Nydam find has now been supplemented by recent finds (Vang Petersen 1988) that are of great importance for the understanding of the Nydam-II finds and the question of *pars-pro-toto* offerings. The Illerup finds are treated in a number of papers, where the interpretation of the whole find group is discussed (*e.g.* Ilkjær & Lønstrup 1983; Ilkjær 1985; Lønstrup 1985), and the Ejsbøl find, including magnificent sword and belt fittings of the Early Germanic Iron Age, has now been published (Ørsnes 1988).

The interpretation of the big weapon offerings has been a subject of some debate, but today most scholars agree upon the hypothesis that they are sacrificed spoils-of-war. As such they tell us a lot about warfare in South Scandinavia that can be compared to battle descriptions in written sources about other parts of contemporary Europe, *e.g.* the Gothic wars of the 3rd-6th centuries. But the bog finds do not say that Scandinavia was more affected by war than areas that lack weapon finds. As most peoples of contemporary Europe seem to have had reason to thank their gods for victories by offering weapons taken from defeated hosts, the explanation of the custom in South Scandinavia must be peculiar to that area, and it seems probable that it is a unique combination of social structure, military and political development, and religious beliefs that resulted in the weapon offerings. To me, it seems to be pointless to try to find a functional/rational explanation apart from the obvious: they served to strengthen society in situations of stress, and in the long run they favoured the military leaders and the tribal heroes.

It is difficult to say where the hostile troops came from, but it seems probable that most conflicts were interregional, *i.e.* that the finds represent disputes over territorial rights and control of resources between neighbouring parties. It is suggested that an offering in the Thorsbjerg bog evinces an attack from as far away as the area between the Elbe and the Rhine (Ilkjær & Lønstrup 1982), and part of the booty of the Illerup votive deposit possibly derives from south-west Sweden or south-east Norway; and in these two cases raiding for booty and honour is a possible explanation.

In this perspective, the bog offerings are a source elucidating the probably bloody process when small tribal areas in South Scandinavia were forged into larger polities by internal rivalry and external pressure.

With my background in Swedish ring-fort research, I find it a mystery that so little is known about the defences of the Germanic Iron Age outside Bornholm. So far, only one modest stronghold is (uncertainly) dated to the period, Trælborg in Jylland (see the most recent survey of Scandinavian fortifications in Mildenberger 1978), but as an indication that more ring-forts once existed it is important. The Olgersdige (Olger's Dyke) at Haderslev, Jylland, is ^{14}C-dated to the Late Roman Iron Age, and it was kept in repair into the Germanic Iron Age (Neumann 1982). An attempt to use this fortification in the tribal history of Jylland has been criticised (N. Lund 1984; Ørsnes 1984), but nevertheless the approach is legitimate: the ramparts are an important element in the study of a growing centralisation of defence. Parts of Trældiget at Kolding, Jylland, were excavated during the gas pipeline project (S. Hvass 1987b). The dating is still unknown, but that it is Iron Age is certain, and a relation to the wars evinced by the bog offerings seems reasonable for some of the ramparts. Trial trenches where ramparts cross wetlands could possibly provide wood for dendro-dating, and only precise datings can give them their proper place in the history of Danish Iron Age defence (most recent survey in Schou Jørgensen 1988). They will contribute directly to the study of internal conflicts and thus indirectly also to the discussion about political territories, but the great number of ramparts in Jylland compared to the two regional cultures discerned by Ringtved (1988) indicate that the relation is not a simple one – ramparts are not necessarily borders.

Blockades across navigable channels into the settled areas often include wooden parts and existing dendro-datings show that defences of this kind were built in the

Roman Iron Age until the 5th century, and then again in the 10th-13th centuries (Crumlin-Pedersen 1985b; 1987a). When more blockades have been dated, the military threat of various periods can be better understood.

Well suited war-ships were a necessary part of the logistics in the Danish archipelago and the finds yield valuable good data on the development from paddled canoes to sailing ships (see above).

Indirectly, too, the c. 570 m long Kanhave Canal crossing the island of Samsø offers evidence of naval skill in the 8th century. Warships stationed in the Stavns Fjord could easily control the channels passing Sjælland to the east and Jylland to the west. The small island is an unlikely base of long-distance trade, but its strategic position controlling the northern approach to the Belts could be used by a Danish navy.

The dendro-dating of the earliest line of the ramparts of Danevirke to A.D. 737 has, as mentioned above, contributed considerably to a renewed discussion about the Danish kingdom and its roots. This rampart is probably based on a long tradition and a developed strategic knowledge about how to defend larger areas. But the magnitude of the construction and its location indicates without much doubt that we are dealing with a royal initiative to secure the southern frontier of a Danish realm against enemies to the south: Slavs, Saxons and further away the Franks. During the period of the Carolingian and Ottonian hegemony, the Danevirke served its purpose with varying success several times and came to include the important proto-town Hedeby (H. H. Andersen *et al.* 1976).

A very interesting aspect of Danevirke is the number of warriors needed to man the parapet. Seventh century Danevirke I is c. 10 km long, and according to an old rule quoted by Mildenberger one man per five meters is needed to hold a wall; this gives 2,000 men plus reserves. Danevirke III, dendro-dated to A.D. 968, needs with its 14 km 2,800 men. This indicates that the 8th century kings had the possibility of mobilising armies as large as the mighty Viking king Harald Bluetooth.

For historians, the understanding of the terminology of the written sources is naturally central. The revived discussion about the meaning and age of the concepts *leding* and *lid* in the military organisation of Denmark in the Viking Age has obviously been stimulated by archaeological research both on land and at sea. It will be interesting to follow the continued debate on the character of the Viking levy. Rikke Malmros bases her paper (1986) on a study of the scaldic poetry and gives a graphic description of an aggressive social order where history is the 'deeds of brave men' and where people and army are synonymous 'people in arms' (quotations from Wolfram 1988:7 about the Goths 500 years earlier). She is convinced that the kings Svend and Knud seized power in England using the *leding.* Niels Lund (1985b), cannot accept this reading of the Scandinavian sources, and using primarily the English sources, he maintains that the levy served only for defence and that the kings abroad acted as private leaders with their private *lid.* To me, the important thing is that England was conquered by a trained army organised according to European standards and based on an effective and national organisation of mobilisation, *leding* or not.

The importance of plunder and tribute for the development of a Danish kingdom and a nation of the Danes is emphasised by many scholars (*e.g.* Randsborg 1980; 1981; P. H. Sawyer 1982), and it is interesting to compare Thomas Lindkvist's discussion (1988) of the Swedish development, retarded about a century, in which the Swedish levy is given an offensive function.

The defences of the Viking Age are a popular subject in Danish archaeology. The frontier to the south was refurbished by King Godfred in A.D. 808 and again by King Harald in 968. Blockades across waterways are known in several places, *e.g.* at Skuldelev in Sjælland and Fotevik in Skåne (Crumlin-Pedersen 1984; 1985b). The 10th century ring-forts of the Trelleborg type have been in the focus of research, but sometimes the emphasis put on them, and especially on the effort by King Harald, is exaggerated (Wilson 1978) – the engineering talents of the builder of the Kanhave Canal and the first Danevirke are equally impressive.

The main contributions are the publication of the Fyrkat fort, Jylland (Olsen & Schmidt 1977; Roesdahl 1977). Here the two main lines of interpretation are presented. O. Olsen advocates the view that the forts mainly served as camps and bases for the raids and conquest of England and that they are associated with King Svend Forkbeard. Roesdahl, on the other hand, prefers to think they were built during the reign of King Harald Bluetooth, and that their main purpose was as royal strongholds in the control of the country and as royal centres of administration and production. This idea was originally proposed by T. E. Christensen (see research summary in his publication of the dendro-dating of Trelleborg, 1984; see also Stilling 1981).

Most commentators on the Fyrkat-publications favour Roesdahl's view (*e.g.* Randsborg 1980; P. H. Sawyer 1980), and after the dendro-dating of Trelleborg and Fyrkat to A.D. 980/981 the problem seemed solved: King Harald was the builder and the conquest of England can be left out as an explanation. O. Olsen has, however, provoked by the dendro-dating, revised the written sources about the date of King Svend's seizure of power and concludes that there is still a possibility for Svend (1980), but most scholars now accept the explanation that the fortresses were part of King Harald's struggle for power at the end of his reign. Roesdahl is now preparing the publication of the excavations in the largest fort, Aggersborg on the Limfjord. Her preliminary papers on the functions of Aggersborg reveal that some difficulties of interpretation still adhere to this fort (1981; 1986).

The ring-forts are impressive monuments of a specific political situation but are not representative of Viking Age defence. Their very short life-time is significant in that respect, and as Roesdahl says "they were not successful. But... they clearly demonstrate the great organizing ability and the resources of tenth century Denmark and its kings, which is the background of Swein's and Cnut's conquest of England. But the fortresses themselves had nothing to do with that" (1987b).

The weapon-graves of the 10th century must be viewed in a similar perspective. They do not represent the Viking army of Danish kings from Olaf to Harald, but, as indicated above, they mirror a certain political and mental situation in which the upper echelons needed to display their solidarity with the old pagan belief (Roesdahl 1983) or to the new social order of the kingdom (Randsborg 1980). Anyhow, these men represent the army leaders and ship commanders, and they were the king's men. The private warrior of the armies raiding western Europe is better studied in Norwegian and Swedish weapon graves.

In an interesting comment on a paper by Porsmose (1980), the Norwegian economic historian Lunden suggests that Danish (and Norwegian) state formation can be explained by a change of military technology that ended in making possible that monopolisation of military and political power we call state formation (= *rigsdannelse*). The role of warfare in social transformations is sketched by Kristiansen & Hedeager (1985) and, indeed, I believe that war for control of resources will be more accepted in years to come as part of the explanation of culture change.

CONCLUDING REMARKS

This brief review of published Danish research demonstrates that the archaeology of the 5th-11th centuries has made considerable progress during the last ten years – and that new finds and discoveries follow in an unbroken stream. The Danish Research Council for the Humanities has felt the need of an intermediary summary of research and supported a research programme *Fra Stamme til Stat i Danmark* (= From Tribe to State in Denmark). The papers discussed at a number of research seminars in 1984–1988, funded by this programme, have been revised and published in three volumes, on Iron Age society (Mortensen & Rasmussen 1988), on Viking Age Denmark and on the problematic Late Germanic Iron Age (Mortensen & Rasmussen forthcoming). In order to present the results of the programme to the international archaeological/historical audience, a survey in English of the development of South Scandinavia from tribal chiefdoms to a Viking kingdom is in preparation (by the present author).

Simultaneously, as these efforts are being made, Randsborg is publishing a review of the first millennium A.D. in Europe (forthcoming) and Hedeager is finishing a volume (1990) on social organisation and change in Iron Age Denmark up to the 7th century embodying the documentation and argumentation of her work, (cf. the Danish agricultural history 1988a and a popular synthesis, 1988b).

It is evident that these interim summaries will very soon be overrun by new discoveries and new interpretations made by a thriving Danish archaeology.

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This survey was written in December 1987. The systematic search for literature covers 1976–1986, but a number of papers from 1987 have been included if noticed. For literature that appeared during 1988, some papers have been included to replace earlier contributions if more easily found, considerably updated, or published in English or German. Some more important new works published in 1987–88 have also been included, but completeness has not been aimed at.

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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.

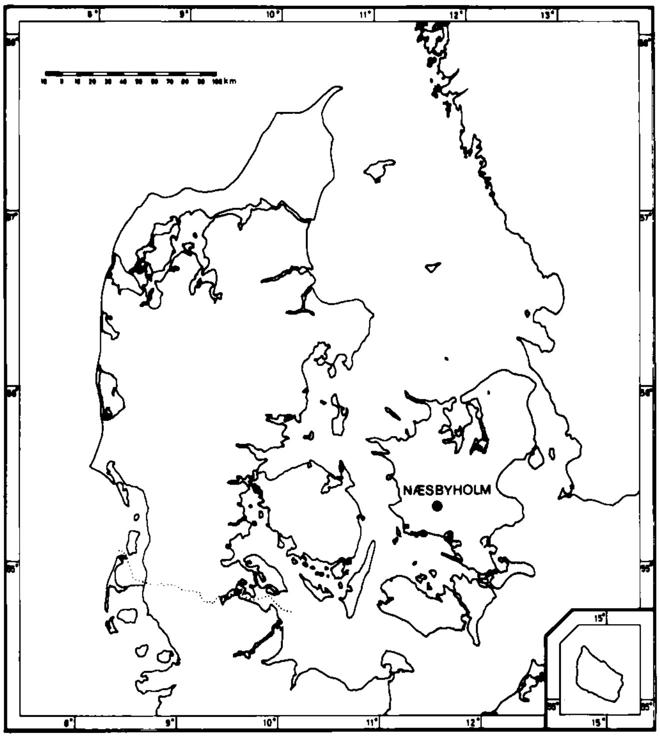

Fig. 1. The location of Næsbyholm Storskov.

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-

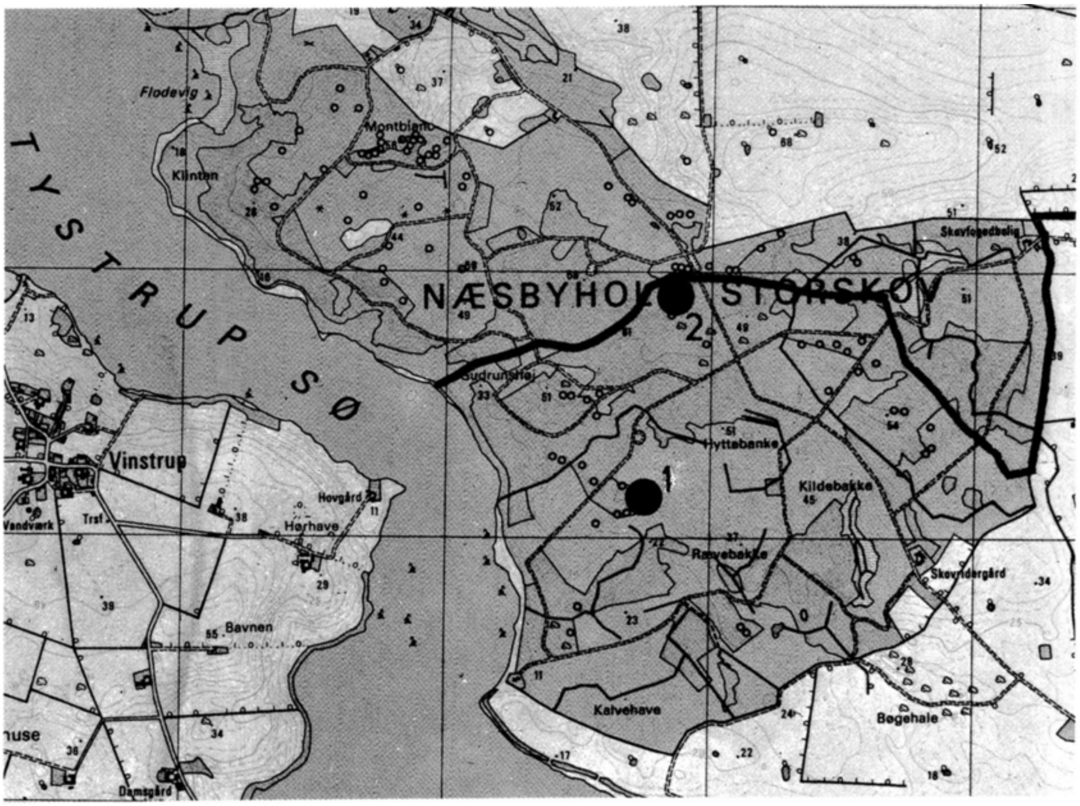

Fig. 2. Næsbyholm Storskov with the location of site 1 and site 2. Reduced section of Geodætisk Institut, Danmark 1:25.000, 1412 IN. (With permission from *Kort- og Matrikelstyrelsen* (A. 881/71)).

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.

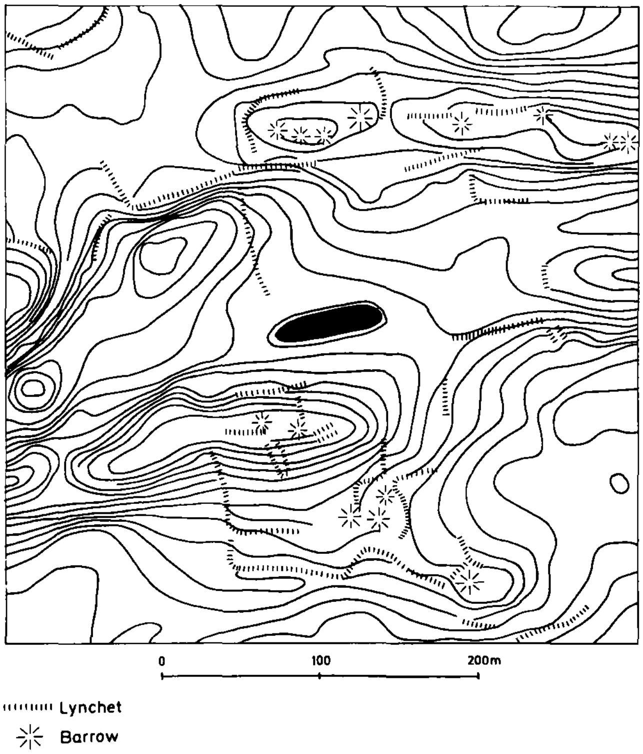

Fig. 3. Map with surface contours (1 m) and prehistoric barrows and lynchets around site 2 (black). Redrawn after original map by V. and G. Nielsen.

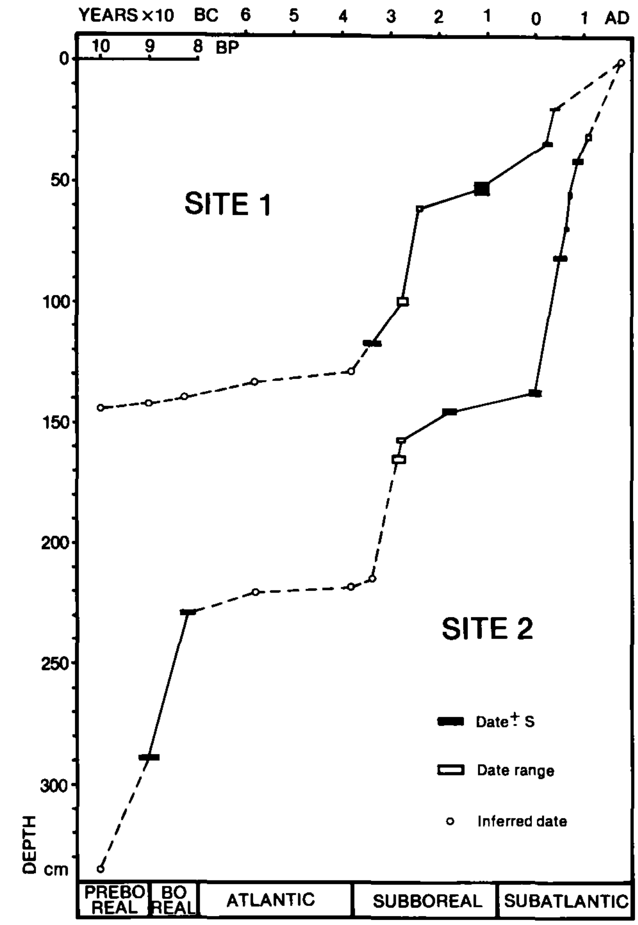

Fig. 4. Radiocarbon dates and age-depth curves for site 1 and site 2.

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-

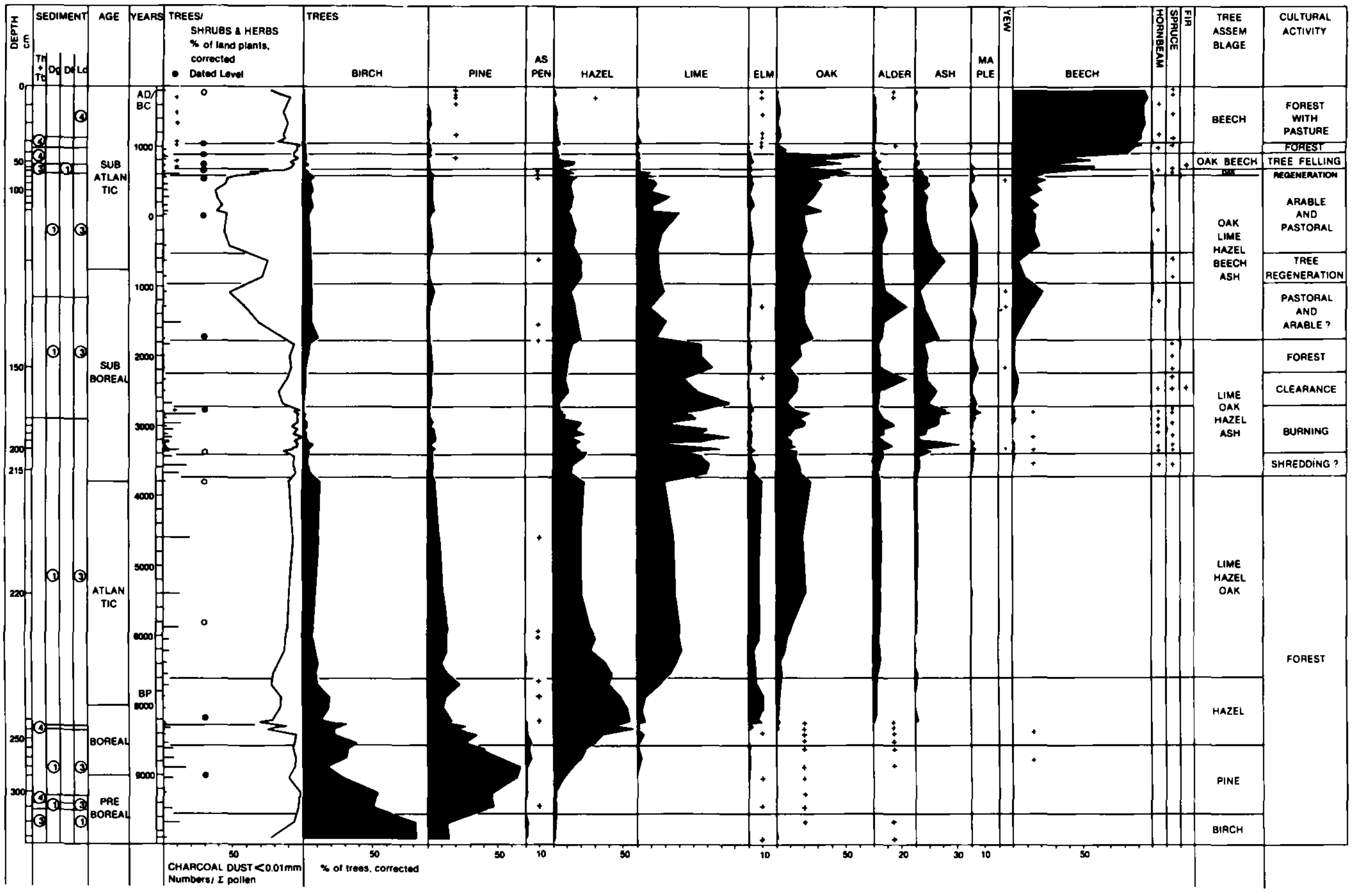

Fig. 5. Pollen diagrams from site 2. Trees and charcoal dust. Sediment components according to Troels-Smith (1955). Th, turfa herbacea. Tb, turfa bryophytica. Dg, detritus granosus. Dl, detritus lignosus, Ld, Limus detrituosus. The figures indicate fractions of volume on a four-degree scale.

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

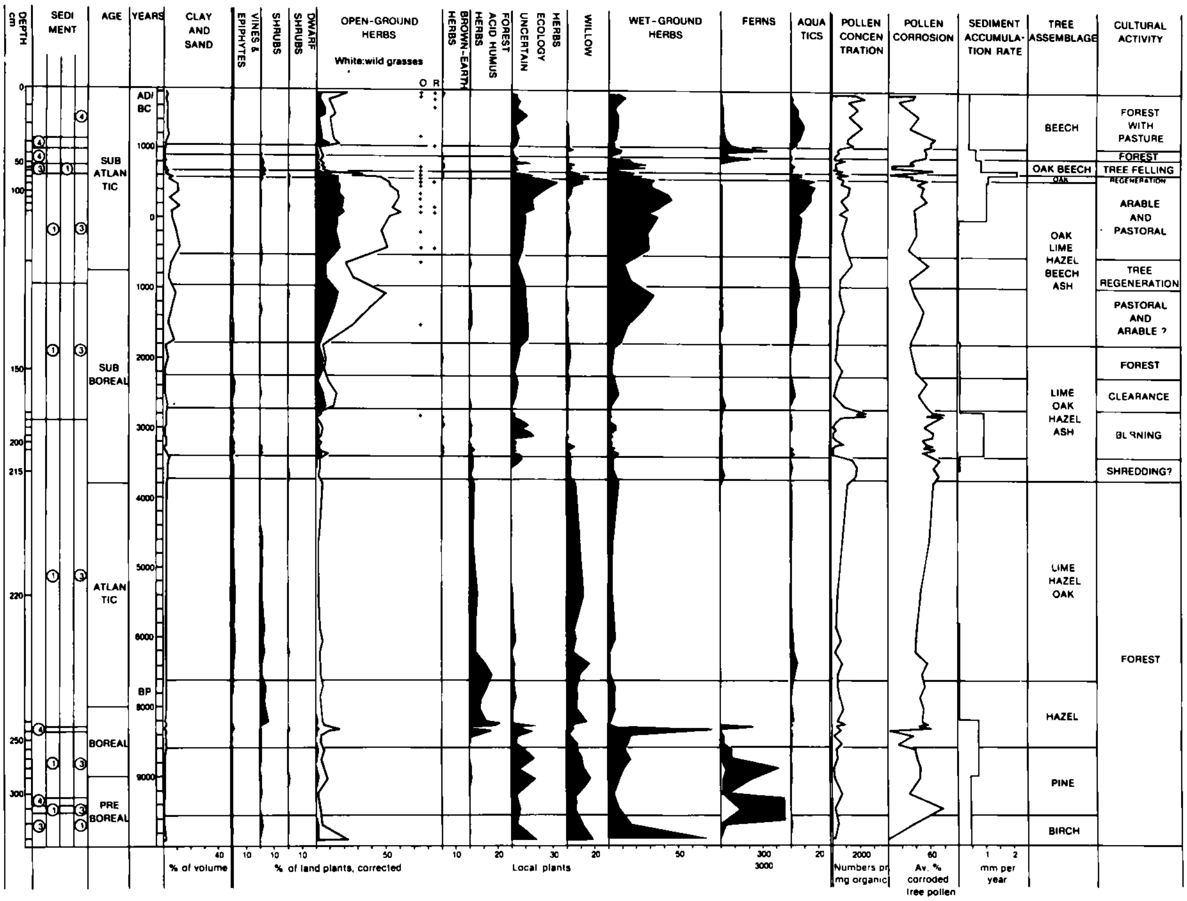

Fig. 6. Site 2. Sand and clay content, groups of non-tree pollen, pollen concentration, pollen corrosion and sediment accumulation rate. O = oats-type, R = rye.

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

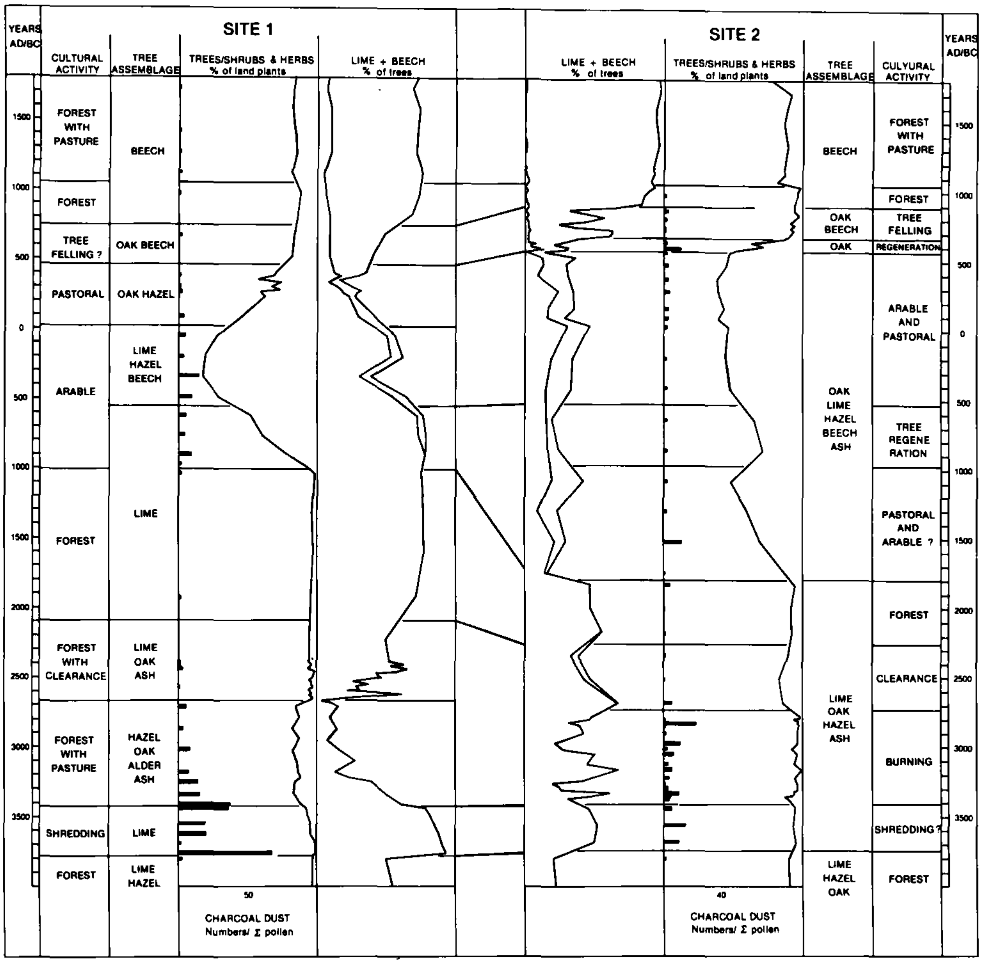

Fig. 7. Site 1 and site 2. Trees, charcoal dust, lime and beech.

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.

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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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Cultural Landscape Development through 5500 Years at Lake Skånsø, Northwestern Jutland as Reflected in a Regional Pollen Diagram

by BENT ODGAARD

INTRODUCTION

This paper presents the main conclusions on cultural landscape development drawn from a pollen analytical investigation of lake sediments from Skånsø. This lake is one of a series of sites chosen to elucidate cultural landscape development within the framework of a cooperation between the Office of Cultural History at the National Agency for Protection of Forests and Sites and the Geological Survey of Denmark. Skånsø was chosen for both archaeological and geological reasons. The lake is situated in an area with a high density of burial mounds, it has an appropriate size for a site of a regional pollen diagram and – very importantly – the sediments are non-calcareous and hence datable by the radiocarbon method.

The results presented here concentrate on cultural history while a detailed report of the entire investigation including the history of the lake and the early postglacial vegetational development will be published in the series of the Geological Survey.

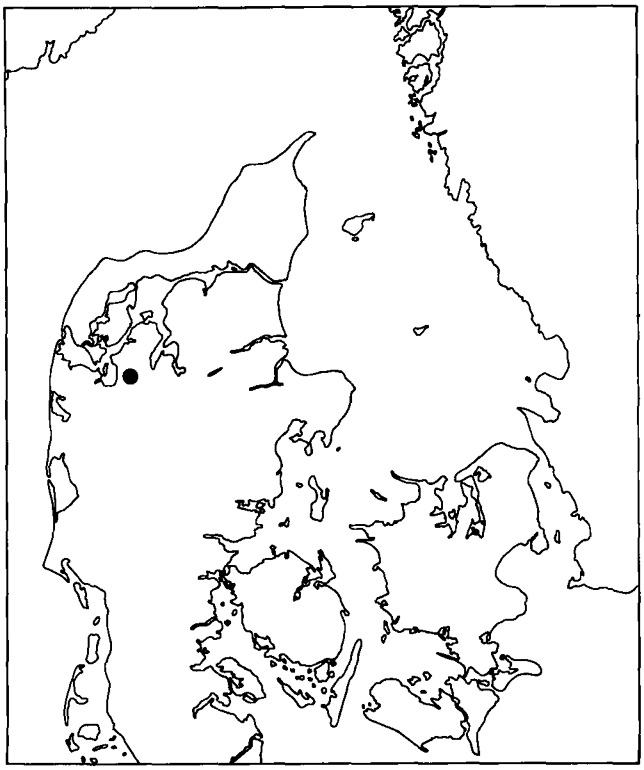


Fig. 1. The location of lake Skånsø.

SITE

Lake Skånsø is situated in northwestern Jutland (Fig. 1) on an outwash plain just north of the main stationary line of the Weichselian ice (last glaciation). The meltwater sand of the outwash plain was deposited during the ablation of the ice. The flat plain is interrupted by numerous kettle holes, formed after the melting af dead ice blocks buried by meltwater sand. Some of these depressions are dry today but several are filled by bogs or lakes like Skånsø.

Skånsø is about 11 ha. (Fig. 2) and has no natural inlet or outlet. It is situated about 2 km from the nearest Weichselian till areas and the pollen diagram can be assumed mainly to reflect the regional vegetational history of the outwash plain.

Radiocarbon dates of the late-glacial lake sediments show that by 10.900 before present (BP) the dead ice had already melted sufficiently for lake Skånsø to come into existence.

35 corings with Hiller and russian peat samplers have revealed an uneven distribution of post-glacial sediments. The distribution along the profile A crossing the middle of the lake from west to east shows this clearly (Fig. 3). In periods of strong winds the local wind is mainly northwestern (Frydendahl 1971). Waves and surface currents induced by strong winds cause deep currents

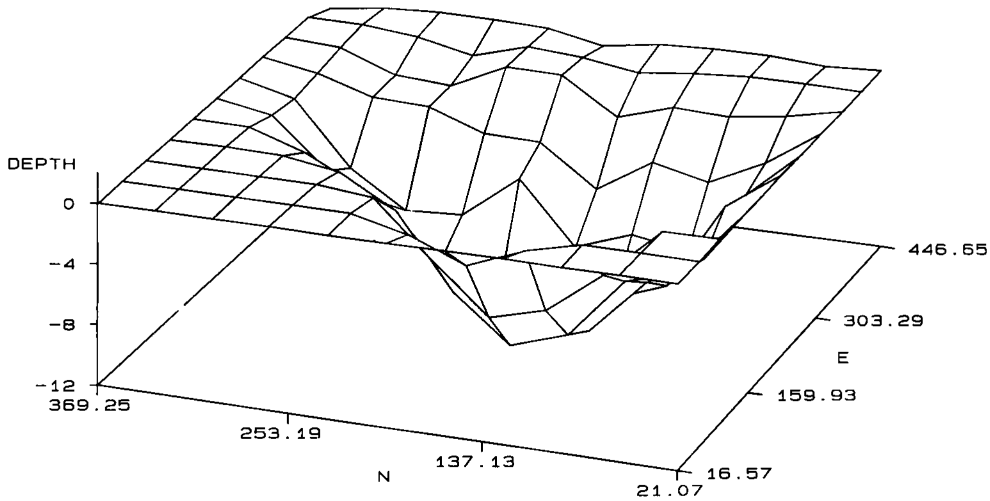


Fig. 2. The morphology of the Skånsø lake basin at the end of the late-glacial period seen from WSW, tilted 40% around the northaxis. Distances in meters.

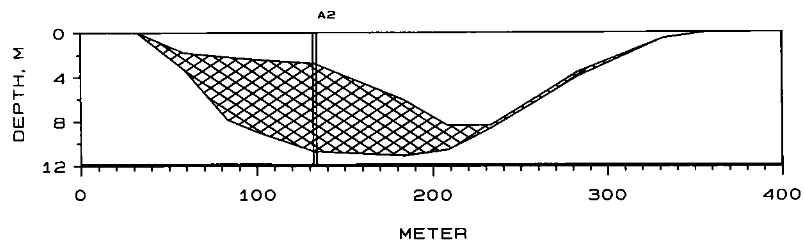


Fig. 3. Cross-section of the post-glacial gyttja (cross-hatched) from west to east through the middle of the lake. The double line marks coring A2.

along the eastern exposed coast of lake Skånsø, which resuspend previously sedimentated material. Along the western coast on the other hand, conditions are quiet during heavy northwestern winds, and sediments are not disturbed. Another effect of this wind-governed sedimentation pattern is that the coring at A2, the main coring point (Fig. 3), only include sediments from the last 7000 years, while older sediments have been located closer to the western shore.

An age/depth relationship at coring A2 has been established from 26 radiocarbon dates by joining mean values of every two dates. From this curve (Fig. 4) a C-14 age has been ascribed to each pollen sample. At a few levels the reliability of the dating curve can be checked by palynological markers. The elm-decline is dated to 5200 BP which is one or two centuries older than expected. The first appearance of rye (Secale) pollen grains seems to be a good chronological marker in Danish regional pollen diagrams. Thus this event has been radiocarbon dated to 2200 BP in four widely spaced diagrams: Holmegård, Zealand; Abkær, South Jutland; Fuglsø, Djursland and Solsø, West Jutland (Aaby 1986, 1988, Odgaard unpublished). At Skånsø rye also appears at 2200 BP.

The dating at 432 cm has not been used in constructing the curve, since it is older than the dating below, and as explained later, probably influenced by older redeposited material in connection with retting of hemp (*Cannabis*). The three other datings in the stage of retting (488 cm, 464 cm, 410 cm) may also be influenced by redeposition to some extent and may therefore give an overestimation of the age of the pollen samples in this part of the sediment.

Generally the age/depth curve seems to give reasonably accurate datings of the pollen spectra. The esti-

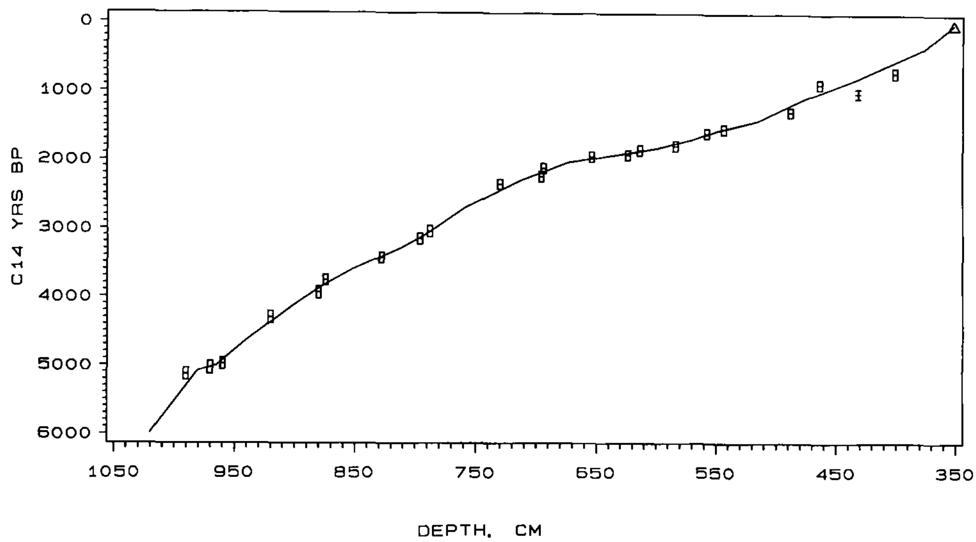


Fig. 4. Uncalibrated radiocarbon dates of coring A2 showing dates with standard deviation. The curve is drawn by joining mean values of two neighbour dates. The dating at 432 cm has not been used in the curve drawing since it is older than the one below and therefore obviously influenced by redeposited material. The surface sample (triangle) has been ascribed the age of 0.

mated ages for the older spectra and those of the last 1500 years might, however, be a few centuries too old.

Skånsø is situated in the crosspoint of two bands of burial mounds, one in the direction SE-NW another SW-NE. Thus about 40 burial mounds have been registered within a radius of 2 km from the lake (Brøndsted 1966).

According to the map by the Royal Danish Academy of Sciences and Letters (1800) and later topographic maps Skånsø was surrounded by heath until the beginning of the 20'th century, after which much of the heathland was reclaimed and conifers planted. Due to the isolated location of Skånsø and the buffering of the heath and plantations the lake has remained rather uninfluenced by modern urban and agricultural eutrophication. Today Skånsø presents one of the finest examples of Danish oligotrophic lakes. This nationally rare lake type harbours an interesting flora of endangered species, which by pollen analysis have been shown to have very long continuity at Skånsø, e.g. Quill-Wort (*Isoetes lacustris*), Water Lobelia (*Lobelia dortmanna*) and Marsh Clubmoss (*Lycopodium inundatum*).

ANALYSIS OF POLLEN AND CHARRED PARTICLES

76 samples of coring A2 have been analysed for pollen, dark-coloured hypha fragments and microscopical charcoal. In each sample at least 1000 land plant pollen grains were counted and the percentages are calculated in relation to the land plant pollen sum or to the corrected tree pollen sum (Andersen 1970). Cereal pollen types (*Hordeum* type, *Triticum* type, *Avena* type) have been identified statistically according to Andersen (1979). Hemp includes *Cannabis/Humulus* type pollen grains with raised pores (French & Moore 1986, Whittington & Gordon 1987).

Brown coloured hyphae are remains of terrestrial fungi, which take part in the biological degradation of soil organic matter. The amount of dark hyphae is thus an indication of the amount of terrestrial material brought into the lake by erosion. The area of hyphae in each pollen slide has been analysed in the microscope by an eyepiece grid permitting a calculation of the area of hyphae relative to the number of land plant pollen grains. The results of the hypha analysis are not shown here but are used in the interpretation of the charcoal curve.

Microscopical charred particles have been analysed along with the hyphae and are likewise expressed in area pr. pollen grain. Microscopical charcoal can be brought into the lake by wind or by water and the amount of charred particles can be expected to reflect the intensity of fires in the area. In tracts with exclusively deciduous forest natural fires are usually regarded as unsignificant. As indicated by the pollen diagram conifers have been

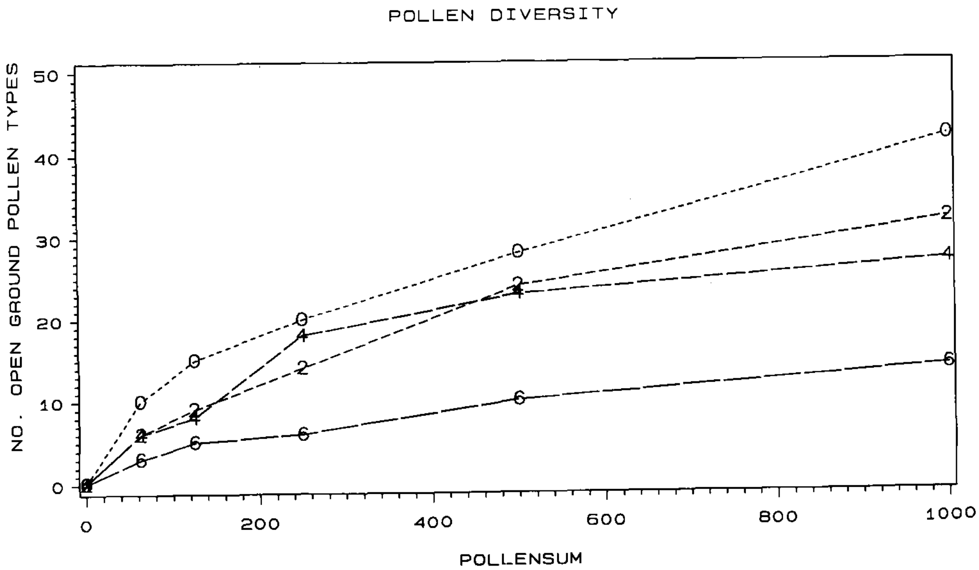


Fig. 5. The number of open ground land plant pollen types at increasing pollen sums in 4 different pollen spectra from Skånsø A2. The number used as a plotting symbol in each graph gives the age of the spectrum in thousands of radiocarbon years BP.

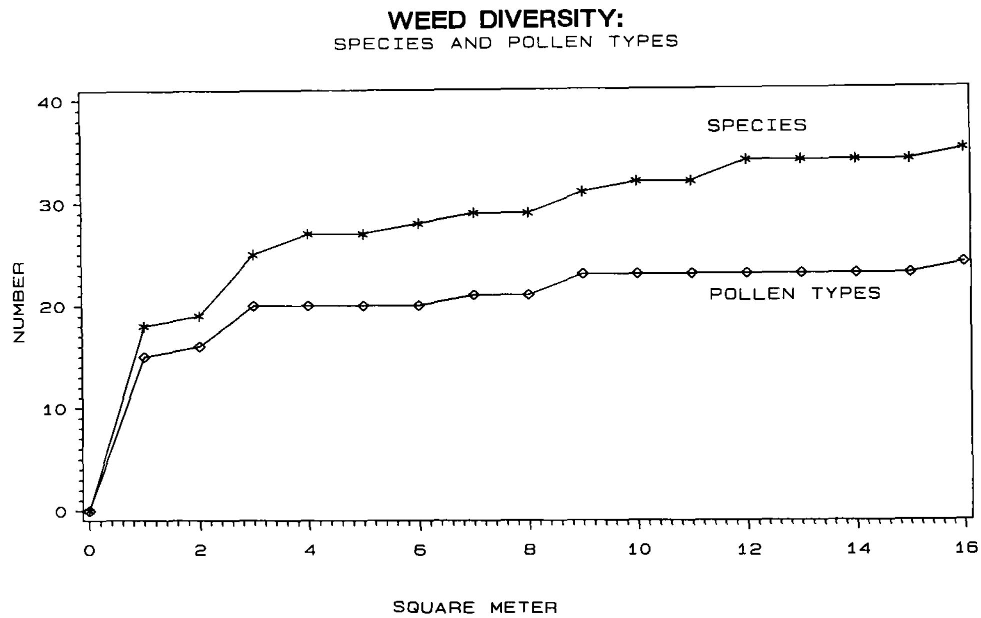


Fig. 6. Cumulative curves of number of plant species and pollen types produced by these at increasing area in garden weed vegetation at Allerød, Denmark.

absent from the Skånsø area through the last 6000 years except perhaps for scattered pine (*Pinus silvestris*) and juniper (*Juniperus communis*) but a field layer of heather (*Calluna*) may have acted both as ignition points for lightning and carrier for surface fires as it does today in the boreal zone (Engelmark 1987). Thus the curve of charred particles can be expected to reflect the sum of both natural and anthropogenic fires.

Fig. 7 displays besides the pollen diagram and the charcoal curve also a diversity graph. The term diversity is here used to denote the number of different pollen types of open ground dry soil plants in each pollen sample. Since the number of pollen types increases as the number of counted pollen grains rises (Fig. 5) the pollen types have been counted at a fixed sum of 1000 land plant pollen grains. The number of different pollen types which can be produced by a vegetation is related to the number of species present, but since several plant species produce identical pollen types a rise in species diversity is not necessarily followed by an increase in pollen diversity especially not in species-rich communities (Fig. 6). Generally, however, there is a good correlation between species richness in modern plant communities and pollen diversity (Birks 1973). Species diversity is of ecological and archaeological interest since this parameter usually rises with increasing anthropogenic influence. Natural woodland communities are not rich in species while especially rough pasture is known to be very rich. Furthermore boundaries between plant communities are very diverse and since anthropogenic influence tends to lead to an increase in the "patchiness" of vegetation, it also increases diversity (Birks et al.1988). A very strong human impact as today, however, favours a few species adapted to continuous disturbance and hence decreases diversity.

Besides species richness pollen diversity in regional pollen diagrams also depends on the effectivity of pollen dispersal and hence the physical structure of the vegetation. In closed woodland windspeed in the trunk space is low (e.g. Andersen 1974, Tauber 1977) and the pollen of woodland herbs has a low chance of escaping the trunk space and tree canopy and eventually of settling in a large lake. In more open vegetation types wind velocities near the ground are higher and herb pollen is more efficiently dispersed and the probability of fossilisation in larger bogs or lakes is higher. Accordingly woodland clearances can be expected to increase pollen diversity in regional pollen diagrams, even if species diversity was actually unchanged. Thus pollen diversity is directly – as a measure of species diversity – or indirectly – reflecting changes in vegetation structure – an important indicator of human influence on the vegetation.

CULTURAL LANDSCAPE DEVELOPMENT

The pollen diagram (Fig. 7) is drawn on a scale of uncalibrated radiocarbon years by means of the age/depth relationship established by the C-14 datings (Fig. 4). Only curves for the important pollen types are shown. Solid lines divide the diagram into one thousand year segments and dotted lines into 10 landscape development phases (l.d.p.) mainly based on the relationship between tree pollen and open ground pollen.

L.d.p. 1. Before 5200 BP.
Sum trees, lime (*Tilia*) and elm (*Ulmus*) high, sum herbs, sorrel (*Rumex acetosella* type), diversity and heather (*Calluna*) low, ash (*Fraxinus*) and oak (*Quercus*) increasing, pine (*Pinus*), hazel (*Corylus*) and charcoal decreasing, ribwort (*Plantago lanceolata*) and types from cultivated species absent.

This segment of the pollen diagram mirrors a virgin forest stage where no unequivocal anthropogenic impact on the vegetation can be traced. The forest types reflected are open with lime and hazel as regional dominants, while alder (*Alnus*), birch (*Betula*), oak and elm are also important. The considerable amounts of pollen of grasses, herbs and heather are typical features of western Danish pollen diagrams (Odgaard 1985, 1988) while the changes of the tree pollen curves through the last part of the Atlantic period are common to the entire country. The extremely high amounts of charcoal in the lowermost analysis is unexpected since there is no other evidence of possible human impact. However, a maximum of terrestrial fungal hyphae at the same level (curve not shown here) suggests that the high concentration of charred particles may be due to increased inwash of terrestrial soil material.

L.d.p. 2. 5200–5100 BP.
Sum trees, ash, oak, lime and charcoal high, herbs and heather low, alder and hazel increasing, elm decreasing, ribwort and pollen types from cultivated species absent.

The elm decline is not very well marked due to the low elm values in the Atlantic. The elm seems to be replaced by oak, alder and hazel. There is no unambiguous evidence of human impact but the high amount of charcoal and slightly raised diversity might suggest forest clearances by fire.

L.d.p. 3. 5100–4800 BP.
Heather, hazel, oak, sorrel, ribwort and charcoal high, sum trees and ash low, diversity increasing, lime decreasing, barley (*Hordeum* type) present.

The first definite evidence of human impact is found in this phase. Shortly after the first appearance of ribwort a minimum in the tree pollen curve and maxima of heather and charcoal indicate forest clearances by fire and a temporary heather expansion. The heather curve, however, quickly drops down almost to the level of the previous zones and here the first cereal pollen grains appear. In the tree pollen diagram weak indications of a classical landnam (Iversen 1941) are seen: a small maximum of birch synchroneous with a minimum in oak, followed by an increase of hazel. Hazel thus seems to be especially important in the forest regeneration phase after the heather expansion.

L.d.p. 4. 4800–4200 BP.
Sum trees, oak and ash high, ribwort and charcoal low, bracken (*Pteridium*) and diversity increasing, heather and lime decreasing, beech (*Fagus*), barley and oat (*Avena* type) present.

In this period the vegetation is quite stable. The forest has regenerated somewhat after the clearances of the previous period, but it is still more open than in the Atlantic. Heather has almost decreased to the pre-elm-decline level. As a whole human impact in this period seems slighter than in phase 3, especially fires are notably more infrequent. The presence of oat is unexpected since macro-remains of *Avena sativa* are only known from Denmark from the Bronze Age onwards (Jensen 1985). This suggests that the pollen grains identified statistically as oat are merely small wheat (*Triticum* type) grains.

L.d.p. 5. 4200–3900 BP.
Grasses, ribwort, sum weeds, mugwort (*Artemisia*), barley, bracken and diversity high, sum trees and charcoal low, oak and ash increasing, hazel and lime decreasing, beech present.

This is a new forest clearance period, this time apparently without much use of fire and heather does not expand. Instead the increase of ribwort, grasses and bracken seems to indicate expanding pastures. The small maximum of barley might also suggest increasing arable farming. This period is probably contemporaneous with the Single Grave Culture.

L.d.p. 6. 3900–3700 BP.
Sum trees, birch, oak and ash high, hazel, sum cultivated, ribwort, sum weeds, bracken and charcoal low, lime decreasing, beech present.

A forest regeneration stage where especially birch is important. Cultural indicators are not as prominent as in the previous period and anthropogenic influence seems slighter.

L.d.p. 7. 3700–2500 BP.
Ash, ribwort and charcoal high, heather, pine, beech, sorrel, sum weeds, grasses, tormentil (*Potentilla* type), buttercup (*Ranunculus acris* type) and diversity increasing, sum trees and oak decreasing, barley, wheat, oat, spurrey and sweet gale (*Myrica*) present.

This is a long period of forest destruction where fires have been frequent. The rising pine value is probably the result of increasing importance of far distance transported pollen as the regional pollen production decreases along with the forest destruction.

The rising beech curve may have the same explanation but the presence of scattered beech trees in the area by the end of the period cannot be excluded. There is no indication of rising importance of arable farming whereas the increasing curves of grasses, heather, sorrel and buttercup as well as the high ribwort values suggest an expansion of nutrient-poor grass-dominated pasture.

L.d.p. 8. 2500–2300 BP.
Birch, pine, buttercup and charcoal high, hazel, lime and ash low, sum trees, beech, barley and sweet gale increasing, grass, sorrel and sum weeds decreasing, rye (*Secale*) absent.

A short stage with some forest regeneration in which especially birch is important. Pastures seem to decrease somewhat, while fields are still present, perhaps even increasing.

L.d.p. 9. 2300–800 BP.
Barley, diversity and charcoal high, pine and buttercup low, heather, birch, sweet gale, crowberry (*Empetrum*), rye, hemp (*Cannabis* type, raised pores) and sorrel increasing, sum trees and oak decreasing, buckwheat (*Fagopyrum*), flax (*Linum usitatissimum*) and cornflower (*Centaurea cyanus*) present.

This long period is generally characterized by forest destruction, interrupted by short periods with slight regenerations of birch. The increase in heather pollen is now not accompanied by the grass curve but by the crowberry and billberry type (*Vaccinium*, not shown) curves, which indicate that heatherheaths are now spreading and reach their maximum at about 800 BP. It is noteworthy that the pine curve drops down to a minimum at about 1600 BP even though the sum trees still decreases. This must reflect a change in the composition of far distance transported component of the pollen rain, which is obviously connected to the broadleaf forest regenera-

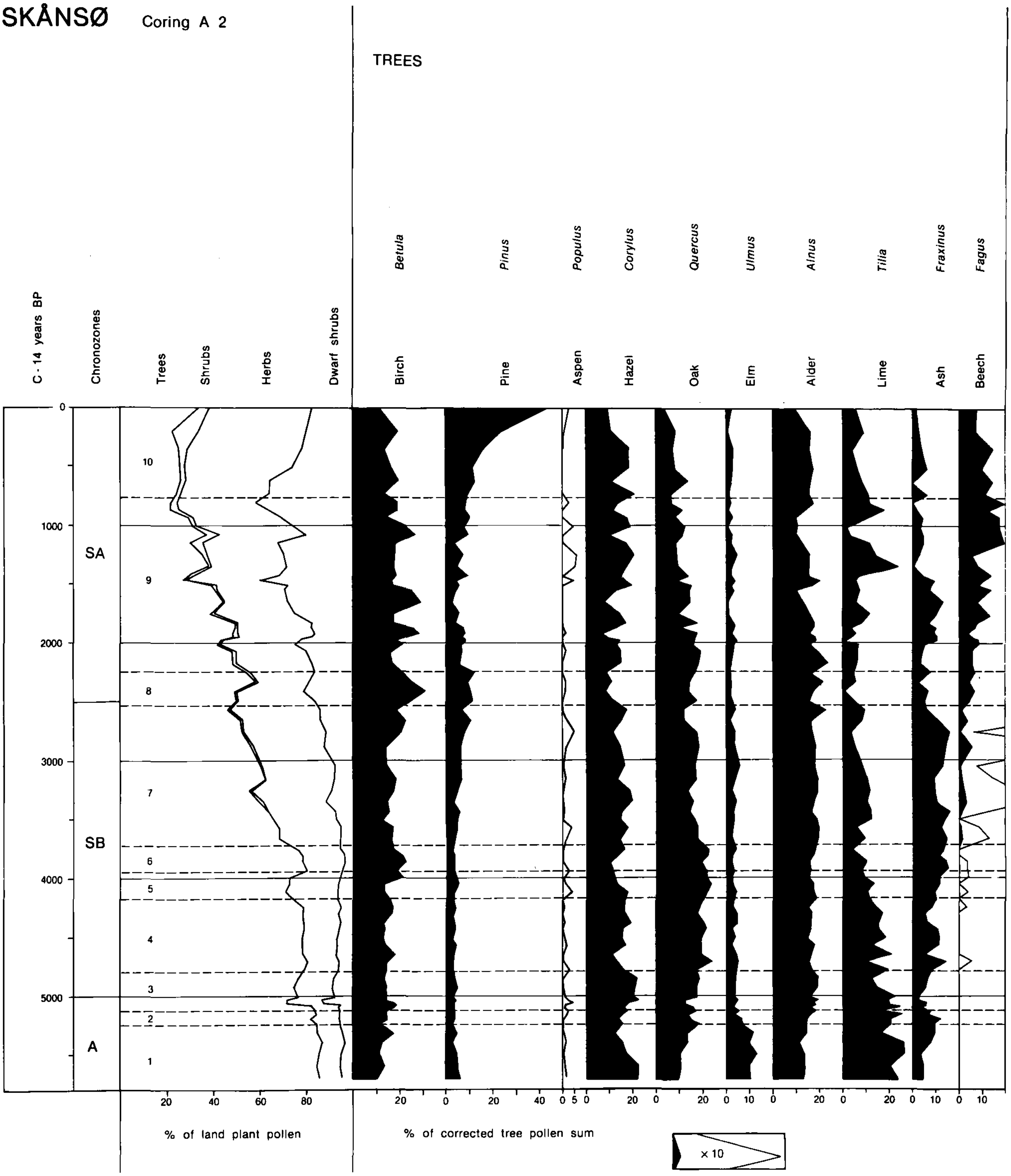
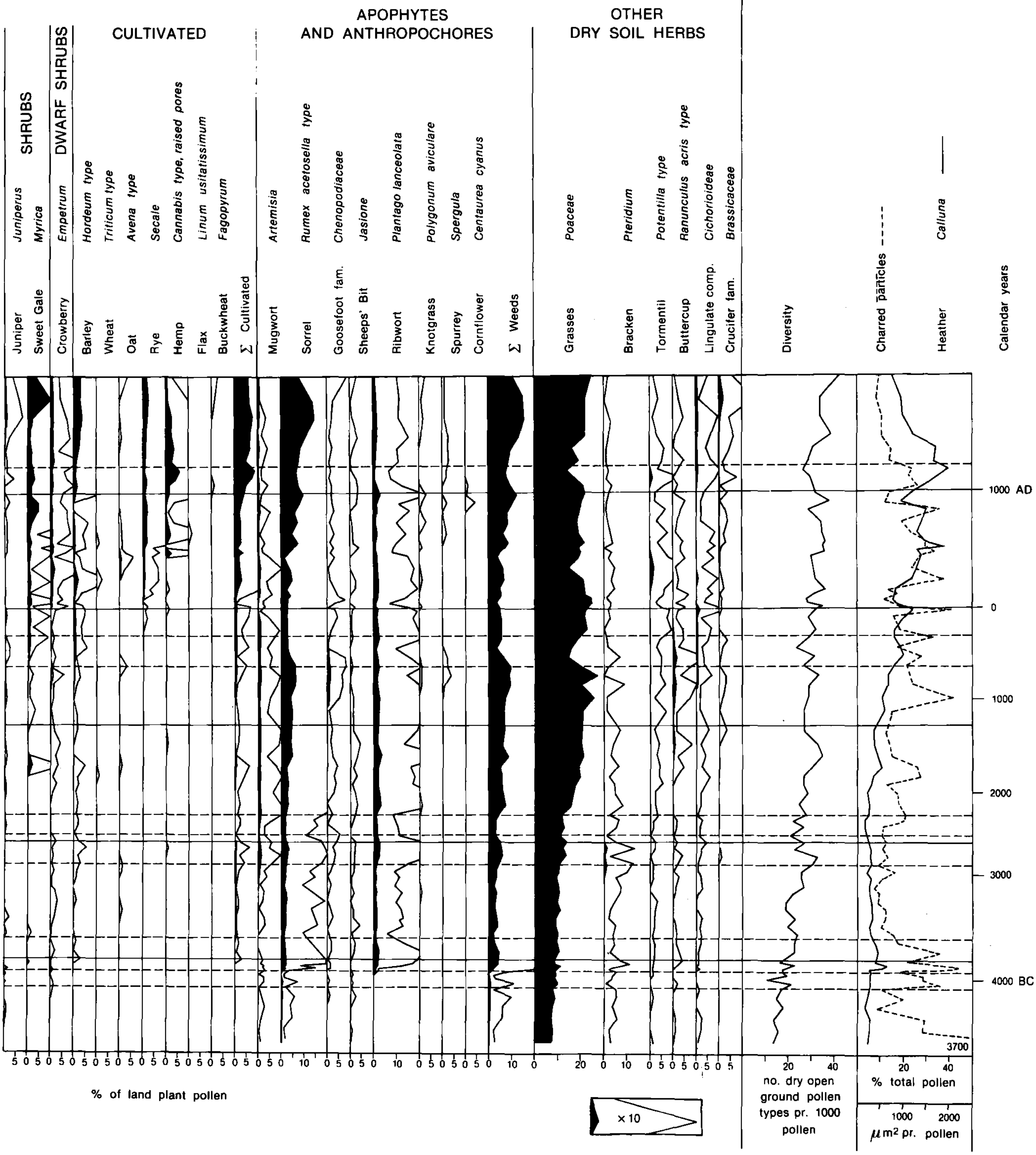


Fig. 7. Pollen diagram from Skånsø A2 drawn on a radiocarbon time scale. From the left is seen a survey diagram giving the main pollen groups. The numbers refer to the landscape development phases delimited by dotted lines. The tree pollen diagram is shown as transformed percentages, which take into account the differential pollen production of the tree species (Andersen 1970). Selected herb pollen types are shown in ecological groups. For explanation of the curves of diversity and charred particles see text.



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tion in eastern Denmark in the German Iron Age known from many pollen diagrams (e.g. Aaby 1986, 1988).

The maximum of beech around 1000 BP is characteristic of pollen diagrams from western and northern Jutland (e.g. Jessen 1935, Odgaard 1985). Much unlike the forested conditions in eastern Denmark at the time of the arrival of beech (Aaby 1986) the landscape in western Jutland was already then very open and heavily exploited. It is not possible to assess how much of the beech pollen in the Skånsø diagram which is transported from till areas and hence to determine whether beech actually grew on the outwash plain. The nearest forest with natural beech today is at Rydhave on boulder clay 7 km SSW of Skånsø.

Judging from the pollen types of cultivated species arable farming increases in importance in the period. Especially barley and rye are cultivated, the latter at least from about 1400 BP.

The high values of hemp pollen from 1500 BP onwards suggest that the lake has been used for retting hemp plants to macerate the stems for disengaging the fibers. To check this possibility samples from the interval 1350–850 BP have been analysed for plant macrofossils. The search was negative as far as hemp remains are concerned but instead many remains of seed-capsules of flax were found in sediments from 1050 BP and younger. Accordingly, the lake has been used for retting of flax at least. The almost total absence of flax pollen is due to the fact that flax is an insect-pollinated plant with a small pollen production. The absence of identifiable hemp macrofossils does not, on the other hand, support the conclusion that hemp was not retted in the lake. Actually seeds of hemp have never been located in Danish prehistoric or medieval deposits (Jensen 1985) although, judging from pollen diagrams (e.g. A. Andersen 1954, S. T. Andersen 1984) the activity of retting seems to have been quite widespread in the Roman Iron Age and later. At Skånsø the retting caused a eutrophication of the lake, which manifested itself by an increase in green and blue-green planktonic algae (not shown here). The retting may also account for the aberrant date at 432 cm (Fig. 4), since retting inevitably causes introduction of soil organic matter (at least in historical times plants with roots were retted, Brøndegaard 1979) and disturbance and redeposition of near-shore lake sediments.

L.d.p. 10. 800–0 BP.

Rye high, sum trees and ash low, pine, barley, sorrel, crucifer family (*Brassicaceae*) and diversity increasing, heather, beech, hemp and charcoal decreasing, buckwheat and spurrey present.

By the start of this period a completely open landscape had come into existence. Fires were not frequent in this phase and heathland decreased. Arable farming, on the other hand, seems to increase. Especially barley and rye are cultivated and retting of hemp (and flax?) probably continues albeit at decreasing intensity. Crumpling of cereal pollen grains have in many cases impeded the identification and some rye pollen grains inevitably have been classified as barley. Thus the barley values are probably exaggerated and the rye percentages underestimated. The high percentages of sorrel, which thrives very well in winter cereal fields cultivated with fallow years, is most likely connected with the growing of rye.

The increase of pine in the top of the diagram reflects the afforestation by conifer plantations and probably also a changing composition of the far distance transported component of the pollen.

DISCUSSION

The Skånsø pollen diagram reflects without interruptions the broad-scale dynamics of a cultural landscape through 5500 C-14 years. The diagram is of typical west Jutish type and therefore has many similarities but also some important dissimilarities with the Solsø diagram (Odgaard 1985, 1988). Solsø is situated about 50 km SSW of Skånsø in an area of sandy till and meltwater sand from the Saalian (last-but-one) glaciation.

At both sites the late Atlantic forest is very open and has much more birch and less elm and lime than is known from sites on Weichselian till in eastern Denmark. However, the Solsø diagram is slightly more extreme than the one from Skånsø indicating that the soil at Solsø was less fertile. Common to both sites is also a Subboreal heathland expansion, but there is a strong difference in timing and vigour. Although new radiocarbon dates have shown that the heather expansion at Solsø starts at 4300 C-14 years BP rather than at the 4800, which is indicated on the published diagram (Odgaard 1985, 1988) this is still 1000 years earlier than the first weak rise in the heather curve at Skånsø. Furthermore the expansion at Solsø is much quicker. At 3500 BP heather has reached 25% whereas at Skånsø this level is not achieved until 2000 years later. So when the forest destruction starts at

Skånsø at 3700 BP the forest is not replaced by heathland but by grass-dominated poor pasture, whereas heath follows immediately upon the forest clearances at Solsø. This difference could be explained as an effect of a more fertile soil at Skånsø which could endure a longer period of grazing before degradation was sufficient for heather to expand. However, the relationship between the heather and charcoal curves at Skånsø indicates that the frequency of fires were also important. Thus before or synchronous with a rise in the heather curve there is almost always an increase of the charcoal values suggesting that heather expanded after vegetation fires. From modern heaths it is well known how vigorously heather spreads after a fire (e.g. Hansen 1976). The temporary heather expansion at 5000 BP when there is a peak in the charcoal curve can be taken as further support for this hypothesis.

A very important common feature of regional pollen diagrams from East Denmark is the forest regeneration period starting around late Roman/early German Iron Age. Studies of the deposition of dust from cultivated fields on the raised bog Fuglsø bog (Aaby 1985) indicates a slight reduction of arable land at this time, if any. The decrease of ribwort which accompany the rise in tree pollen in eastern Danish pollen diagrams at this level suggests that pasture was replaced by forest.

In the Skånsø diagram as well as other regional pollen diagrams from western Jutland (Iversen 1941: Bølling Sø, Andersen 1954: Tinglev Sø, Jonassen 1950: Krag Sø, Jonassen 1959: Fiil Sø, Odgaard 1985, 1988: Solsø) an Iron Age forest regeneration phase is absent. A decline of pastoral farming seems to be completely lacking here. This feature is important in order to understand the history of beech in western Jutland. Admittedly, the predominantly sandy soils of west Jutland do not present optimal edaphic conditions for beech but today the tree thrives as well here as on infertile soils in northern Jutland and northern Zealand where beech is unquestionably indigenous. Lindquist (1959) drew a line through Jutland to delimit the westernmost stands of natural beech. This line coincides with the border between areas with an Iron Age forest regeneration and those without. The German Iron Age forest expansion in eastern Denmark is exactly the period when beech became a dominant tree here, but beech never had the same opportunity in western Denmark. It may thus be argued that the line of Lindquist (1959) is primarily caused by differences in cultural history rather than by edaphic or climatic factors. As a modern parallel Worsøe (1980, 1981) has documented how local presence or absence of beech in Central Jutland is determined by the historical use of the woodlands.

Until now heathland expansions in western Jutland have only been radiocarbon dated at Skånsø and Solsø. At a few other sites along the main stationary line, however, the first heath expansions can be dated to the Subatlantic period by correlation of the pollen diagrams (Iversen 1941: Bølling Sø, Andersen 1954: Tinglev Sø). The tentative scheme that emerges from these investigations is that the first heath expansion is oldest (early Subboreal) on leached sandy till in the central part of western Jutland, while considerably younger (late Subboreal or early Subatlantic) on outwash plains close to the main stationary line of the Weichselian glaciation. This scheme is, however, very crude and needs further testing. To check the timing of forest destruction on an outwash plain situated quite far from the main stationary line a pollen diagram is now being prepared from Lake Kragsø near Karup. Preliminary results indicate that forest destruction and heath expansion are rather late here like at Skånsø. Thus more and more the strong and early anthropogenic impact at Solsø stands out as unique and striking.

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Debate

Prehistoric Migrations – the Case of the Single Grave and Corded Ware Cultures

By KRISTIAN KRISTIANSEN

MIGRATION IN RETROSPECT

Diffusion and migrations are phenomena on a continuous scale of cultural and social interaction and change. Throughout the 1960's and 70's such studies concentrated upon developing our knowledge of the basic forms of such interaction – from reciprocal exchange over elite exchange/prestige goods exchange to trade (Earle & Ericsson 1977, Renfrew 1975). It has, however, become increasingly clear that a prerequisite for such studies is a better understanding of the social formation and constitution of culture as a spatial phenomenon. From acknowledging the complexity of the problem (Hodder 1978a) we have during the 1980's seen a increasing number of studies trying to delineate some of the mechanisms by which material culture is constituted and maintained as part of social and political strategies (e.g. Hodder 1982a & b).

Since diffusion and migrations were among the most critized explanatory concepts of so-called traditional archaeology modern archaeology has not yet come to terms with them either in archaeological or in theoretical terms. This paper is a preliminary attempt to incorporate the geographical movement of social groups into the conceptual and explanatory framework of archaeology.[1] How do we delineate various types of migrations against such phenomena as elite exchange, trade and marriage alliances? And how do we account for such phenomena in structural and evolutionary terms? Before answering these questions it will be useful to discuss the background to the present situation in more detail.

Throughout the 1960's and 70's a number of studies demonstrated the archaeological inconsistencies and inadequate theoretical status of prehistoric migrations and diffusion (Adams 1968, Binford 1968, Clark 1966, Myhre & Myhre 1972, Renfrew 1973 & 1979). Although a number of studies that combined historical and archaeological sources could demonstrate convincing regularities between ethnic groups and material culture (Hachmann, Kosasack & Kuhn 1962), this proved impossible in other cases (Hachmann 1970, Clarke 1968, ch. 9), just as the ethnographic record showed no clear pattern (Hodder 1978b). It seemed increasingly difficult to establish reliable criteria that could be used more generally (e.g. Crossland & Birchall 1974, Thompson 1957, Arutjunov and Chazanov 1981, Rouse 1986). On the other hand it could be shown that an internal framework of social and economic change often accounted more convincingly for the evidence as part of an autonomous development (summarized in Renfrew 1973 and 1979). Functional adjustments to various forms of social and ecological stress in combination with international information exchange adapted to local needs were seen as regulating factors (e.g. Renfrew and Shennan 1982, Bintliff 1985). Soon this relegated the concepts of migration and diffusion from the realm of serious archaeological discussion within the new archaeology of the 1960's and 1970's. Today it is implicitly accepted that migrations played no significant role in the course of European prehistory (e.g. Champion et al. 1984), also demonstrated in the latest work of Colin Renfrew (1987). Some point of critique should be raised against this approach:

1. Modern archaeology has convincingly demonstrated that material culture is complex and rarely reducible to an overlapping pattern of cultural traits (Clarke 1968 fig. 58), a basic notion behind the traditional concept of culture, language and ethnicity. However, it is still implicitly believed that a migration presupposes an unchanged geographical movement of recurrent cultural traits, otherwise it is refuted (Shennan 1978). Thus the new archaeology has, as a paradox, maintained the traditional notion of culture as a one dimensional phenomenon in its critique of migrations. One reason for this is of course the refusal to take population movements seriously, since they were not considered relevant to explaining social change Therefore the concept was not dealt with in a systematic way. But I believe there is more to it.

2. Just as the old parallelism between cultural change and migrations was rooted in a modern notion of national and political history, cultures and migrations replacing nations and battles, so it can be argued that the prevailing parallelism between social change and peaceful internal development is rooted in post-war decolonization and the development of modern middle class welfare society, international information exchange and internal social change substituting for international cooperation (United Nations, EC etc.) and social reforms. Culture, ethnicity and migrations were thus seen as linked to the political ideology that led to the disasters of two world wars. (Jensen 1988, Klejn 1974). A new theoretical framework was

therefore needed that was in accordance with the political ideology after World War Two. It became one of evolution, progress and peaceful internal development. I propose that these changes in ideological climate of the present are important in order to understand some of the reluctance of modern archaeology to deal with the traditional concepts of culture, ethnicity and migrations. This, however, had some serious concequences.

3. A theoretical and methodological framework without devices for identifying and interpreting the movement of social and/or ethnic groups, normally labelled under the general term migration, is unlikely to make convincing progress in other fields of social and cultural interaction. To exclude one phenomenon of social and cultural change in favour of others distorts our general ability to identify and explain such change. A framework of social change should thus include both conflict and harmony, migrations and information exchange. Migrations may both be a result of and result in social and economic disruption, including geographical displacement and warfare. The inclusion of the study of migrations into modern archaeology, however, makes it necessary to make certain theoretical claims. First it should be made clear that any such study should be contextualized, culturally and structurally. There exist no universal categories that allow the identification and explanation of such phenomena. Second: any such study must be evaluated against the historical background preceeding it. Only in this way can changes be identified and explained. Third: a migration, of whatever kind, is always a sympton, not a primary cause, and so it has to be explained within a broader framework of social organisation, contradiction and change

In a recent paper I have tried to take this into account on a larger scale of social transformation in temperate Eurasia (Kristiansen 1989). In the following I shall concentrate on a case study, that of the Single Grave Culture, or Battle Axe Culture, in Jutland, which is part of the larger complex of Corded Ware cultures that spread throughout Europe during the early third millenium. The objective is to create a more systematic archaeological basis for analyzing and evaluating the question of migration and social change.

THE SINGLE GRAVE CULTURE – A CASE STUDY

In recent years the conception of the origin of the Single Grave Culture has changed according to the general shift in explanatory framework within archaeology. Earlier scholars such as Sophus Müller (1898) and P. V. Glob (1944) saw this culture as representing a migration into Denmark of Indo-European speaking peoples, bringing with them a new, dominant culture that gradually took over and subordinated the peaceful megalithic people. Out of this evolved the ranked Bronze Age society. With the advent of C14 it became clear that the Single Grave Culture succeeded the TRB or Megalithic Culture in Jutland (Malmros and Tauber 1975), whereas the latter still lived on in the Danish islands in modified form (Davidsen 1980). In combination with the new trends in archaeology research focused on demonstrating internal change from the TRB to the SGC (e.g. Ebbesen 1980, Kristiansen 1982, Malmros 1979) in combination with international information exchange of new ritual and social value systems. Since such explanations had taken precedence in explaining the Corded Ware/Battle Axe Complex (Malmer 1962, Häussler 1963 & 76, Neustupny 1969), it was difficult to maintain a different explanation for the Danish case. No systematic attempt was ever made, however, to refute or confirm the migration hypothesis. With few exceptions (Davidsen 1975 and 1978, Jørgensen 1977) there simply occurred a drift in approach that was never sustained by systematic research (Becker 1981 for a summary). Let us therefore in some detail consider the criteria employed to support the two hypotheses.

The migration hypothesis:

1. The SGC appears at once and fully developed. There are no links to the existing TRB culture. SGC differs from TRB in terms of material culture, technology (pottery, flint), religion, and, as we now know, social organisation and subsistence (see discussion below for references).

2. Its primary area of settlement, the more marginal soils in central, western and southern Jutland, mostly lies outside the settlement areas of the TRB culture. The two cultures are thus in the earliest phase mutually exclusive (Davidsen 1975, fig. 7), with a brief period of chronological overlap at the peripheries of expansion (Damm 1989).

3. Where geographical overlap with the TRB culture occurs in the initial phase it represents a break of cultural continuity, the TRB comes to a complete stop, and is replaced by the SGC (Rostholm 1982, Jørgensen 1977 & 1985).

4. There is virtually no evidence of contact between the SGC and still existing TRB culture groups in eastern Denmark. Amber, controlled by the SGC, thus disappears from the TRB culture, just as good flint and its technology, controlled by the TRB, is not available to the SGC (Ebbesen 1986). Ebbesen concludes his analysis in the following statement: "Thus during MN B (the time of the SGC) there existed a distributional, and probably also a communicational barrier between the classic SGC regions in middle and central Jutland and the rest of the country" (Ebbesen 1986, 37 f.).

5. The subsequent stages indicate a continous expansion of settlement; that is, a slowed down continuation of migration into previously settled regions of the TRB culture, creating a mixed culture (Skaarup 1986, Andersen 1986).

It should be noted that these findings are based upon one of the most complete and representative archaeological materials in archaeology, since the SGC was systematically excavated in a large campaign in the late 19th century, later followed by numerous excavations. The material has been systematically analysed by Glob (1944), Struve (1955) and the preceding period of the TRB culture in Jutland by Davidsen (1978). Local in depth studies confirms this picture, both regional settlement surveys (Mathiassen 1948, Skamby 1984) and local excavation programs, although we lack a modern treatment of the numerous finds since Globs work. Although archaeological formation processes could be responsible for some of the variation between Jutland and Eastern Denmark (Malmer 1986), recent research has confirmed that regional and chronological differences between the SGC and the TRB are to be considered real and representative for eastern Denmark (Ebbesen 1986, Andersen 1986, Skaarup 1985).

The autonomous hypothesis:

It follows from the above observations (1–4) that it is impossible to point out traits that indicate cultural continuity between the TRB and the SGC. One can, however, point out a number of changes within the TRB culture that may account for the readiness of the final TRB to adopt a new social and cultural organisation in Jutland. They are:

1. A gradual change in ecology and economy in some regions towards open pastures and husbandry, the dominant subsistence strategy of the SGC (Davidsen 1978: 140 ff., Madsen 1982, fig. 17).

2. A local change in burial customs in Jutland towards single burials in stone packed flat graves, although this was still related to the megalith and different from the subsequent burial customs of the SGC in barrows (Jørgensen 1977).

3. Pressure from expanding coastal fishers and hunters, the Pitted Ware Culture (Becker 1980), from Sweden and the Baltic, leading to some changes in material culture (e.g. pottery), and economy (e.g. hunting). This might be seen as reflecting a crisis of the traditional farming communities, in combination with climatic change (Kristiansen 1982: 260, Hedeager & Kristiansen 1988: 71 ff.).

According to this scenario, expansion of settlement onto the marginal lands in Jutland, as a result of internal crisis of the TRB culture, led to radical social and cultural changes. Thus the SGC is regarded as a social and ecological adaptation to marginal environments, just as the Pitted Ware Culture is regarded as an adaptation to the Swedish and Danish coasts.

This internal framework, however, fails to account for a number of features that remains unexplained or only partly explained. Anthropology teaches us that significant cultural changes may occur as a response to external and internal crisis, e.g. religious movements, although most cases relate to the effects of western imperialism (e.g. Wallace 1970). In the case of the Single Grave Culture the change was complete – within a generation or two a new and mature cultural, religious and social framework was in place.To imagine that this should have happened as a internal transformation, from a culture that in most respects was quite different, leaving no traces of the former culture (it should be stressed, once more, that the change is not only religious, but includes all major aspects of social and economic life), demands support from the material evidence of the late TRB Culture in terms of demography (population pressure), abandonment of TRB settlements in Eastern Denmark, and some technological and cultural continuity, at least at the level of cultural relicts. This support is difficult to mobilize, looking at the published evidence. First of all it does not seem very likely that the TRB culture could supply the numbers of people indicated by the archaeological and palaeobotanical record, showing that most of central and western Jutland was settled by the SGC, except if there still existed a local population of hunters and fishers. The evidence does not point towards surviving hunter/fishers in Denmark (Andersen and Sterum 1970–71). On the other hand it is known that demographic growth can be rapid, and we know too little about TRB settlement continuity/discontinuity in Eastern Jutland/Denmark. Mapping of single finds, however, suggest some settlement continuity (Nielsen 1977: fig. 14, Ebbesen 1986), which does not support local migration and cultural change on a larger scale within Jutland.

Although the TRB culture had already transformed the forest into pastures in some regions in Jutland (Odgaard 1985), especially in eastern Denmark (Andersen 1985, Andersen et al. 1984), the SGC is characterized by a major clearance and burning horizon throghout Jutland (a real "landnam" much more extensive than the earlier TRB "landnam"), whose main purpose was the creation of heathland or pastures for large herds (Odgaard 1985 & 1987, Andersen in press). No agricultural indicators occur at this stage, and no house structures have yet been identified.[2] In the later stages houses are small and partly subterranean, occurring in small clusters of two or three (Hvass 1986). Some agriculture was practiced, however, although grain impressions on pottery are much less frequent than in the TRB (Rostholm 1986). Recent evidence also suggest that the SGC cultivated barley only, in opposition to the TRB which preferred wheat (Robinson & Kempfner 1987, Hedeager & Kristiansen 1987, 76 ff. for a recent summary).

If one accepts the autonomous hypothesis it also has to be explained why there was no contact between the mother group (the TRB culture) and its offspring (the SGC), except if one envisage a revolution, stimulated by the new expanding SGC ideology, followed by warfare and local migrations. This presupposes a build up of local contradictions and political organization on a scale I consider unlikely, although contradictions within the TRB groups were presumably part of the process of social transformation in several regions in Europe, where the two cultures merged. In Jutland, however, it is obviously more likely that such a situation was the result of an immigrating people which the TRB culture resisted by all means. Such a cultural barrier corresponds well to a situation on internal stress and resistance between two ethnic groups, as proposed by Hodder (1979, plus examples in Hodder 1982). During the process of expansion, however, it seems likely that many TRB people in Jutland "converted" to the SGC ethnicity, since ethnicity is a cultural code that can be adopted through socialization, e.g. marriage alliances – or force (Damm unpublished). The social organisation of the SGC was geared to expansion (Sherratt 1981), by establishing new settlements through alliances and cultural inclusion, supplemented by warfare, to secure domination, much in the same manner as described for tribal pastoralists in Africa (Sahlins 1961, Bonte 1977). Milisaurus and Kruk have recently through detailed research of a micro-region in Poland come to conclusions that would seem to support such a scenario (Milisaurus and Kruk 1989). In fact even researchers who reject the migration hyphothesis, agree that the SGC and Battle Axe cultures were based upon an ideology of hierarchy, warfare and domination (Malmer 1989). How such an ideology should be accepted peacefully by an alien culture, with whom there had been no previous contacts remains the paradox.

Also the continous eastward expansion over time of the SGC into areas of TRB culture, leading to a number of cultural changes (Skaarup 1986, Andersen 1986), apparently through both warfare and alliances, would seem to be a more likely scenario for a still expanding foreign people.

To this can be added that the cultural resistance or opposition between the original core areas of the SGC in Jutland, and the rest of Denmark, continued to manifest itself very clearly in the archaeological record until 1500 B.C., that is through more than 1000 years, when the mature Nordic Bronze Age Culture finally integrated it within its framework (Kristiansen 1987). This adds a significant historical dimension to the migration hypothesis, since such resistant social and cultural traditions are most probably to be seen as a result of ethnicity, and perhaps also a different language at first.

Having discussed the two alternative hypotheses there is little left in support of a "pure" autonomous hypothesis. The evidence is, as it stands today, rather conclusive: the case of the SGC in Jutland must be considered to represent a classic example of a migrating, tribal people, settling within a very short period of time in a new, sparsely populated environment, largely defined by resistance from existing TRB settlements. They belonged to the Corded Ware/Battle Axe cultural complex, and show greatest familarity with similar groups stretching through Northern Germany (Schl.-Holstein) to the Netherlands (van der Waals 1965), local groups in Switzerland (Strahm 1971) and the Baltic/Poland (Kilian 1955, Machnik 1981b, Wyszomirska 1989), with more remote links to the lowlands north of the Carpathians and the forest/steppe zone of the Pontic region (Machnik 1981a: Taf. 1, p. 281, Rulf 1981).

This of course is not the final word about the Single Grave Culture. However, the exercise of presenting and testing the two traditional alternative hypotheses has hopefully served its heuristic purpose – to establish a more well defined and well argued platform for future discussions. The burden of falsification now lies on the shoulders of supporters of the autonomous hypothesis. Having left the middle ground between the two alternatives rather open, I expect this to be more fully explored in the future.

THE CORDED WARE CULTURE – A REVIEW

How do these findings relate to the European Corded Ware Culture of which they are part?[3] It is difficult to point out any obvious local parent group to the SGR Culture. What makes the problem even more intriguing, and interesting, is the fact that the SGC in Jutland is among the few regions where virgin settlement took place. Thus the original migrating cultural complex is intact, in opposition to most other local groups of the Corded Ware complex. This makes comparisons difficult. Finally, no understanding of the origin of local groups is likely to materialize before the problems of the genesis of the whole Corded Ware complex reaches a more mature stage in terms of theoretical framework and archaeological analysis. Little has happened in these respects since Mats Malmer's analytical developments (1962) and David Clarke's methodological proposals (Clarke 1968: Table II). At present two conflicting "models" are at hand, basing themselves upon very different perspectives of cultural change, one giving priority to internal forces,- another to external forces. They have been summarized most coherently in recent works by respectively Steve Shennan (1986 a & b, critique Malmer 1989: 8) and Maria Gimbutas (1979, 1980 & 1986, critique Häusler 1985).[4]

Shennan sees the changes as an interaction between changing ecological conditions of production and interregional exchange of corresponding new social and religious value systems, whereas Gimbutas rather sees changes as caused primarily by so-called Kurgan steppe pastoralists intruding into Eastern and Central Europe in a number of waves leading to social and economic transformations. Shennan argues that changes were peaceful, since dispersed settlements replaced more centralized and fortified settlements (also Starling 1983), whereas Gimbutas argues, on the basis of axes, new bow and arrow techniques and horse riding, that it was one of conflict. Both agree that warfare must have taken on a new character and that changes in social organisation were decisive.

Model 1 does not account for various types of population movements since they are à priori denied, whereas model 2 uses migrations as an explanation, instead of trying to explain why they should occur. It is apparently taken for granted that Kurgan people were expansive, but this needs qualification.[5] In much the same way Shennan takes for granted that social interaction was the prime integrating mechanism. That also needs qualification. None of these frameworks are thus fully satisfactory, although Shennan's model is the more acceptable, since it takes into account and tries to explain the actual processes of change from a theoretical perspective. A major critique to be raised against Gimbutas' approach is that it has not responded to the theoretical critique of its prewar ethnic/migratory framework, nor defined the conditions to be met in order to identify various types of migration and acculturation. Therefore, although some of the general historical trends may be correct, acceptable theoretical and methodological underpinnings are lacking.

Both Shennan's and Gimbutas' interpretations are models, or explanatory frameworks, trying to account for the historical and social processes at work in general terms. To proceed from that we need to develop and apply such models in the working out of more specific case studies that take into account the whole variety of evidence, not only burials types or pottery, such as Gallay (1981), Strahm (1981) or Machnik (1981) (fig. 1). During the prevailing discussion of the origin of the Corded Ware Culture opponents and proponents of the migration hypthesis have relied upon empirical studies of material culture without paying due consideration to the cultural and structural frame-

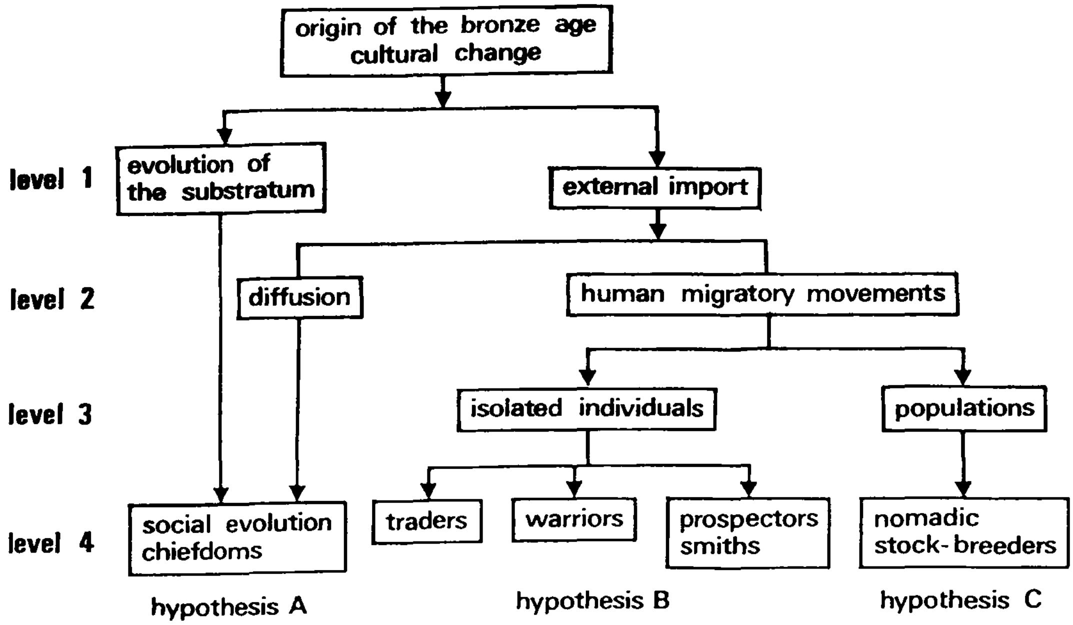


Fig. 1. Explanatory models for the evolution of Bronze Age society in the Alpine region. The components of the models may interact simultaneously in various combinations through time and space (after Gallay 1981).

work within which it operated. Proponents have often relied on a select list of traits, focusing only on points of similarity, but ignoring the local cultural context. Opponents, on the other hand, have focused on points of variation and have therefore been so eager to take all aspects of material culture into account that they have dissolved it into too many components, regardless of their internal social and cultural meaning (discussion in Klejn 1969, Clarke 1968, 287 ff.).

In order to throw some more light on the nature of change, and the present situation of research, I shall briefly discuss some of the factors considered to be significant.

Genesis: Today most researchers agree that the genesis of the Corded Ware complex is, for the major part, to be sought in Central Europe, rooted in large scale economic and social changes, with Baden and Globular Amphorae Cultures playing a major role (Sochacki 1980, Kruk 1980, summarized in Sherrat 1981). These major economic changes and their continuity in the Corded Ware Cultures were already summarized 20 years ago by Neustupny (1968). They created a necessary economic and social background, although they were also subject to external influences throughout their development, some of them much discussed, e.g. Gimbutas' Kurgan wave 1 and 2. Thus the Globular Amphora Culture has an eastern branch, defined by pottery, which cannot be derived from its western branch (Nortman 1985, in opposition to Sulimirski 1968: 50 f.), and this may account for some of its so-called Kurgan traits (Gimbutas 1979). However, neither Häusler in his recent work (1983), nor others are able to point out a specific region of origin for e.g. the Corded Ware pottery (a recent summary by Buchvaldek 1980). But it is generally agreed that the CWC spread in obedience to local conditions and exhibits a large variety both in terms of the actual processes of expansion and in terms of cultural mix. This leads on to a consideration of the impact of Kurgan traditions of the steppe and forest-steppe regions in the actual formation of the Corded Ware and Battle Axe cultures.

Kurgan influences: Although both pottery and battle axes of the CWC may be given a Central European origin, it also seems rather obvious that this does not account for a number of distinct features in burial ritual. Here a Kurgan origin is still most likely, although Häusler in his works maintain that the CWC of Central Europe and the Ochergrabkultur, by some also called the Pit Grave, Jamna or Kurgan Culture, stretching from the Volga to Hungary, represent two different cultural complexes (Häusler 1963, 1967, 1974 & 1976). Such a distinction is obviously dependent upon definitions, but it seems to be generally agreed that the pastoral farmers of the Pit Grave or Ochre Grave Culture proper did not expand beyond the river Theiss in Hungary (Ecsedy 1979). It also seems clear, however, that it is exactly this mixture between Kurgan burial ritual and Corded Ware material culture that produces the classic package of the Battle Axe/Single Grave Culture in Northern Eurasia, or some of the classic early Corded Ware groups, as pointed out by many scholars (see especially Struwe 1955).[6] And it has not, in my opinion, been convincingly argued that they could not have mixed in a combined process of migrations and local processes of change. On the contrary, C14 dates seem to support a rapid process of migrations and acculturation from 3000/2900 B.C. in Eastern Europe to 2800 B.C. in Jutland and Northern Euro-

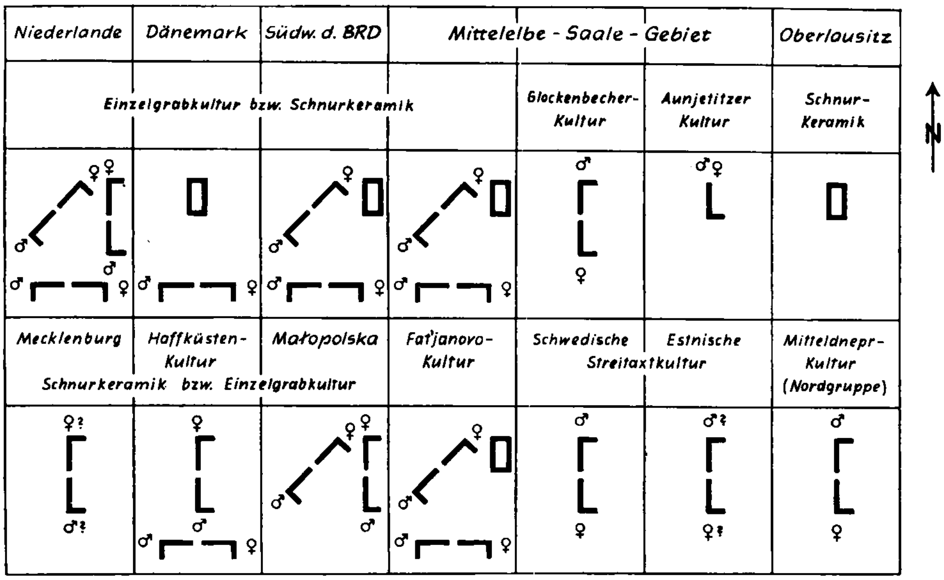


Fig. 2. Schematic presentation of basic principles of burial positions in the Late Neolithic/Early Bronze Age Cultures in northern Eurasia (after Häusler 1983).

pe (Gimbutas 1979, Pape 1981). This is reflected in the so-called "gemeineuropäisches Horizont" (Buchvaldek 1986 for a recent status), which by many scholars is taken to represent an initial migrating phase from the east, originating at the interface between Kurgan and Late Neolithic Cultures between the Dniepr/Dnestr and the upper Vistula/Oder[7] (Sulimirski 1968: 84 ff., map VIII and X; Buchvaldek 1985), which in terms of topography forms a natural continuum. It lends support to the hypothesis that we also find this phase in Jutland, and that it represents a genuine case of tribal migration, actually the conclusion of a common-European migration. As has been pointed out correctly by Buchvaldek recently, a first generation of settlers are not likely to leave much evidence, compared to succeeding generations (Buchvaldek 1985: 488, Abb. 3). Häusler has further demonstrated that in terms of burial positions the SGC belong to a northern Eurasian complex characterized by strict divisions according to kin, sex and age (fig. 2).[8] On this background it seems probable that recent excavations in both Jutland and the steppe region may reveal further similarities in terms of burial constructions and ritual, e.g. house or hut constructions, if subjected to systematic, comparative analyses.

Nature of expansion: Also the nature of geographical spread of the Corded Ware and Battle Axe cultures lends support to this model (fig. 2): in Central Europe small pockets of local Corded Ware groups at rivers and in valley systems, with large "empty regions" between them where resistance was too strong, alternating with regions of more massive expansion where conditions were favourable or receptive, as in the North European lowlands characterized by the Single Grave/Battle Axe Cultures. To this may be added an often observed, but none the less significant geographical dimension: the massive spread not only to central and northwestern Europe, but also to Sweden, Finland and eastwards into the USSR (the Middle Dnieper and Fatjanovo groups, e.g. Ozols 1962) that would seem to favour an eastern rather than a central or west European source. Since most groups of the Corded Ware and Battle Axe cultures are chronologically synchronous (Pape 1981), this also suggests radiation in many directions from one or a few regions of origin.

Anthropology: Although the sample is uneven and small it seems clear that no specific anthropological type is linked to the CWC in Europe. The material varies regionally and locally, but is generally dominated by the more gracile Mediterrannean type, supporting an autochthonous tradition. Some "kurganisation" in populations can be observed in eastern Europe, decreasing westward and is not observable in western Europe (Schwidetzsky 1980). This is by some taken to account for an influx of "kurgan" populations throughout the neolithic of Europe (the three "waves": Gimbutas 1979), but should probably be restricted to account for the small, well defined "Kurgan" populations penetrating into Eastern Europe (e.g. Ecsedy 1979). The Kurgan type is anthropologically characterized as tall (average of males 173 cm), robust and with curved forehead. Two variants are distinguished: proto-Nordic and proto-Cro-Magnon. Again a marked border is the river Theiss, east of which a Kurgan population can be defined, apparently most clearly among males, whereas the women are often of the gracile European/Mediterrannean type, reflecting marriages with local women (Marcswik 1979). Also the Baltic group is distinctly different from the common European type.

In Denmark (and Sweden) a marked increase in mean height (7–8 cm) can be observed between the TRB and the Late Neolithic Dagger Period (Bennike 1985: fig. 13), which may have taken place during the Single Grave period. Unfortunately most skeletal material originates from Eastern Denmark, that is outside the original Single Grave core region, and here continuity prevails. A recent Danish find with preserved Single Grave skeletons from Jutland, however, seems to suggest anthropological traits falling outside the normal Neolithic range, which may be supported by a reanalysis of some of the Swedish evidence (Petersen 1988, During 1989), but we must await more complete, up to dage analyses, just as we need more material from the SGC. Since very few skeleton remains are preserved from the SGC we cannot evaluate the impact of new populations compared to other factors, e.g. changed or improved diet. Especially milk products tend to raise the height. A recent survey of dental conditions of Single Grave/Battle Axe material in Denmark and Sweden has indicated some differences compared to other neolithic groups. Especially "enamel hypoplasia", which reflect periods in young age of starvation/bad nutrition or periods of illnes and fever, was rare, suggesting excellent living conditions for the buried populations, probably due to a dominance of milk/meat products (Alexandersen 1989: 176).

While anthropological data from Denmark does not at present allow the identification of a migration, due to lack of representative data, it seems clear that there existed larger regional differences throughout Europe rooted in a more remote past (Menk 1980). In the Late Neolithic/Early Bronze Age (Aunjetitz) there is apparently a distinct difference between Scandinavian and Central European populations. Anthropological evidence does then seem to rule out Central Europe as the origin of the Battle Axe/Single Grave Culture in Denmark and Sweden.

Indigenous hunter/gatherers. The question of a surviving mesolithic substratum is an old one, but has recently been revived by especially Krzak (1981) proposing that the Corded Ware complex originated in areas of mesolithic tradition in Europe. This has been firmly rejected and, it seems, quite rightly (e.g. Häusler 1983). On the other hand there are a number of traits in burial customs of the Ochre grave/Kurgan cultures that bear resemblances to mesolithic traditions of northern Eurasia, as observed by especially Häusler in his works. In the early third millennium there existed two major cultural complexes in this region: in the forest region the Combed Ware/Pitted Ware-groups of semi-neolithic hunter/fishers (Wyszomirska 1984: fig. 5) and in the steppe region the Ochre Grave/Corded Ware cultures. Quite naturally they interacted throughout their frontiers in the Baltic and in the USSR. It is remarkable, however, that they both expanded westwards around 3000 B.C. – the Pitted Ware shortly before, the Kurgan/Battle Axe Cultures shortly after. This leads on to the impact of climatic change.

Climatic change. A number of independent climatic observations suggest that a climatic change towards cooler and wetter climate occurred around 3000 B.C. or shortly after. (Aaby 1976, articles in Harding 1982, Wigley et al. 1981, especially Bowden et al. 1981: fig. 21.2 & 21.3 and Porter 1981). The first significant climatic detoriation after the Boreal/Atlantic optimum occurred around 4000 B.C. coinciding with the advent of agriculture in northern and western Europe, later to be followed by other climatic fluctuations. It may not then be accidental that the climatic decline around 3000 B.C. in much the same way saw an expansion of new social and economic practices. Such a climatic change may have favoured grassing of more marginal soils and may have caused problems in the traditional agricultural communities, establishing a pattern of long term oscilliations between central and marginal agricultural regions throughout Europe (discussion in Whittle 1982). In Scandinavia the effect of climatic deterioration in the later 4th millennium is demonstrated in the southward retreat of agriculture and the concommitant expansion of hunter/fishers of the Pitted Ware/Comb Ware tradition from northern Eurasia (Graslund 1981). Thus the Pitted Ware and the Battle Axe cultures could be suggested as representing different but interacting responses to large scale ecological and climatic changes in respectively the forest zone and the steppe zone of Eurasia.

It should be stressed, however, that no climatic determinism is to be implied. Social and economic dynamics determine the course of development whereas ecology and climate set barriers that are sometimes transcended.

Technological and economic innovations. The importance of the secondary products revolution as a contributory factor to the spread of the Corded Ware/Battle Axe Cultures is perhaps somewhat overstated. As indicated by Sherrat (1981 table 10.9 & 10.10) both ox-traction, ard ploughing and probably also wheels and milk products belong with the TRB Culture of the 4th millennium. What is left for the Corded Ware and Single Grave Cultures is mainly the exploitation of sheep for wool and perhaps horse riding. This had some social and economic consequences: sheep tolerate soils of lower quality and the horse allowed more rapid social interaction. Another basic precondition, however, was the combination of open landscapes in the settled areas and still large tracts of unsettled secondary soils. Thus the scene was set for wide scale changes and interactions between the semi-arid steppe regions of Eurasia and the lightly forested secondary soils in Europe, as convincingly demonstrated by Sherrat (1981: 295 ff.). This included both actual migrations and the spread of new linguistic and social systems (Sherratt and Sherratt 1988).[9] It seems to me that Sherratt's interpretation more satisfactory than others accounts for the available evidence and allows a combination of both Shennan's and Gimbutas' models.

Although we may be able to define and locate some of the constituing elements in the development of the CWC, it is not, at present, possible neither to describe nor *explain* its precise origin, although Sulimirski (1968) and Buchvaldek (1985) have made convincing proposals (fig. 3). One reason for this is already mentioned – the general lack of theoretical and analytical sophistication in Corded Ware studies. Another is the neglect of coming to terms with the nature of population movements. Neither parties have taken into account the complex nature of migrations. *First:* a migration need not take place in one sweep, but can act as a kind of catalyst, one group forcing others tobreak up, thereby dissolving the image of a unified material culture. *Second:* migrations put very specific demands

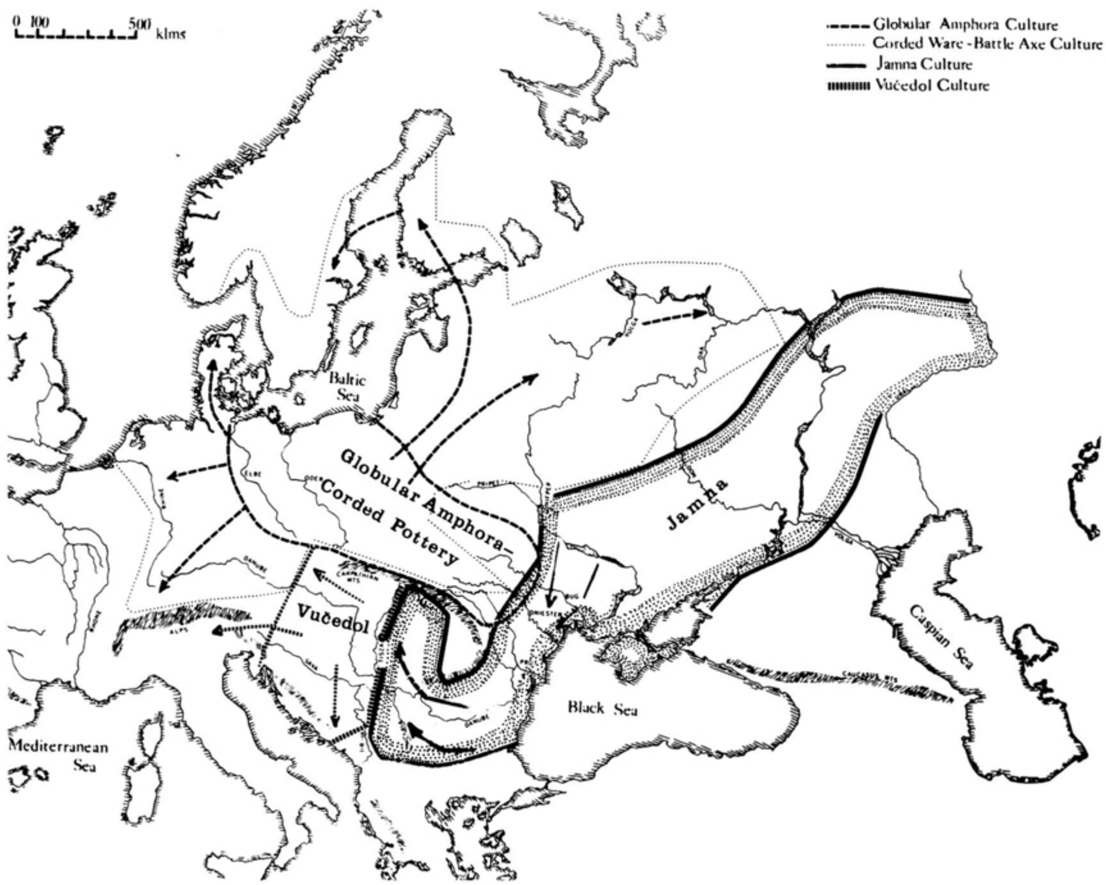
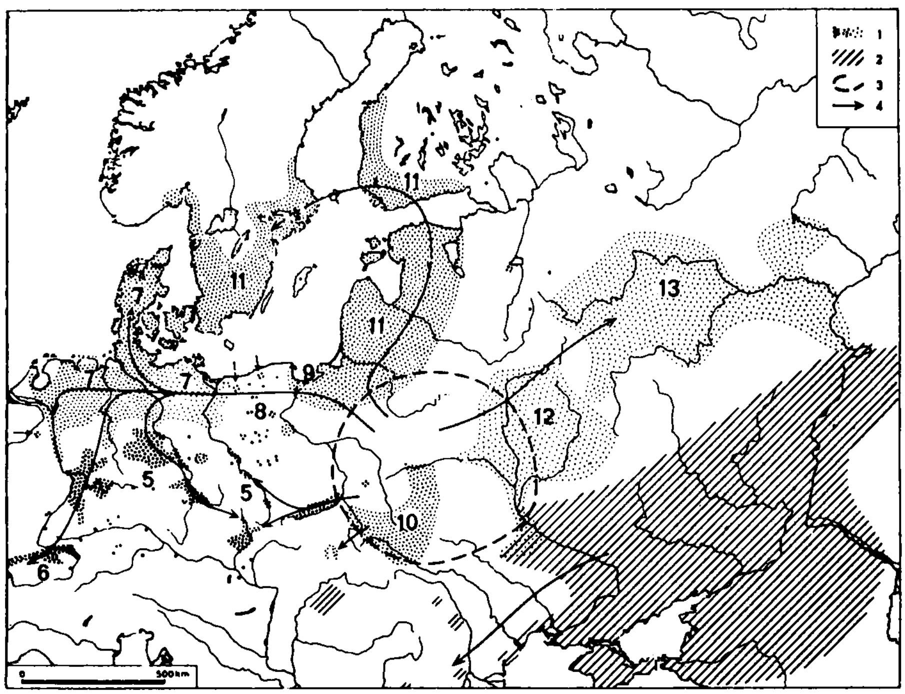


Fig. 3a. Geographical model for the genesis and expansion of the Corded Ware/Battle Axe cultural complex (after Gimbutas 1986).



b. Geographical presentation of Corded Ware/Jamna cultural groups, and a proposal for the origin and spread of the Corded Ware/Battle Axe cultural complex. 1) Distribution of Corded Ware Culture Groups; 2) Jamna Culture; 3) presumed area of origin; 4) presumed main directions of the primary distribution; 5) CW in Central Europa; 6) CW in Switzecland; 7) CW in NW Europe ("Single Grave Culture" in Denmark and NW Germany, "Standvoetbeker" culture in the Netherlands, CW on the lower Oder river; 8) CW in Great Poland; 9) "Rzucewo-Baltic Haff Culture"; 10) CW in the West Ukraine and in SE Poland; 11) East Baltic of "Boat-shaped axes"; 12) Middle Dnieper group; 13) Fatjanovo and Balanovo groups (after Buchvaldek 1980).

upon those involved leading to specific changes and adjustments in material culture and social organisation. Consequently we cannot expect à priori to find a unified material culture between areas of supposed origin and areas of final settlement. Thus the selective mechanisms operating under the specific conditions of migrations have never been systematically analyzed. We here need comparative studies under historical control. In order to improve on this situation I shall finally discuss the identification of migrations and after that try to outline some types of migrations and their contexts. It is a heuristic sketch without any attempt to cover or refer more than a segment of the relevant literature.

A TENTATIVE SCHEME FOR POPULATION MOVEMENTS

We have until now employed the traditional concept "migration". As it bears many simplistic and value loaded associations with it, one might prefer the more neutral expression "population movements" to stress the diversity of such movements – from individuals over select groups of traders and warriors to whole populations. In the following we are mainly concerned with movements of larger groups of people. Although "large" remains a relative word, it serves to differentiate between individual movements of marriage partners, mercenaries, traders or settlements from the co-ordinated movements of a group of people, whether voluntarily or forced, to occupy a new area. It marks a not easily definable difference between "interaction" and "take over" (or at least an attempt to take over) by moving in larger groups of people, whether farmers, traders, warriors or all at the same time. There are obviously intermediate stages of various types of domination.

The first problem confronting any study of such phenomena is that of identification.

Identification includes three elements:
- intrusion of an alien group (resettling)
- a migratory route (connection)
- a mother culture (origin)

Historically the process operates in the opposite order to this, but identification in the archaeological sense is mostly reversed, beginning where the process stops; and for very good reasons, since the replacement of one culture by another is often the most conclusive evidence archaeologist can come up with (e.g. the Single Grave Culture). As previously indicated it may take many forms from virgin settlement to various types of cultural mix, the processes of which are still badly known.

Migratory routes are the most difficult to trace due to the selective mechanisms at work. In several well documented cases both the mother culture and the final region of settling down can be traced, whereas the route is only represented by scattered finds (e.g. the Bastarnae: Schlette 1977, the Cimbric/Teutonic migrations: Seyer 1976 Abb. 51, several Germanic migrations: Krüger 1977, the Langobards: Werner 1962). Thus, it is clear that without literary sources a number of well known migrations could not have been identified archaeologically, at least not in our present stage of knowledge (e.g. the Cimbric/Teutonic, and several North American and African historical migrations). This, however, also depends upon the scale and nature of migrations to which we shall now turn.

Contexts and types of population movements. In the following we distinguish between full scale and select movements. Other criteria may be employed, such as speed and directionability, but they belong with a later archaeological discussion about the nature of migrations, e.g. differences between settlement expansion and population movements and the possibility of distinguishing between them (Neustupny 1981).

1). The full scale movement of social groups may be differentiated into three types:
- displacement by states/empires
- social conflict/tribal competition
- ecological/economic pressure

The full scale movement of tribal groups, including children, livestock etc. is not very well documented in prehistory, except for Caesar's description of the Helvetii, and some Celtic and Viking immigrations. The Single Grave Culture, however, probably belongs here. It should be pointed out that even such large migrations did not normally deprive a region of its population, but rather represented the combined effect of several groups or settlement units joining together, as it is known from the Viking period. We should not therefore à priori expect major displacements or decline of settlement in those regions providing the people, although it may sometimes occur.

Causes include political displacement of oppositional ethnic groups, a policy followed by all empires throughout history (the Jews in Babylonia, Celtic and Germanic tribes by the Romans etc.), internal social conflict/exclusion (part of the Viking expansion, e.g. Eric the Red and his group leaving for Greenland, some of the Polynesian expansion), political subordination or the threat of it by intruding dynasties (several Iron Age migrations), social and ecological constraints (the Corded Ware Culture/the Single Grave Culture in Jutland, the Cimbric/Teutonic migration from Jutland), and planned migrations to take up new land (the Helvetii as described by Caesar, several of the Pueblo cultures in the American Southwest).

2). Select movements of social groups may be divided into at least four variants:
- conquest
- mercenaries
- trading stations/colonies
- labour/stigmatized groups

Migrations of select social groups is probably as widespread in prehistory as in history. It includes the intruding of foreign chieftains/kings and their retinue taking over control – so-called conquest migrations. Examples include the recurrent influx of nomadic groups in Europe, from the Scythians, the Huns to Genghis Khan, some of the Tumulus expansion of the Middle Bronze Age, part of the the Celtic and Viking expansion and the widespread feature of intruding dynasties in the myths of origin of African kingdoms. This may either result in a fast acculturation or an influx of larger groups from the home base of the new leaders, which could explain part of the Nordic Bronze Age expansion. Also mercenaries probably belong here, since on return they often bring with them strong influences, such as the Germanic mercenaries in the Roman army.

From historical sources we have ample evidence of such military/political movements and take overs (for comparative discusison, see Webb 1975), that have often left rather weak traces in the archaeological records (e.g. the Huns as documented by Werner 1956, or the Vikings). This is not at all surprising given the nature of such migrations. What has left an impact, however, is often place names, since they symbolize the political/administrative take-over of a region. Thus place names are probably a good indicator of succesful conquest migrations.

Another type is represented by trading stations/colonies, which is often characterized by the same lack of a clear archaeological identification, or of a mix, such as the Vikings in Russia, the Myceneans/Greeks and Phoenecians in the Meditarrannean (Kimmig 1982).

Finally there are the eternal migrations of stigmatized ethnic groups taking up specific tasks, such as blacksmiths/potters, trade and barter (jews/gypsies), labour (slaves), which is to be seen as a more permanent structural outcome of large scale processes of ethnic displacement and exploitation in empires throughout history.

From the above observations a certain processual development in the type of migrations may be suggested, tribal migrations of the neolithic mainly caused by ecological/demographic problems, to trade and conquest migrations/further migrations of conquered peoples in later periods from the Bronze Age onwards. This also implies differential impact upon material culture. Such a scheme was recently proposed by Colin Renfrew, although he preferred to fix the evolutionary fault line for elite domination with the beginning of the Iron Age (Renfrew 1987:131 ff.). We should, however, be cautious not to apply excessively simplistic models. Tribal chiefdoms may very well from an early stage have migrated according to a model of elite domination, just as migrations without any rational demographic or ecological background may be found, e.g. to seek mythical origins or just sheer explorations of new land. In most cases that we know of, there was already a familiarity with the new lands either through exchange, trade, alliances or explorations (Helms 1988).

In conclusion the archaeological identification and the cultural and structural contexts of migrations or population movements are still badly understood. They depend on the level of social and political organisation and their interaction with demographic, economic/ecological and political factors. Some cases are rather clearly due to ecological/demographic problems (some of the Iron Age migrations, e.g. the Cimbric/Teutonic migration), but in more advanced stages of social and political organisation military conquest may also force subdued groups to migrate. Even internal contradictions and competition is known to have led to migrations (e.g. Eric the Red). States and empires reallocate whole ethnic groups, just as they in periods of crisis are tempting centres of wealth for migrating tribes from outside the empire (e.g. the Germanic people and the Roman empire). All this is historically well known, but has attracted only little attention from archaeologists.

When dealing with the structural and cultural framework of migrations we also have to face the problem of ethnicity and language (Barth 1967, Hodder 1982, Herrmann 1988) and their relationship to material culture, since a strong element of ethnicity is implicitly assumed in the identification of migrations. This includes the difficult problems of "ethnogenesis" towards whose prehistoric reality I remain sceptical.[10] We should be aware that ethnicity may often be exclusive and class defined and that the modern notion of ethniticy as all-embracing (a people) may not be applied uncritically to prehistory. We should also be aware that different ethnic groups may coexist, as demonstrated by Barth (1967), often as a result of migrating groups taking up new niches.

Thus, our ability to identify and understand ethnicity, population movements and language in the archaeological record depends primarily on our ability to identify and explain the social and economic framework within which they operated, as recently suggested by Colin Renfrew (1987). But even that will not do. If we want to see some future advances in the study of population movements, it is necessary to carry out comparative studies under historical and contextual control in order to specify those conditions under which they may occur and the selective mechanisms at work during processes of replacement and change. This is a precondition for understanding and identifying the material correlates of various types of population movements.

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This paper was first presented at the second Nordic conference on the Battle Axe Period, held in Lund, Sweden, 31st October to 2nd November 1988, and later in England at the TAG conference in Newcastle, December 1989, in a session organized by this author titled: "New Perspectives on Prehistoric Migrations". The lively and constructive responses received on both occasions convinced me that time was ripe to re-open the discussion about prehistoric migrations – 40 years after the publication of Childe's "Prehistoric Migrations in Europe". Although I have maintained the paper mostly unchanged, the contributions from both occasions have helped to clarify some of the more crucial questions and formulations. Finally I want to thank David Liversage for correcting the English.

NOTES

1. A note of clarification: diffusion is a covering, descriptive concept for the transmission and change of material culture that does not account for its underlying social mechanisms. Migration is likewise a covering concept for the movement of people, from whole populations to smaller groups. Here, too, the underlying social mechanisms are not accounted for.
2. A few indeterminable structures have been excavated. One is circular and certainly not a house (Rostholm 1986). Another consists of lines of stake holes (Liversage 1987, fig. 1), resembling similar

structures from New Guinea, used to tether pigs at the tribal feasts and exchanges (Feil 1987). As more and more SGC sites have been uncovered in Jutland with maschinery (stripping of plough soil) in search of constructions with negative results (no postholes), the question must now be raised if the early phase employed solid house constructions at all, or only tent like constructions that could be easily moved. We know, however, from burials that wooden construction was mastered without difficulty.

3. Presentations and discussions on the Corded Ware/Battle Axe cultures in Europe are found in Behrends & Schlette (1967) and in Behrends (1981).
4. A lively discussion about the nature of autochthonous development, migrations versus cultural exchange and their role in social change was carried out some years ago by Klejn (1978) and Häusler (1978). Since then Häusler has developed his arguments, especially against Gimbutas, in a number of works (Häusler 1981 and 1985). The problem with the discussion, however, is that it is not underpinned either theoretically or with systematic analyses of a body of material (e.g. simple statistics and diagrams). Instead we are presented with numerous references to select finds and literature whose significance cannot be evaluated due to the lack of a proper theoretical and methodological framework. It is symptomatic that Häusler has not applied his useful definitions of burial positions systematically in a concrete analysis, nor has Gimbutas ever defined a migration.
5. In a recent work Anthony (1986) has reconsidered the Kurgan cultures in terms of social and economic adaptations and changes. Especially the role of the domestication of the horse is considered with reference to the Plains Indians of North America. This study is among the first to offer a satisfactory theoretical framework for understanding and explaining the dynamics of Kurgan Cultures.
6. Häusler defines à priori certain elements as indicators of an auctochthonous cultural development, such as the position of the dead. He argues, quite rightly, that burial ritual reflects a ritual core relating to social organisation, but he selects only certain traits as significant. Even here there seem to be more similarities than differences, despite claims of the opposite. The many specific similarities between e.g. Fatjanovo and Middle Germany, or the Middle Dniepr Culture and the Single Grave Culture in Jutland are ascribed to information exchange, but with no attempt to explain how and why that should have happened between these groups so far apart (see also note 4).
7. Although this horizon has been subject to critique during the 1960's, recent excavations and research have tended to confirm its historical authenticity as the oldest phase (Machnik 1981: 190, Rulf 1981, Sulimirski 1968, map IX). Strahm in his analysis of the Swiss evidence concluded about origins: "Sicher ist aber, das zwischen aller schnurkeramischen Kulturen ein genetischer Zusammenhang besteht, der alle Gruppen auf eine gemeinsame Grundform reduziert" (Strahm 1971).
8. Polarization of male/female is a feature of pastoral societies that are characterized by strict division of labour between the sexes, and by kinship systems aimed at securing herd relationships, transmission of property and alliances (discussion in Bonte 1977, Goody 1976). In the archaeological record of the Corded Ware/Battle Axe culture these features are underlined by dichotomies of left/right, east/west, north/south in positioning the dead. Together with other ritualized social features, such as double male burials (twins), wagon, horse and dog burials, the stressing of warfare in burials etc. they have been taken to represent some of the classical features of Indo-European social organisation. Also Häusler has pointed out striking similarities between burials rituals as described in the Vedas and as documented in the Ochregrave complex in several of his works cited above.
9. I shall not enter the discussion about the Indo-European problem, but rather point out, that the two dominating models – the autochthonous and the intrusive – imply different interpretations of the origin and spread of indo-european languages (Renfrew 1987, Gimbutas 1986; discussion in Current Anthropology 1988, vol. 29, no. 3 and Antiquity 62, 1988). Until we reach a more mature understanding of migrations and the transmission of information in European history, archaeology will not be able to provide a useful framework for linguistics (see Mallory 1989 for a usefull summary of the archaeological evidence of the Pontic regions and beyond). With respect to Indo-European social organization on there is probably more to be gained by comparison with various types of prehistoric social structures. Here there is little correspondence between the kind of social structures dominating in the Early Neolithic of Europe (Vinca/Starcevo/Bandkeramik) and so-called Indo-European social structures (Dumezil 1956, Benveniste 1973, critically discussed by Renfrew 1987, 250 ff.), which bear more resemblance to later Neolithic/Bronze Age types of social organisation, although Renfrew prefers the Iron Age as the proper parallel. These differences have been pointed out in terms of ideology and religion most strongly by Gimbutas (in press), but are widely recognized in terms of economy, settlements and social organisation (Thomas 1988). A good case for comparative evidence in terms of processes of social and linguistic expansion and change is offered in Oceania (Kirch and Green 1987). Especially the chiefly package identified as Lapita, offers some interesting parallels to the Corded Ware complex.
10. The recent discussion about the ethnogenesis of the Lapps by Odner (1985) offers a good example of this problem, especially the relationship between the rise of ethnicity, language and social and economic changes (Olsen 1985). See also the recent discussion of the Celts in Renfrew (1987, ch. 9). For a more traditional approach, see Horst and Schlette (1988).

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Reviews

HANS GÖRANSSON: *Neolithic Man and The Forest Environment around Alvastra Pile Dwelling.* Theses and papers in North-European Archeology 20. 90 pp. Lund University Press.

When different scientific disciplines pursue a common subject, new explanations of interest to both may arise. However, specialists in one field may not be able to evaluate difficulties and limitations in others. The archaeologist sees and interprets objects found in the earth, whereas the pollen analyst sees and interprets pollen grains incorporated in sediments. In either case, the evaluation of the conclusions requires specialized knowledge.

Pollen analysis may appear objective, as grains are identified and then counted. However, identification itself raises problems, and exactitude of identification varies widely with the individual analyst. Thus, identifications of "cereal" pollen grains give causes for doubt, unless they are based on size statistics and morphological observations (cp. Beug 1961, Andersen 1979, Köhler and Lange 1979). One may also see pollen of a genus, *Filipendula*, identified with *F. vulgaris* in some pollen spectra and with *F. ulmaria* in others, although the pollen of the two species are indistinguishable. Such species identifications have no ecological significance.

The calculation of the pollen counts raises other problems. Percentage calculations are still widely used, as they may show how one component replaces another. The tree pollen sum is fairly easy to delimit, although some borderline cases, hazel e.g., are considered varyingly by individual analysts. Tree pollen percentages, however, do not reflect tree composition directly. Disregarding problems of dispersal, pollen productivity in trees varies widely. If some high pollen producers (*Betula, Alnus, Pinus, Corylus*) are reduced and others not (*Quercus*), then the latter will become even more overrepresented, whereas low pollen producers (*Tilia, Fraxinus*), if not corrected are still underrepresented (cp. Andersen 1970, Bradshaw 1981). Therefore, partly corrected tree pollen spectra are not less distorted than the uncorrected.

The construction and interpretation of pollen diagrams are also influenced by problems of identification. If the identified taxa include a variety of species with ambiguous habitat preferences (Liguliflorae, Rubiaceae, Umbelliferae, Caryophyllaceae), then, these taxa cannot be considered indicative of pasture or dry meadow. Even more definitely identified taxa (*Rumex acetosella* coll., *Artemisia*) can hardly be classified as crop weeds, as their preferences for habitat also are ambiguous, and because prehistoric weed floras and cultivation methods are not sufficiently well known for such a distinction (Behre 1981, Willerding 1986, Groenman-van Waateringe 1988). Pollen grains from these taxa occur since the Lateglacial. Hence, scattered grains of them give no certainty of human interference with the vegetation.

The above mentioned examples may warn the non-specialist that pollen-analytical evidence may not always be unambiguous and needs scrutiny before being accepted. All of them occur in H. Göransson's publication.

Today it has become fashionable first to construct a "model" and then to prove it by searching for evidence (cp. Birks 1985). This method was used by H. Göransson. He mentions earlier models, which in fact do not differ greatly, and then advances a new model for the utilization of the nemoral deciduous forests in North-West Europe from Mesolithic time up to Middle Neolithic time. Evidence for this model is searched for in pollen diagrams from Östgötaland, Sweden.

Göransson's model includes a "Mesolithic coppice phase", an "Early Neolithic destruction phase", and a "Middle Neolithic coppice phase". Trees are assumed to have been girdled but allowed to shoot from the living bases providing material for browsing and leaf fodder, and glades were cultivated with cereals, in the two coppice phases. The forest is, however, assumed to have been so dense that few pollen grains from the glades could reach bogs or lakes. Hence, the tree composition did not change and the pollen from cultivated plants is difficult to find. These phases correspond to the Atlantic "virgin forest" and the Neolithic "forest regeneration phase" of previous investigators. Göransson's Early Neolithic destruction phase corresponds to the "*landnam* phase" of Iversen and others. Trees, particularly elm and lime, were damaged by cold winters and diseases, and were further damaged by fires and browsing so that pollen from open areas could be transported into lakes and bogs, in Göransson's model.

Thirteen pollen diagrams from Östgötaland are presented. Some of them could be dated by radiocarbon. The Mesolithic coppice phase could be represented in five. None of them contradict the model. Elm and lime are common, and scattered grains of *Artemisia* and *Rumex acetosella*, and low amounts of *Pteridium* and *Populus*, may indicate glades. Varying amounts of charcoal dust are also recorded. These pollen grains could also derive from openings caused by wind-throw and natural fires in the pine woods. Two pollen grains from Dags Mosse "seem to be of *Triticum*-type" (p. 34). Cereal growing occurred in Central Europe at that time, and cereals might have been known in Sweden. However, judging from the illustrations (Fig. 47 a and b), the pollen grains do not differ from certain wild grasses (*Glyceria, Elymus, Ammophila*). Hence, evidence for Göransson's Mesolithic coppice phase is difficult to find.

The Early Neolithic destruction phase is especially reflected in nine pollen diagrams. There are minima for elm and lime and maxima for pine, birch and sometimes hazel, *Populus* and *Pteridium*, scattered grains of *Plantago lanceolata*; and *Artemisia* pollen may be common. Charcoal dust is usually also frequent. This phase clearly was "destructive" for elm and lime, but it is difficult to accept the climatic explanation, as both trees are still common in Russia and tolerate low winter temperatures, which could not have occurred in western Europe. Furthermore, no diseases have been demonstrated for lime. Natural "destruction" of lime therefore is very unlikely, and if man erradicated lime, then why not elm?

Eight pollen diagrams may reflect the Middle Neolithic coppice phase more or less clearly, among them diagrams from the Alvastra Mire. There is an increase of elm and lime whereas *Plantago lanceolata, Artemisia* and other indicators of open areas are scarce. Charcoal dust is scarce in some diagrams and common in others. The pile dwelling of Alvastra seems to fall at the beginning of the "coppice phase", or rather at the end of the "destruction phase", as the lime values are still low. H. Göransson finds these types of evidence indicative of coppiced woodland, where young trees shooting from the tree bases were cut down at regular intervals and the glades produced in this way were used for growing cereals for a few years. Göransson emphasises the occurrence of large grass pollen grains identified as cereals in pollen diagrams from the Isberga kettle-hole (Figs. 25 and 26), whereas this pollen type is very scarce or absent at the other sites. Cereal pollen is difficult to distinguish from the pollen of *Glyceria*, which may occur abundantly in small kettle-holes (Andersen 1979), and no data on size or surface sculpturing support a distinction of the large grass pollen grains from the Isberga site from *Glyceria* pollen. Hence, Göransson's model for this coppice phase is also difficult to prove – or disprove.

Piles of hazel were used extensively for construction purposes and were probably derived from coppices in Neolithic time (Godwin 1975, Malmros 1986), and hazel and alder coppices were used for pasture or swidden cultivation of cereals (Andersen 1985, 1989). The piles used for construction of the Alvastra dwelling could also have derived from coppiced woodland (Bartholin 1978). H. Göranssons proposition that coppiced woodlands were used extensively in Neolithic time thus is very likely. These finds, however, rather belong to the "destruction" or "landnam phase", or the end of it, and not to the "coppice phase".

Göransson's article presents valuable pollen diagrams from the Alvastra area. In the present reviewer's opinion the preconceived models, however fascinating, may lead the investigator to look too hard for proof of his model. Coppice phases, as defined by Göransson, are difficult to prove or disprove in pollen analyses from lakes and bogs, if tree composition did not change, and if pollen from small glades could not reach the investigation site. Hence, the model must remain a model. The destruction phase is easier to demonstrate; however, opinions differ considerably as to its explanation.

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LARS BLOMQVIST: *Megalitgravarna i Sverige. Typ, tid, rum och social miljö.* Theses and Papers in Archaelogy, New Series, Published by the Institute of Archaeology at the University of Stockholm, 1, Stockholm 1989. 333 pp. With English summary.

The appearance of a monographical survey of the megalithic tombs in a given area has become far too rare an event despite the fact that this group of prehistoric monuments is one of the most imposing and frequently discussed in Europe. But now we can welcome a survey of the 484 known megalithic tombs of Sweden, which – apart from giving a lot of listed data – deals with numerous aspects of megalithic tombs. Nevertheless this book is not a survey comparable to Audrey Henshall's on the Scottish megalithic tombs: the survey is not provided with a catalogue proper or an analysis of the finds.

The main part of the thesis is a morphological analysis of the megalithic tombs, the various constructional elements being first defined, then the monuments grouped and divided into different types and sub-types by means of statistical methods. Then the chronology and spatial pattern of each type is thoroughly examined, as well as the location of the tombs in different types of land, related to topography and geology. A final chapter deals with the social and economical background. A number of appendices – for instance, many important distribution maps of the various types of graves – gives further documentation.

As mentioned, a catalogue proper is missing. This is certainly a failing in a monograph like this. However this lack is partly remedied by a complete list of the morphological traits of each tomb, as well as by plans of a large number of these, and a full list of all the finds with references to the litterature. Unfortunately the list of morphological traits is written as (computer) codes, which makes it very difficult to read unless one is willing to learn the codes. Also in analysing the different traits in the text itself these codes are used, making the reading of this part of the book unnecessarily slow.

When an archaeological material such as the megalithic tombs is studied, and especially when dealing with their spatial distribution and their evidence, for instance as to population background and its density, the assessment of representativity is of crucial importance. And here I believe the author underestimates the number of tombs obliterated by later agricultural or building activities. Even though he deals with the problem in a separate chapter (p. 12–15) the conclusions as to representativity, at least in the Scanian area, do not seem to be adequately founded. A very early systematic registration project carried out by the Danish National Museum in the second half of the last century yielded invaluable information about the number and location of tombs now destroyed and under plough. Of the known 7287 megalithic tombs in Denmark, only 2354 have survived (32%). Glimpses from older reports and maps however, show that also before the last half of the 19th century very many monuments must have disappeared. It seems to be a quite sound estimate of Klaus Ebbesen (quoted by Lars Blomqvist) that the number of megalithic tombs which have survived in Denmark are only about a tenth of the original number! A recent study of an area north of Copenhagen, in which were included older documents that have not come into the files of the National Museum, suggests that in certain regions the number of destroyed tombs considerably exceeds 10 times the preserved number preserved, or 3 times the number of known tombs.

What Lars Blomqvist does not make clear, is that there is in Sweden no survey comparable to the Danish one. Only well into the present century has a systematic registration scheme been implemented in Sweden. Accordingly there are not the same possibilities of evaluating representativity in Sweden as in Denmark. As to Scania, the part of Sweden closest to Denmark and partly with the same sort of landscape, we are told, without further documentation, that the estimated number of megalithic tombs should be only 50% higher than the 109 registered sites, and that there is no reason to transfer the frequency of destruction from Denmark to Sweden. Here I cannot agree, the differences between Zealand and neighbouring Scania cannot be that great (from 50% to 1000% or more), and as a matter of fact, there are in existence Swedish documents which hint at a similar destruction rate for Scania (e.g. in the Malmö area) as for Zealand.

It seems quite right however, that the destruction rate has been much lower in the west coast area of central Sweden, where the tombs are not situated in agricultural land, and where there are plenty of natural sources of stone for building materials.

The problems of representativity become most clear in chapter 7.3 dealing with burial intensity, where an attempt is made to calculate number of burials per generation in a given area. On page 177, the author estimates that the dolmens of Zealand have served 408 groups of people. But the number of dolmens used for the analysis is the known number, not the original number which must have been considerably higher, and even though reference is made to the work of Klaus Ebbesen, the author does not pay attention to that very conclusion. Accordingly, the mentioned estimate of groups involved is built on a false assumption. Furthermore the Danish and Swedish material is now compared directly in order to find differences in burial intensity, thus disregarding the earlier statement in the chapter on representativity, of differential destruction rate. One needs to consider both the different rates of destruction in the different Swedish regions and the various qualities of registrations.

One of the most important parts of the thesis is the computer analysis of the constructional elements – it is of great value that an objective and statistical method has been employed in order to define and separate the different types of megalithic tombs. This enables the author to draw very interesting conclusions as to the differential distribution of certain types of tombs and morphological traits in the following chapters. The dolmen is defined as a grave with a passage shorter than 2,0 or 1,7 m (according to region!), or no passage at all, including three subgroups, dolmens with rectangular chambers, dolmens with square chambers and dolmens with polygonal chambers. All passage tombs have passages longer than the lengths mentioned, and also here subgroups can be established, with regional differences, as in some areas the chamber is expanded, in others the passage. Also other constructional elements, such as the occurrence of sill-stones in the passage, are included in the analysis.

Even though such an objective way of treating an archaeological material is indeed very welcome, one often feels that this kind of computer analysis tells us what we have already been aware of for years. As a matter of fact the definitions do not differ very much from those of the Danish tombs presented by Sophus Müller in his book "Vor Oldtid" from 1897. And it comes certainly as no surprise that only few rectangular dolmens have a passage, or that no dolmens of this type have drywalling. As mentioned, it is the length of the passage which is the decisive factor in separating the dolmen and the passage grave. In Denmark the preference has been laid on defining a passage grave as having a passage whose axis is not in the extension of the axis of the chamber. The advantage of this definition is that it is not biased by tombs whose passage has been partly destroyed and therefore is shorter than was originally the case. The table on page 46 clearly shows that this definition could have been used to separate dolmens from passage graves. On the other hand the chosen definitions of the Swedish tombs seem to be a better tool for describing the local differences here. Even though there are some differences between Danish and Swedish megalithic tombs, and there are Danish local types unknown to Sweden, it is not explained why the classification is not applicable in Denmark.

Then the main elements are analysed. A very interesting chapter (p. 62–69) deals with the passage and the orientation of the entrance. When trying to evaluate whether the Neolithic people preferred specific directions, representing for instance sunrise at specific times of the year, it is essential not only to look at the tombs on a map, but to use the actual horizon, and that is what Lars Blomquist has done in collaboration with an astronomer. The result shows that there is no preferred orientation, only that easterly-south-easterly orientations predominate, hinting at an interest for sunrise in the period between February-March and October-November. Since the astronomical aspect of megalithic tombs is widely discussed by the interested public it is indeed praiseworthy that these problems are being dealt with seriously and objectively by a professional archaeologist. The same can be said about the analysis of the dimensions of the megalithic tombs, indicating that there is no positive proof that the claimed international unit "the Megalithic Yard" has been used.

A chapter (p. 94–110) deals with chronological aspects, and not surprisingly it is concluded that the simpler dolmens were erected in the early Neolithic, the larger dolmens at the transition early/middle Neolithic and the passage graves in the first part of the middle Neolithic.

An interesting point is that there are very few artifacts from the early part of the Corded Ware Culture in the megalithic tombs, hinting at a break in the burial tradition at this time. It is stated that the only place in Scandinavia, where there is evidence of a continuity of burial at the Funnel Beaker Culture/Single Grave Culture transition is the island of Zealand. But what about for instance the thick-butted hollow-bladed flint-axes, the B flint-axes, and tanged arrowheads, which are known from megalithic tombs in other parts of Denmark as well as from Scania? The complex problems of the Pitted Ware Culture in relation to the questions of continuity at this time are not considered.

Even though an examination of the pottery evidence obviously is not the subject of this thesis, the author concludes that the latest phase of the Funnel Beaker Culture (MN V) must have started already during MN I, and that there are no find combinations which contradict this. It is to be emphasised here, that even though the division of the middle Neolithic pottery styles made by Klaus Ebbesen have been disputed, this is supported by a number of settlement finds, showing that there is no possibility of MN V being simultaneous with MN I or the immediately following middle Neolithic periods and, furthermore, the radiocarbon datings published in an article quoted by the author clearly show, that there is not even an overlap between these datings of MN I and MN IV/V.

The relatively few radiocarbon datings of the megalithic tombs themselves are reviewed, and it is concluded that the megalithic tombs were built within a few hundred years around 3500 BC.

In a shorter section (4.4) the complex problems of the development which led to the building of the megalithic tombs are taken up. Initially we are told that the NW-French, English (what about the Scottish?) and Irish megalithic tombs belong to the same area of tradition. It is proposed that the spectacular trapezoidal (cultic) houses of Lepenski Vir could represent the origin of megalithic tombs since they are very similar in plan with some of those from the areas mentioned above. A totally superficial and purposeless comparison is made with Irish megalithic tombs. To include the houses of Lepenski Vir so far separated in time and space from megalithic tombs will confuse the complex discussion of the origin of megalithic tombs rather than stimulate it. Why go to Yugoslavia when in the late Mesolithic of Brittany we have a fair background for (local) development of the earliest and most impressive megalithic tradition of Europe?!

Also the the Danish earthen long barrows are mentioned in this connection, and their possible house-shape and the use of mortuary houses is underlined. But it is still a question to what extent the earthen long barrows have incorporated true mortuary houses. On page 113 a reconstruction drawing of a mortuary house from the Danish site at Rustrup is shown, but there is no mortuary house of this kind at the site – what is shown is a reconstruction drawing of a supposed mortuary house from the English Fussel's Lodge Long Barrow (an interpretation, which incidentally is questioned by a number of British scholars). This mistake could have been avoided if the author had used the Rustrup-publication proper, not a short, popular, preliminary one. On the same page, another short article of this type is quoted, although the site (Lindebjerg) has been fully published; nor is the thorough review article (in *Proceedings of* the Prehistoric Society no. 45, 1979) on the Danish earthen long barrows even mentioned.

The author is more succesful when approaching the Scandinavian megalithic material: the development of the Danish dolmens is shortly mentioned, and the differences between the Swedish and the Danish tombs are discussed, the relatively high degree of uniformity of the Swedish megalithic tombs is seen against the background of the greater variation among the Danish ones. Also some morphological traits are separated and their Danish or German background considered.

It is of interest to learn that in the Swedish West Coast region it was the long passage which "grew", while in Scania the chamber was enlarged. But within a relatively short period of time the two elements seem to have been considered equal; and it is at about this time that the impressive number of passage tombs of the Fallbygden region was erected.

The morphological/typological analysis of the megalithic tombs enables the author to draw interesting conclusions as to local traits and the individual areas of innovation and development. For instance, the morphological analysis has demonstrated that the West Coast region did not seem to have much contact with Scania, but rather with North Jutland, and also the relative paucity of finds in the megalithic tombs links these two areas (here a study of the evidence of pottery and other artifact types could probably have accentuated this link). The constructional elements in Scania show connections with Denmark as well as Northern Germany.

Also the chapter on the topographical situation of the tombs and their relation to soil-type is worth mentioning.

The final chapter on social and economic behaviour is doubtless the weakest part of the book. It begins with a section expressing some generalities as to the possible vehicles of sea transport, and transport times between different regions, which does not give us any better insight. Some of the known evidence of local traits within the Funnel Beaker Culture is quoted, and a map showing different areas of tradition is presented (page 172). There is nothing, however, which justifies the exact mapping of the foci of these areas, at least as regards Denmark. Why, for instance, is the alleged centre of the n-e Danish area placed on Southern Zealand, when the distribution of a peculiarity of the shape of certain passage grave chambers and a special pottery ornament show "points of gravity" respectively in the Smålands Sea and in the Baltic South East of the Island of Falster – how can we talk about centres when different local cultural traits show diverging distributions? In the map the North German area south of the Baltic Sea is not included, even though the pottery evidence and tomb morphology demonstrates that the southernmost Danish isles and this area might belong to the same "area of tradition". A particular ornamental pattern – checkerboard ornamentation – has its "point of gravity" in the Baltic Sea South of Scania with finds in Scania, South-east Zealand, Møn, Bornholm and Rügen, thus hinting at other "areas of tradition" than those proposed by the map.

The following section (p. 173–179) is an attempt to determine the intensity of burial during the time of the Funnel Beaker Culture and to find regional and chronological differences in this intensity. The analysis and conclusions, however, are built upon presumptions which go much further than our factual evidence. We have already touched upon the problems of representativity. The author estimates that a dolmen was made to contain 1–4 bodies, the passage tombs 10–20. The number of burials is probably not an unsound estimate; but it is a crucial problem, that so very, very few tombs have yielded properly analysed skeletal material. We have no information which can reveal to us whether the burial rate in a single community remained the same during the period in question or not, and we cannot say whether there might have been different ritual attitudes affecting the number of individuals buried in the tombs. We do not know to what extent the dolmens were used for burials during the middle Neolithic period, but the Danish Klokkehøj evidence (quoted by the author) demonstrates clearly that this can be the case. This Klokkehøj evidence of intensive middle neolithic use of dolmens is mentioned, but it does not find its way into the analysis proper.

We are told that the (possible) lack of burial continuity at the beginning of the Single Grave Culture might be due to lack of space – the chambers were now filled up with bodies. But the evidence and possibility of burials of excarnated bones or the removal of bones which is documented and discussed in the quoted Klokkehøj publication is not considered. When dealing with issues like burial intensity and demography it is astonishing to find that the most successful studies of this kind (from Orkney, and here to a much larger extent built upon factual data) are not even quoted.

The assessed numbers of burial and the burial intensity are reviewed on the known number of tombs in Denmark and Sweden. But due to differential regional obliteration rates and very different quality of recording of megalithic tombs, the sources of error are staggering and the different sets of data are incompatible. Incidentally the author seems to compare the numbers of passage graves in the two countries directly, even though his definition disagrees with the current Danish one.

The conclusion, that the intensity of burial at the beginning of the Middle Neolithic in Denmark either dropped or was unchanged, whereas in Sweden it increased, is therefore built on a chain of hypothetical assessments. It must be admitted, however, that the author himself ends this section recapitulating that "the sources of error are too great to draw conclusions from the megalithic tombs themselves by such calculations" (p. 179).

The next section (p. 179–184) deals with the labour involved in and the economy underlying the construction of the megalithic tombs. The complex problems of neolithisation and the use of the environment at the time of the megalithic tombs are dealt with in a couple of pages!! However, new and fresh thoughts are expressed as to the labour involved in the opening of the forest, the number of animals and their "output" of calories needed for a society building a megalithic tomb and the land necessary for this production. The Fallbygden region is of special interest in this respect, since almost all the tombs here are of the developed passage grave type, hinting that they were built during a relatively short period of time. Considering the possible intensity of burial seen in relation to the potentialities of this region, the population estimate has indeed very wide brackets – between 500 and 12000 individuals. Blomqvist makes it quite clear how this great span shows the difficulties in making calculations of population. Nevertheless, it is much more stimulating to see calculations based on data from one local area, rather than comparing areas in a way involving too many sources of error.

A final section deals with the hypothesis that the megalithic tombs can be regarded as territorial markers. With some justification the author criticises the Swedish attempts, but he does not mention the Danish attempts to see clusterings reflecting tribal territories, although the article on this problem is quoted in the literature list. It is also surprising that he has not taken any notice of the very interesting literature on this aspect of the megalithic tombs in The British Isles (especially Orkney), where both chronology and spatial distribution are considered. Blomqvist's only non-Swedish reference to this issue is a popular book on the Carbon-14 revolution. Even though there are many problems with the notions of megalithic tombs serving as territorial foci, Blomqvist seems to go too far by simply rejecting the matter as merely hypotheses and speculations, especially in view of the fact that quite a number of the preceding pages in his own work is of a speculative nature.

The basic parts of this thesis are fundamentally sound, but in the wish to touch upon almost *all* aspects related to megalithic tombs, the quality sometimes tends to become uneven, and not in all cases has the author given himself enough time to become acquainted with the relevant and fundamental literature outside Sweden.

Flemming Kaul

ALAN SAVILLE *(et al.) Hazleton North: the excavation of a Neolithic long cairn of the Cotswold-Severn group*. English Heritage Archaeological Report no. 13. London 1990. 281 pp.

This lavish report is on the complete excavation of a large megalithic burial cairn of the Severn-Cotswold group. Perhaps it is the most complete and detailed report of its kind that has ever appeared. There are 281 pages of text and 234 consecutively numbered figures, and a series of specialist reports on the human and animal bones, the plant and molluscan remains, the soils, geological aspects, a geophysical survey, and the radiocarbon dates. One loses count of the number of plans and sections, but obviously they have been drawn in enormous detail in the field and have been re-drawn most professionally for the publication. Eight of them are large pullout plans. One of these shows the 53 m long and up to 19 m wide cairn after removal of the topsoil, with all stones down to a size of about 3 cm drawn. According to my calculation there are between 100,000 and 200,000 stones in this plan alone. Fortunately we are not given equally detailed plans for every 20 cm down through the mass of stones, but the three-dimensional aspect is well dealt with through the section drawings. There are also many plans of particular parts of the construction like the internal walling or the original outer revetment and collapsed material outside it, and explanatory plans illustrating questions dealt with in the text. Not least impressive are the plans of the chambers, both the master plans with all bones superimposed and the simplified plans showing details, as for instance skulls or femurs, or bones that could be compaired. There are a very large number of excellent and informative photographs, which not only back up the explanations in the text, but show that the site was always neat and tidy and the weather unfailingly ideal for archaeological photography. There are several contributors, but Alan Saville is cited alone as author. Not a cheap excavation or a cheap publication.

The monument was a cairn built of slabs of limestone, prized out of quarries on both sides of the cairn. It was built in roughly rectangular areas along both sides an axial spine following a system that must have been rather like building in bays outlined by rows of stakes, a method that has been reported at sites in both Denmark and England. The outside of the cairn was bounded by a neat dry wall, which originally increased in height towards the wide "proximal" end of the cairn. At this end there were projecting "horns" and a blank concave facade, as in many other Severn-Cotswold tombs, while the chambers were in the middle of the sides. A large and consistent series of C14 dates places Hazleton North soon after 3000 bc uncalibrated, so it was roughly the same age as the earliest mortuary structures in Denmark.

The most interesting part was the two burial chambers in the middle of the north and south sides. Each had an entrance, a passage, and a chamber, separated by jambs and/or sills. It is symptomatic of the high standard of the excavation that a long section was drawn right down a passage that was only a meter wide.

At the West Kennett long barrow Piggott set out the theory that whole bodies were put in the chambers, but while or after they decayed parts of them were 'borrowed' to be used at rituals taking place elsewhere, perhaps at the causewayed enclosures, where scattered human bones are not uncommon. It was skulls and long bones that there was most use for, and they were not always returned. The consequence of this activity was both that the skeletons were disturbed and that they were very incomplete, with skulls and long bones being the most underrepresented. This is not an "ossuary theory". The ossuary theory is that bones are defleshed (or excarnated) elsewhere, and laid in for the first time as skeletal parts. The West Kennett theory is that whole bodies were put in the chambers, and parts of them later taken out again.

It has been surprisingly difficult to find support anywhere except West Kennett for this very attractive theory, but conditions could hardly be better than at Hazleton North, where if the results are disappointing, it can be that the archaeologists were so centred on excavational finesses that they forget the important things. Reading the report it is in all events evident that there had been a lot of rummaging around in the chambers and passage, and the bones were very broken and in a confused mass, except for one or two final burials in the north entrance area. It was not only dry bones, but also coherent bits of corpses that got pushed around. This rummaging was not merely an incidental accompaniment to the deposition of new corpses (another of the possible theories), for it had been done most thoroughly in places where there were no new corpses.

Despite the space taken up, we are not given enough raw data to judge for ourselves. It seems fairly clear that only a little survived of each corpse (except the last ones), but it seems at the same time that all parts of the skeletons were roughly equally represented. In all events there is no very significant excess of patellas, though there may be of foot bones. Other small bones of the body are not dealt with. One must therefore accept that no consistent pattern has been demonstrated involving the removal of skulls and long bones and leaving behind of uninteresting bones like ribs, knee caps, scapulae, or vertebrae. No doubt the fragmentary condition of a lot of the material made it very difficult to deal adequately with these questions, but the authors seem uninterested, and even unaware of the West Kennett long barrow and the various views that exist. In all events the placing of several skulls a little inwards from the entrance does look like the return of the witch-doctor's requisites. In contrast with the later Danish collective tombs, very few grave goods were put in with the bodies.

This book raises the question how detailed an archaeological report ought to be. Excavations of objects like this generally appear in 25-35 page articles and still contain enough documentation to satisfy most archaeological readers, but that way we would have been deprived of many of the photographs. The vast majority of readers will certainly skip over a lot of this book, and with such a wealth of detail may well find it difficult to find exactly the information they think important. On the other hand the excavation was obviously superb, carried out and recorded with perfect consistency, so perhaps for once it was worth devoting so much time and money to post-excavation and publication. This was definitely an excavator's excavation. Perhaps English Heritage should also have invested in a ghost-writer, who with a fresh mind could have unravelled some of the problems that arise when even the best excavators are over-familiar with their subject, and made it also into a readers' report.

David Liversage

TERESA DĄBROWSKA: *Wczesne fazy kultury przeworskiej. Chronologia – Zasięg – powiązania* (Frühstufen der Przeworsk-Kultur. Chronologie – Gebiet – Verbindungen). Państwowe Wydawnictwo Naukowe, Warszawa 1988, 339 pp.

One could long have wished for a successor to Józef Kostrzewski's "Die Ostgermanische Kultur..." (1919). Late pre-Roman chronology builds largely on forms with their main distribution east of the Oder, just as the myth of eastern elements in north Jutland and in particular in the Kraghede material, has been mooted for nearly a century.

Now the successor has almost come. Teresa Dąbrowska's new book "Wczesne fazy..." (The Early Phases of the Przeworsk Culture) gives a really good up-to-date survey, but one thing is lacking to succeed Kostrzewski, the language. Even the by East European standards very full German resumé of 20 pages cannot compensate. The work will remain inaccessible to the majority of west European scholars. This is much to be regretted, as Polish research has progressed far since the days of Kostrzewski, and the Przeworsk finds are so rich and varied that in many ways they provide a key to the problems of late pre-Roman times in northern Europe. This is not the only recent key Polish work that has appeared in this way. The series, Prahistoria Ziem Polskich (Prehistory of the Lands of Poland, Warsaw 1975–81), a fine scholarly survey, appeared in Polish, without resumés in other languages, and in so small an edition that only local demand could be satisfied. The references in Dąbrowska's book tell the same story - a mass of weighty studies only a few of which have been made available to the west European readership. One may hope that the new political opening in the East will lead to a similar opening in archaeology.

The aim of the book is not to set up new typologies – that has been done in full measure by generations of Polish and German scholars (including the author herself). The aim is rather to trace the Przeworsk Culture's origins and cultural relations. We begin (chapter II) with a short account of the present state of research on the chronology of the later pre-Roman Iron Age. In Poland this is called period "A" following Eggers, and it is subdivided into the three phases A_1, A_2, and A_3. These can be further sub-divided – a pure A_2, a transitional period A_2/A_3, a pure A_3, and a more problematical transitional phase A_3/B_1. The principal leading forms are still fibulae and weapons, although pottery, belt fittings, and ornaments play a role. The chronology is supported by an enviably long series of large, well excavated cemeteries. In terms of absolute chronology the beginning of A_1 is placed at the end of the 3rd century B.C., of A_2 in the middle of the second half of the second century B.C., and A_3 begins in the middle of the last century B.C. and continues into the first decades of our era. Each phase thus lasts about 75 years, and the sub-phases last for about a generation. It can be objected that not enough attention is given to the settlement material and this creates unnecessary uncertainty about some conclusions later in the work. The detailed chronology provides, however, a good basis of cultural historical interpretations, and the discussion of cultural contacts and currents adds a new dimension. This is also intended.

To begin with, the distribution of the Przeworsk Culture is analyzed in relation to the fine chronology. It is found that by and large the culture occupied from the beginning the area it was later to fill, though the earliest graves appear to be concentrated to Silesia and Kujavia (chapt. III). In Silesia the Przeworsk Culture took over from the regional La Tène group, while the remaining areas, i.e. central Poland, Kujavia and Mazovia, had until then been occupied by the Pomeranian Culture (also known as the Bell-Grave culture) (chapt. IV). The relation between these two cultures has always been a problem for Polish archaeology. From the German side it was before the war maintained that there was a clear cultural and demographic break (e.g. von Richthofen 1930), while from the Polish side a gradual and continuous development was postulated (e.g. Kostrzewski 1965). The discussion, which was coloured by the geopolitical situation, to some extent died with the scholars of the

Kossina school (of whom Kostrzewski ironically enough was one) (Martens 1988). T. Dąbrowska has returned to the matter and shows here that an earlier Pomeranian presence can only be shown on 5% of all the Przeworsk sites. At most of these the Przeworsk occupation does not begin until period A_2 or A_3. If the succession were gradual then, it could only be documented at considerably less than 5% of the total Przeworsk sites! One could add here that 5% is so few that the co-existence can rest on factors no less haphazard than the occurrence of Neolithic pottery on the same sites would be. However, Dąbrowska goes a little further, and points to a little group of sites where she is of the opinion that peaceful co-existence between bearers of the Przeworsk and Pomeranian cultures can be shown into period A_2 (pp. 97–99). The relationship with the surrounding cultures must have been different, for the Przeworsk Culture clearly surrounded itself with a broad, uninhabited buffer zone.

In the succeeding chapters (V-VII) the author considers the pre-Roman Przeworsk Culture's complex mesh of contacts with the outside world – the Celts, the Jastorf Culture, northern Jutland, the Poieneşti-Łukaševka Culture, and the Mediterranean. Here we will only take note of the northern contacts. These have been dealt with separately by the same author in German after the book had gone to press in 1984 (Dabrowska 1988). As this article in some ways complements the book it will be included here.

The synchronization of the different regional chronologies is not dealt with at any one place in the book. Nevertheless the following picture can be extracted (see in particular pp. 193–94):

	La Tène	Przeworsk	Jastorf	Jutland (north)
225 B.C.				
	C_1	A_1	Ripdorf IIa	II
	C_2		Ripdorf IIb	IIIa
125 B.C.				
	D_1	A_2	Seedorf IIc	IIIa
50 B.C.				
	D_2	A_3	Seedorf IId	IIIb
A.D. 10–20				
	EARLY ROMAN IRON AGE			

The periodisation of the Jastorf Culture follows Hingst 1959.

It can be seen that there is a considerable difference between this view and that of C. J. Becker (most recently 1980, 56, fig. 1), where period IIIa is equated with Seedorf and the entire pre-Roman phase of the Przeworsk Culture. Dabrowska explains the difference with the argument that fibulae with bulbs on the bow (*Kugelfibeln*) are dated to period IIIa in Denmark. Furthermore the Przeworsk-influenced Latènisation tendencies like rich grave furnishings and weapon graves first appear at a late stage in period IIIa, with find combinations that would best be described as A_2 in Przeworsk terms. As A_1 in recent Polish archaeology is synchronized with Hingst's phases IIa/IIb (e.g. Wolągewicz 1982, 84–85), the same follows for the early part of IIIa, or part of it.

The problem in judging these suggested synchronizations is, unfortunately, that the Danish material fails us, especially in Jutland. There are simply no well furnished graves with leading forms from the early period. However at Kraghede in grave A-1 there was found an iron fibula of Kostrzewski's B construction. B fibulae are a leading type of period A_1, but can also be found in A_2. The later ones are usually short (<8 cm; *Wczesne fazy...* 15–19). The one from Kraghede lacks the foot, but even without it measures 10 cm. Whether the fibula dates the context is an open question, as the pottery from the grave is highly atypical for its usual dating (Becker 1961, 261; Martens 1989). Another early find is the two-edged sword in Kraghede grave 3, which to judge from illustrations (Klindt-Jensen 1949, fig. 13) seems to agree with Kostrzewski's type I. Dąbrowska dates this type mainly to A_1, but indicates that it may occasionally occur in A_2. As only a jar with two handles (Klindt-Jensen 1949, fig. 29a) is published out of the five pots and iron knife found in this grave, the dating of the grave remains somewhat unclear. The problem of synchronization is all the more frustrating because the finds from Bornholm, the only material in which a substantial number of interregional metal forms are known, are either unpublished or put forward in a confusing manner (but see note).

It is a problem for late pre-Roman studies in Denmark that well dated graves from period IIIA are virtually absent. This cannot be explained away only as lack of research. Graves of this period are rare because they are most frequently found alone and are therefore difficult to localise (Funen and Bornholm are exceptions to the rule). This should not make one give up – on the contrary the search for the missing graves from period II and IIIa should be intensified and the existing material be published, especially now that so much is known about the settlements. It can be of vital importance for the understanding of possible influences from the south-east.

Dąbrowska's discussion of north Jutland contacts (called "Jastorf" in the book, 167–75) is naturally affected by the poor state of publication in Jutland. It seems likely that the distribution map of Przeworsk-like pottey in Denmark (Dąbrowska 1988, fig. 4, 201) is mainly an expression of how Danish research has focussed in south and central Jutland on the typical and in Vendsyssel on the atypical (Becker 1961; Klindt-Jensen 1949; Martens 1989). In burial customs, however, the special character of north Jutland still seems valid. Dąbrowska points out that the earliest weapon forms in north Jutland can be dated to A_2 (single-edged sword, shield bosses like Bohnsack 3 and 4). On Bornholm earlier forms are present (from A_1), and this should show the direction of movement of the influences. However single-edged swords are most common in the Przeworsk Culture's northern neighbour, Oksywia, so the inspiration could just as well come from this quarter. Against this argues, according to Dąbrowska, the use of pit cremation in both north Jutland and the Przeworsk Culture, in contrast with the Oksywia weapon graves, which are always urn burials. Here however the author forgets that pit cremation had been the rule in Vendsyssel since the latest Bronze Age (Becker 1980).

Equally interesting for Danish archaeologists is the existence of 'Jastorf' pottery in Przeworsk contexts and still further to the south-east. This exotic pottery, which clearly has parallels in period II/IIIa of Jutland, occurs at Przeworsk settlements, which are almost as little known as the cemeteries are familiar. Other "Jastorf" influences mentioned by Dąbrowska are bulb-on-bow fibulae and crown neck-rings. Also clay "fire-dogs" and decorated hearths are cited as traits of both cultures. These external elements in the otherwise so homogeneous Przeworsk complex are encountered particularly in the NE part of its area. Here also occur wetland deposits, a type of discovery otherwise unknown in the region.

On the base of these external elements, which seem concentrated in the early phase of the culture, the author closes with the following culturel historical thesis (chapt. IX). The Przeworsk Culture takes form in the region against the background of the cultural disturbance brought about by the migration of the Bastarnae through the area at the transition to the late pre-Roman Iron Age. According to the written records these people make their appearance on the BlackSea coast just when the Poineşti-Lukaševka Culture with its Jastorf traits and the Przeworsk Culture first appear. No less interesting is the way the author points out that the Przeworsk Culture is more closely linked to distant regions than to its own immediate neighbours. The resulting judgement that the underlying cause lies in the political alliances of the times, is set out with noteworthy caution by the author (Dąbrowska 1988, 194) – a point otherwise calling for a considerably more advanced political system than generally attributed to the period.

In general the book would have gained by having a larger number of illustrations, as one needs to have a considerable library at hand in order to follow her analysis and comparisons. Teresa Dąbrowska's new book is beyond doubt a major contribution to pre-Roman archaeology from one of Poland's leading scholars. Let us hope it soon appears in German or English translation, so it can take its rightful place among the definitive works of the subject [translated by D. Liversage].

Jes Martens

NOTE

After completion of the review appeared the publication of the pre-Roman graves from Nørre Sandegård on Bornholm (Becker 1990). It seems to support the above proposals for synchronization.

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MARGARETA BESKOW SJÖBERG (ed.): *Ölands järnåldersgravfält,* Vol. I. Riksantikvarieämbetet och Statens Historiska Museer, Kalmar 1987. 438 pp. in *quarto* with numerous maps and illustrations.

This is the first of a four-volume work in which Öland's thousands of Iron Age graves will be presented collectively for the first time. This volume begins with the parishes of Alböke, Köping, Räppling, Löt, Egby, Bredsätra, and Gärdslösa, seven parishes and seven chapters, each constructed like a nest of Chinese boxes. Each chapter begins with a presentation of the parish in question, its topography, geology, and history, from which the view is gradually brought closer. A survey of recorded sites with graves is followed by a individual description of the graves accompanied by determinations of the extensive osteological material; this is supplemented by a list of the finds of graves that were not properly investigated. There follow descriptions and illustrations of the contents of each grave (most of the objects are shown at scale 1:1). Each chapter ends with a summary in Swedish and English of the Iron Age graves in the parish, including their topographical situation and chronological spacing. All chapters are illustrated with numerous photographs, drawings of finds, and plans/maps.

The book's last chapter, to which there also is an English translation, is not merely a summary, but takes up a number of central questions concerning Iron Age settlement and its relationship to the graves. In this chapter there is a fine series of maps, not only of the graves, but also of dated settlement sites from the older and younger Iron Ages, objects of gold of the later Roman Iron Age and Migration Period, and silver objects from the Viking Age. The area of study has the further advantage that it includes Skedemosse with its large Iron Age ritual deposits. In other words the chapter opens for a series of questions which unavoidably arise in a "parish survey" of this kind. The book is more than a catalogue because it deals with a series of central questions connected with Öland's Iron Age.

The considerable work going into the publication was carried out by a project group consisting of many specialists whose work has made them familiar with the parish they deal with. This has not only made an undertaking of this size possible, but has brought it up on a level that would otherwise have been difficult to reach. On the other hand enough central direction has to be retained to ensure that uniformity and perspective are not lost in detail. The book lives fully up to this requirement.

With this publications Swedish archaeologists have wished to open up for studies of Öland's rich Iron Age, and have done so in a way that will answer most of the questions Iron Age scholars will wish to ask for many years to come, many of which are entered into in the last chapter. Also the book with its systematic arrangement is easy to find one's way around in and has excellent maps, all relevant references to the literature, an abundance of drawings of objects found (here direct cross-references between descriptions and illustrations would have been an advantage), and a careful account of its own preconditions. This is the beginning of a large and important project, whose continuation and completion are awaited with expectation. And last but not least – the book is beautiful! [Translated by D. Liversage].

Lotte Hedeager

Danmarks længste udgravning. Arkæologi på naturgassens vej 1979–86 (The longest excavation in Denmark. Archaeology along the natural gas pipeline 1979–86). Udgivet af Nationalmuseet og de danske naturgasselskaber. Poul Kristensens Forlag, Herning. 1987. 516 pp. With summaries in English.

Our Danish collegues got a great chance for large archaeological survey of their country in combination with small excavations when in 1979 the Parliament decided the major part of the danish energy-supply to be based on natural gas. The investigations were due to a cooperation between the gas companies and the archaeological authorities: the pipeline in the projection phase should be placed with greatest consideration for the protected monuments and time was left for reconnaissance surveys and trial excavations before the final work with the pipeline was done. Sometimes the route of the gaspipe had to be moved because of the risk to disturb important archaeological remains on the line or nearby. This happend e.g. in the Gudme-region, south-east Funen, to spare an area which was a centre of cult and trading in the Germanic Iron Age.

The pipelines were laid from Frøslev in the south to Viborg in the north and from the North Sea in the west to Copenhagen in the east, that means a length of about 3000 km including all criss-crossed ditches completed up to 1986 with a width of 10–20 m in an average. In the beginning the responsibility for all scientific efforts lay with the Archaeological Office, but later it was transferred to the Archaeological Secreteriat of the State Antiquary for coordination. Most of the actual fieldwork however, had to be carried out all over the country, by the local museums whose members even wrote the reports concerning 250 excavations with areas from 200 m2 to more than 1000 m2: the actual work was done in the field. It still continues (in particular in north Jutland: 500 ff.) as all small distribution lines have not yet been laid.

The book now published on the investigations caused by the main pipeline-project is not only a well arranged collection of all or at least the more important reports in the topographical section as the most valuable part of the publication. At the same time it contains larger contributions in form of a more common introduction to archaeological fieldwork (e.g. 9 ff.: 'About the Finding of Hidden Relics of the Past – in Time'; 21 ff.: 'If you learn to use your eyes...'; 87 ff.: 'Holes in the Ground') as well as an outline of Danish prehistory in essential part already known without the news from the gasline (e.g. 37 ff.: 'The Prehistory of Denmark – after the Natural Gas'; 107 ff.: 'Medieval Pottery'). Furthermore small essays of common importance are incorporated (e.g. 10: 'The Past and the Law'; 132: 'Building with Stone in the Middle Ages'; 162: 'The Runic Stone from Snoldelev'; 308: 'Construction-work and Archaeology'; 372: 'Bronze Casting'; 411: 'Animal Bones from Archaeological Excavations'; 417: 'Ridged Fields and Ploughing Furrows in Denmark') and even short special remarks on archaeological methods (e.g. 12: 'Geophysical Prospections'; 14: 'Phosphate Analysis'; 94 ff.: 'Thousands of Potsherds'; 101: 'Thermoluminescence Dating'; 256: 'Computers and Excavations'; 305: 'Dendrochronology'; 316: 'Radiocarbon Dating'; 359: 'Pollen Analysis'; 400: 'Metal Detections'). All the mentioned articles up to now are of course published in Danish but there is no difficulty for a foreigner to take part in the conclusions as detailed summaries or in some cases even English versions follow pp. 423 to 484 and 513 to 516.

The main topographical part (pp. 113 to 422) is only given in a Danish version but there are English translations of the illustration-texts. This part covers about 1700 findplaces in all, most of them unknown before the start of the gasline project and some only seldom visible on the surface. First field observations brought the basic information for the researches between the coursefixing of a pipestretch and the bringing down of the pipes. By this method a lot of sites could be located and investigated, but it was almost impossible to identify bog offerings and other objects covered e.g. by a layer of sand. Therefore a large number of trial excavations had to be carried out with the result that only about a fifth of them extended to full excavations. With a width of a least 10 metres and a length of some 3000 kilometres an area of more than 30 square kilometres has been investigated. About 1700 relics were registered. That means nearly 60 objects per square kilometre. Before the gas project, only about three sites per square kilometre were known in the Danish territory. This comparison may be one of the most important results of the described work as it brings an idea of how much archaeological material still remains below the surface in the open country.

Of course it is impossible to mention all the more important sites discovered during the preparation of the gasline in a short review like this. But some must be named.

First of all it should be noted, that relics of settlements formed the overwhelming part of the sites – about 650. In some extent they are characterised by flint objects up to the Iron Age. In terms of chronology not all periods are equally represented. So settlements from the Neolithic are richly documented in the reconnaissance material, but only few of them were worth an excavation, so a 15 m long and 6 m wide two-aisled long-house at Ornehus, Præstø amt (site no. 413) from the Passage Grave period or the Dolmen period. Settlement finds from the Early Bronze Age are rare but such from the Late Bronze Age were discovered in large quantity with three-aisled houses mainly 15–30 m long. Most houses however belong to the younger periods, i.e. especially to the Iron Age, but even there no spectacular features came to light. The longest found in Bække, Ribe amt (site no. 1422), measured 50.5 m. From the Middle Ages only about 35 sites are reported at all, some of them remains of deserted villages.

Closely related to the settlements is a cult house from the Bronze Age (site no. 4) from Sandagergård, Frederiksborg amt. This had a double stoneframe of 18,5 x 7,5 m with a thin culture layer and three urn graves inside, all dating to period IV. Just south of this probably ritual structure and in obvious connection with the building there were found two or three menhirs and four stones with rock carvings showing raised hands (adorating).

Further noteworthy discoveries are a three-aisled long-house under a Bronze Age barrow at Byhøj, Sorø amt (site no. 336), a Bronze Age hoard with new and broken objects from Lindø, Odense amt (site no. 440) – important because hoards normally turn up by chance, a Viking Age grave with two horses and four dogs (maybe indicating special forms of hunting) from Stavrby, Odense amt (site no. 549) and a large village in Katrinelund, Skanderborg amt (site no. 1072) of Migration Period date – a period from which settlements generally are difficult to recognize.

Altogether the picture of the Danish prehistory has not been revolutionised by the researches in connection with the gasline – the density of sites, however, has grown considerably and the work is still in progress. Our Danish collegues had a unique chance and they took it up. As a published result they produced a multicomponent book, including some archaeological highlights, which is a well made and welcome treasure for everyone interested in the prehistory of northern Europe.

Torsten Capelle

Book Chronicle

Books received in 1989

Bekker-Nielsen, H. & Nielsen, H.F.: *Beretning fra syvende tværfaglige vikingesymposium. Odense Universitet 1988.* Forlaget Hikuin & Afdelingen for Middelalder-arkæologi, Aarhus Universitet, 1989. 55pp. (orders to: Forlaget Hikuin, Moesgård, DK.8270 Højbjerg)

This modest series of reports has been issued annually since 1982 presenting three papers selected among those read at the annual inter-disciplinary Viking symposium held in turn in Aarhus, Odense, and Copenhagen. Papers are in both English and Scandinavian languages. The scope of the symposia is the whole of the Viking sphere, including Scandinavia, the British Isles and the North Atlantic Islands.

Hingst, Hans: *Urnenfriedhöfe der vorrömischen Eisenzeit aus Südostholstein* (Urnenfriedhöfe Schleswig-Holsteins Band 12). Offa.Bücher, Band 67. Karl Wachholtz Verlag, Neumünster 1989. 274pp. 133 plates, 29 maps.

Nine recently investigated urn cemeteries in southeastern Holstein illustrate aspects of social differentiation and regional group formation from the Pre-Roman to the Roman Iron Age.

Lagler, Kerstin: *Sörup II und Südensee. Zwei eisenzeitliche Urnenfriedhöfe in Angeln* (Urnenfriedhöfe Schleswig-Holsteins Band 13). Offa-Bücher, Band 68. Karl Wachholtz Verlag, Neumünster 1989. 121pp, 77 maps, 65 plates.

The publication of two Iron Age cemeteries in Schleswig: Sörup II (184 graves) and Südensee (265 graves). Camparisons are made with contemporary urn grave cemeteries on Funen, Denmark. Interpretations are suggested regarding social group and sex of the deceased.

Larsson, Lars: *The Skateholm Projekt. I, Man an Environment.* Acta Regiae Societatis humaniorum litterarum lundensis LXXIX. Almqvist & Wiksell, Stockholm, 1988. 180 pp.

Interdisciplinary studies of palaeoenvironment, fauna, and human dentition relating to the settlement and grave finds from the Late Mesolithic site at Skateholm in South Scania, Sweden.

Liebgott, Niels-Knud: *Dansk Middelalderarkæologi.* G.E.C. Gad, Kobenhavn 1989. 344 pp.

The results of medieval archaeology in Denmark since 1950. This well-illustrated book is written entirely in Danish but has many references.

Madsen, Torsten (ed.): *Multivariate Archaeology. Numerical Approaches in Scandinavian Archaeology.* Jutland Archaeological Society Publications XXI (distributed by Aarhus University Press), 1988. 151pp.

Eleven papers exercise the use of multivariate statistical Methods in archaelology. The problems treated include typology, chronology, and distribution, and the methods are employed on complex archaeological material from sites as wide apart as Arctic Norway and The Arabian Gulf.

Mikkelsen, Vald. M.: *The Commons of Rejnstrup, Denmark. The exploitation of marginal land from antiquity to present time and its influence on the vegetation.* The Royal Danish Academy of Sciences an Letters, Biologiske Skrifter 33. Munksgaard, Copenhagen 1989. 34pp.

Archaeological and palynological investigations together with studies of archives illuminate the vegetational history and the exploitation of an area of 190 ha from the Neolithic to present times.

Mortensen, P. & Rasmussen, B.M.(eds.): *Jernalderens Stammesamfund. Fra stamme til Stat i Danmark 1.* Jutland Archaeological Society Publications XXII (distribution by Aarhus University Press), 1988. 149pp. Summaries.

Thr first volume of a series of publications resulting from the Danish research programme "Fra Stamme til Stat" (from tribe to state). Nine papers deal with problems of chronology, regional variation, army equipment, transport, economy, and ethnoarchaeology.

Poulsen, Jens (ed.): *Regionale forhold i Nordisk Bronzealder.* Jutland Archaeological Society Publications vol. XXIV, 1989. 188pp. Distribution: Aarhus University Press.

Report of the 5th Nordic Symposium on Bronze Age Studies, Sandbjerg 1987. It Contains 20 papers by Scandinavian and German Bronze Age specialists. Two papers are written in English and 18 in Scandinavian languages with summaries in English.

Street, Martin: *Jäger und Schamanen. Bedburg - Königshoven, ein Wohnplatz am Niederrhein vor 10000 Jahren.* Römisch-Germanisches Zentralmuseum, Mainz 1989. 55pp.

Short, well-illustrated report on the finds from a Pre-Boreal hunting camp found in an open-cast coal-mining district near Münchengladbach on the Lower Rhine.

Walton, Penelope: *Textiles, Cordage and Raw Fibre from 16-22 Coppergate.* The Archaeology of York, Volume 17: The Small Finds, Fascicule 5. Published for the York Archaeological Trust by the Council for British Archaeology. Dorchester, 1989. 169pp, 19 plates, 1 microfiche (with diagrams).

Under study are 211 samples of raw fibre, cordage and wool, silk an linen textiles from the Anglo-Scandinavian and medieval levels at Coppergate, including the first British find of a Viking sock.